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Sensors and Sensor Networks (Sensors)

Program Solicitation
NSF 05-526
***Replaces Document* NSF 04-522**

National Science Foundation
Directorate for Engineering
Directorate for Geosciences
Office of Polar Programs

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

March 03, 2005

REVISIONS AND UPDATES

The anticipated funding amount from the Directorate for Engineering has been reduced to $20,000,000. That amount has been inserted in the "Award Information" sections in the program solicitation.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Sensors and Sensor Networks (Sensors)

Synopsis of Program:

The National Science Foundation (NSF), through the Directorate for Engineering, the Directorate for Geosciences, and the Office of Polar Programs, announces a broad interdisciplinary program of research and education in the area of advanced sensor development. This solicitation seeks to advance fundamental knowledge in engineering of materials, concepts and designs for new sensors; networked sensor systems in a distributed environment; terrestrial, atmospheric, and aquatic environmental analysis; the integration of sensors into engineered systems; and the interpretation and use of sensor data in decision-making processes. The Directorate for Mathematical and Physical Sciences, the Directorate for Education and Human Resources, and the Directorate for Social, Behavioral, and Economic Sciences plan to participate in the reviews and identify proposals of mutual interest and may provide co-funding for programs of high quality that meet their programmatic requirements.

Please note that this is a much narrower solicitation than its predecessor, NSF 04-522. Proposals outside the scope of the topical areas described in this solicitation are subject to return without review.

Cognizant Program Officer(s):

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

- 47.041 --- Engineering
- 47.050 --- Geosciences
- 47.078 --- Office of Polar Programs

Eligibility Information

- **Organization Limit:**

  Only U.S academic institutions and nonprofit research organizations are eligible to submit proposals. This limitation also applies to subawards. Proposals may be submitted in support of individual investigators, small teams, and interdisciplinary research groups.

- **PI Eligibility Limit:**

  An individual researcher may not be named as a participant on more than one proposal submitted to this solicitation. This limitation includes participation as a PI, coPI, Senior Researcher, Consultant, or any other role for which financial remuneration is requested.

- **Limit on Number of Proposals:** None Specified.

Award Information

- **Anticipated Type of Award:** Standard or Continuing Grant
- **Estimated Number of Awards:** 40 including Individual-Investigator (up to $125,000 per year for 3 years), Small-Team (up to $250,000 per year for 3 years), and Interdisciplinary-Research-Group (up to $500,000 per year for up to 5 years) awards.
- **Anticipated Funding Amount:** $20,000,000 from the Directorate for Engineering and up to $3,000,000 additionally from other NSF Directorates/Offices, subject to availability of funds, and the quality and appropriateness of proposals received.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Full Proposal Preparation Instructions:** This solicitation contains information that supplements 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 not required.
- **Indirect Cost (F&A) Limitations:** Not Applicable.
- **Other Budgetary Limitations:** Not Applicable.

C. Due Dates

- **Full Proposal Deadline Date(s)** (due by 5 p.m. proposer's local time):
  March 03, 2005

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.

TABLE OF CONTENTS

I. INTRODUCTION

In recent years, sensor research has been undergoing a quiet revolution, promising to have significant impact on a broad range of applications relating to national security, health care, the environment, energy, food safety, and manufacturing. The convergence of the Internet, communications, and information technologies with techniques for miniaturization now provides vast opportunities for the development and application of sensor systems to meet these needs. Emerging technologies have the potential to decrease the size, weight and cost of sensors and sensor arrays by orders of magnitude, as well as to increase their spatial and temporal resolution and accuracy. Soon large numbers of sensors may be integrated into systems to improve performance and lifetime, and decrease life-cycle costs. Sensors are also beginning to incorporate active elements for self-test, calibration and maintenance. Communications networks will enable rapid access to information and computing, eliminating the barriers of distance and time for telemedicine, transportation, detecting toxic agents, recording spatial and temporal variations in terrestrial, atmospheric, and aquatic environmental parameters, and monitoring the security of civil and engineering infrastructures. New geophysical/geochemical sensor networks will permit more effective monitoring of volcanic or seismic activity, severe wind patterns, and the health of the atmosphere and earth's subsurface. The coming years will likely see a growing reliance on and need for more powerful sensor systems, with increased performance and functionality.

Realization of the potential of new sensors and sensor technologies will require fundamental advances in many areas such as: (1) the ability to respond to specific stimuli such as toxic chemicals and biological agents and their precursors, motion and vibration, heat, light and other physical phenomena, (2) enhanced sensitivity, selectivity, speed, robustness, and fewer false alarms, (3) the ability to function unattended and autonomously in unusual/extreme/complex environments, and (4) new decision-theoretic approaches to the use of sensed data in support of decision making. Some of these needs can be addressed by the design and synthesis of materials with functionalized receptors for next-generation devices. The materials may be of varying porosity enabling them to detect single toxic compounds in complex mixtures, or physical configurations that have surfaces with microchannels for microfluidic discrimination. Genomic tools may be incorporated to aid in characterizing ecological changes in aquatic and terrestrial environments. The full battery of advanced biological, chemical and materials research can be brought to bear on this challenge, including the design of functional nano- and meso-scale complex structures.

Fundamental research is also needed in sensor fabrication and manufacture, integration with electronics on a chip, and signal processing. Robustness under anticipated manufacturing schemes is also required, along with progress towards miniaturization, reduced cost and lower power consumption. Integration of sensors, processors, energy sources, and the communications network interface on a chip would facilitate the exchange of sensor data and critical information with the outside world. Information extraction may involve detection of events or objects of interest, estimation of key parameters, and human-in-the-loop or closed-loop adaptive feedback. Arrays of ultra low-power wireless nodes coupled with advanced control algorithms may be incorporated in high-bandwidth reconfigurable networks with high-speed connectivity to processing centers for decision and responsive action.

Sensing principles include but are not limited to mechanical, chemical, thermal, electrical, chromatographic, magnetic, biological, fluidic, optical, acoustic, ultrasonic, and mass sensing. Sensors may be exposed to hostile environments. They may be incorporated in mobile robotic systems, stationary platforms, or into manufacturing systems. Their environment may include high temperatures, high pressure, high vibration, high noise, or corrosive chemicals. In biological systems, the sensors themselves must not adversely affect the system or organism.

To meet future societal needs, it will be necessary for sensor systems to leverage and incorporate projected advances in adjacent technologies, such as nanofabrication, biosystems, massively distributed networks, ubiquitous computing, broadband wireless communications, and information and decision systems.

Integration of research and education in the area of sensors has the potential to attract students to a fruitful interdisciplinary area with obvious societal benefits, and help build a diverse scientific workforce.

Recent NSF workshop reports, which discuss projected sensor needs, may be found at http://www.chemistry.gatech.edu/sensingforum-02 and http://www.ce.berkeley.edu/Programs/Geoengineering/sensors.

II. PROGRAM DESCRIPTION

This multidisciplinary research activity seeks to advance fundamental knowledge in new technologies for sensors and sensor networks, and in the use of sensor data in control and decision-making across a broad range of potential applications, such as those noted above. Research funded under this solicitation may be carried out by individual investigators, by small teams, or by larger interdisciplinary groups. To be eligible, the proposed research must apply engineering principles to address the needs of future sensing systems, while advancing engineering knowledge. Proposals are required to include in the Project Description the engineering principles to be applied and the advances anticipated in engineering knowledge as an outcome of the work. Those proposals that focus instead on areas such as the physical sciences, materials research, or information technology are outside the scope of this solicitation and should be directed to the appropriate disciplinary programs. Proposed research on advanced sensing concepts must identify and address target applications, and projects should show a clear relationship to the requirements of the application. Research proposed on sensors to be deployed in extreme environments must include an adequate plan for testing under those conditions. The community is encouraged to be innovative in educational aspects of sensor research. Projects should include underrepresented groups through the research and outreach.

TOPICAL AREAS

This solicitation will provide research support under the following topical areas. These areas are relatively broad. Examples are provided to illustrate the general intent of this activity and are not intended to be all-inclusive.

Engineering of Materials, Concepts and Designs for New Sensors and Sensing Systems

This topical area emphasizes the engineering of materials and devices that are suitable for applications in technology and environmental observation; generic materials research and systems intended for analytical laboratory uses are excluded. Proposed research should lead to sensors that are sensitive, selective, and stable with rapid response time. Examples of research topics of interest include those emphasizing engineering concepts for the synthesis and use of thin films, microfluidics, tailored surfaces, selective separation agents, combustion and plasma systems, as well as the design and control of chemical reactors, reactive and multiphase processes, and thermal processing systems. Other examples include: biomimetic sensors including hybrids consisting of proteins, enzyme fragments, biocatalysts and other macromolecules with affinity domains that can be linked to surfaces; sensors to analyze signature bioactivities from cell to environment; bioMEMS; biocompatibility; wireless sensors; chip-based systems incorporating multiple sensors, computation, actuation, and wireless interfaces; sensor systems capable of remote activation and interrogation; RFID devices; lightweight sensor power sources; novel optical and acoustical imaging concepts; new modeling and simulation tools; new techniques for on-sensor self-calibration and self-test; enhanced specificity to maximize accuracy and minimize false alarms; sensors for operation in harsh environments; new methods for sensor fabrication, manufacture and encapsulation; sensors to enable new consumer products and services, as well as more economical manufacture and delivery; sensors for closed-loop control of manufactured products such as automotive fuel injection systems; sensors to detect wear in consumer products and enable self-diagnosis and repair; and advanced sensors for detection/control of chatter and stress in cutting tools, and real-time monitoring of cutting fluids, machined surfaces, and welding joints This topical area also includes the interface of sensors with other systems, and technologies for achieving higher spatial and temporal resolution, lower cost, greater robustness, and increased lifetime and reliability.

Engineering Applications of Networked Sensors; Interpretation of Data; Responsive Action

This area addresses system-level application areas. Research issues include: decision and control theory for sensed information; new statistical algorithms for sensor networks; sampling, pattern recognition, state estimation, false-alarm, and feedback theory for sensed data; tailored supervisory control systems; optimal sensor locations for effective process or system control; optimal design of sensor arrays for manufactured systems; mathematical and hybrid system tools for monitoring distributed networks of large arrays of sensors and actuators; power-aware sensor networks with self-configuring, self-healing, and self-optimizing capabilities; decision-theoretic approaches to the use of sensor data in decision making processes, including engineering design, production scheduling, quality control, inventory control, and maintenance and repair of products and manufacturing systems; new theory and algorithms to incorporate uncertainty and risk into decision making for use with imperfectly sensed data; and integrated hand-held sensors. System-level sensor applications include: biomedical health monitoring, diagnosis, and therapy; image-guided surgery; health monitoring systems for civil/mechanical/aero structures; sensing systems to monitor the health and throughput of manufacturing processes and for real-time supply chain coordination; crisis management sensor systems; autonomous sensor networks for homeland security; detection and response to severe environmental events; surveillance technology; robotics; mobile sensor networks; tracking/monitoring of mobile units (e.g., for inventory control, transportation); monitoring of variability in terrestrial, atmospheric, and aquatic environments; and sensor assessment (reliability, verification, validation).

Environmental Sensors and Sensing Systems

A unifying theme of this topical area is to stimulate fundamental advances in *in situ* and remote sensing systems, with a goal towards observing, modeling and analyzing a wide range of complex environmental materials or compounds, life forms, and processes. Proposed research should leverage recent advances in microelectronics, photonics, telemetry, robotics, wireless communication, and other methods for sensing of physical, biological, and chemical parameters. Research proposals should seek to increase real-time data-gathering opportunities, reduce or eliminate the need for human attention, minimize environmental impact and presence, avoid or minimize effects of biological and chemical fouling that degrade long-term reliability, and enable sensor technologies that provide environmental data of high quality and comparability, and are capable of wide dissemination. Research on advanced sensing technologies that combine intelligent, adaptive systems with associated software for data collection, complex modeling, simulation, pattern recognition, management, and analysis is encouraged. Research is also encouraged on sensing systems that seek to understand and reduce the environmental impact of the service sector, of manufacturing processes, and of the use, reuse and recycling of consumer products. It should be emphasized that this activity intends to support fundamental advances in new or greatly improved sensor systems; proposals to conduct long-term monitoring or deployment of off-the-shelf or fully developed sensor systems are outside the scope of this solicitation and will not be considered for support.

Interdisciplinary proposals submitted under this topical area must build meaningful partnerships between sensor engineers and appropriate discipline scientists, and strengthen the linkage between engineering and science applications. Individual-investigator proposals for environmental sensing will be accepted by appropriate divisions in the Directorate for Engineering, such as the Bioengineering & Environmental Systems (BES) and Design, Manufacture and Industrial Innovation (DMII), but not by the Directorate for Geosciences or the Office of Polar Programs. Investigators submitting proposals to this theme must first contact the appropriate Program Manager in the Directorate for Geosciences, Office of Polar Programs, or the Directorate for Engineering to determine whether the proposed work meets current programmatic guidelines.

INTEGRATION OF SENSOR RESEARCH AND EDUCATION

This Program Solicitation emphasizes the integration of research and education, including curriculum development, and innovative sensor test beds with remote access to demonstrate research concepts, educate students, and illustrate future technological directions. Emphasis includes widely available, low-cost, demonstration modules that would benefit graduate, undergraduate, and K-12 education. Goals include attracting students to a fruitful interdisciplinary area with clear societal benefits, and building a diverse scientific and engineering workforce knowledgeable of sensor technologies.

TYPES OF SUPPORT

While important research advances by individual investigators are anticipated, a major goal of this solicitation is to stimulate highly innovative, interdisciplinary research at the interfaces of sensor technology and rapidly developing areas in science and engineering. It is likely that competitive proposals will involve research in more than one of the topical areas listed above. Sensor and Sensor Network research issues must be the central focus of the proposed work, and cross-disciplinary collaborations involving engineers is strongly encouraged for small team and interdisciplinary research group projects. Proposals that deal only tangentially with sensors are outside the scope of this solicitation and may be returned without review. This would include, for example, proposals addressing system-level applications, which do not also promise creative and enabling sensor research. Similarly, proposals with a primary emphasis on the physical sciences, geoscience, or polar research will not be considered eligible for funding unless they build meaningful partnerships between sensor and network engineers and the discipline scientists, and propose fundamental advances in sensors and sensor networks by engineering/ scientific researchers to strengthen the linkage between engineering and science applications. Finally, while information science has an important role to play in long-range, interdisciplinary sensor research, proposals stressing general information technology for sensors and sensor nets are outside the scope of this solicitation and should be directed in 2005 to appropriate disciplinary programs. This would include research in networking; communications; distributed and embedded systems; and sensor-based data acquisition, signal processing, and information systems. Proposers should consult with the directorate contact to determine whether the proposed research is suitable and encouraged for the Sensors and Sensor Networks competition in that directorate.

Projects funded under this solicitation will support collaborative research and education activities of the following types: 1) Sensor Individual Investigator (SII), 2) Sensor Small Teams (SST), and 3) Sensor Interdisciplinary Research Groups (SIRG). Each proposal should have an integrating research and education focus with components aimed at the development of a skilled workforce.

1. Sensor Individual Investigator (SII) proposals by single investigators, or several investigators within the same discipline, should involve innovative and high-risk sensor research. All such proposals should contain “Sensors:” at the beginning of the title, and must be directed to the most appropriate disciplinary program within the directorate that will be responsible for proposal evaluation. While individual investigator proposals will be accepted by all participating divisions of the Directorate for Engineering, the Directorate for Geosciences and the Office of Polar Programs will not accept Individual Investigator proposals under this solicitation.

2. Sensor Small Team (SST) proposals must involve fundamental contributions in research and education by investigators in multiple disciplines. They should generate new concepts and approaches that are enabled by the synergistic interaction of diverse technical fields. The proposals should contain two or three investigators, all listed on the cover page of the proposal, and having the diverse skills necessary to pursue the research objectives. All such proposals should contain "SST:" at the beginning of the title. They must be directed to "ECS – Sensor Small Teams" for administrative purposes.

3. Sensor Interdisciplinary Research Group (SIRG) proposals are intended to address research challenges on problems of breadth and complexity, where a synergistic blend of expertise is needed to make significant contributions. SIRG proposals must involve fundamental research contributions by investigators in diverse disciplines, involving one or a combination of the topical areas described above. Sensor proposals with the promise for significant advances by multiple collaborating investigators are especially encouraged. The proposals should contain three or more investigators, all listed on the cover page of the proposal, with time committed in the budget, and having the diverse skills necessary to pursue the research objectives. They should have a focus on integrating research and education with components aimed at the development of a skilled workforce. All such proposals should contain "SIRG:" at the beginning of the title. They must be directed to "ECS – Sensor Interdisciplinary Research Groups" for administrative purposes.

A grantees' conference at NSF (Arlington, Virginia) at the end of the second year will enable the principal investigators of SSTs and SIRGs 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 proposal budget for attendance at this conference.

III. ELIGIBILITY INFORMATION

Proposals may only be submitted by U.S academic institutions and nonprofit research organizations in support of individual investigators, small teams, and larger interdisciplinary research groups. This limitation also applies to subawards. An individual researcher may not be named as a participant on more than one proposal submitted to this solicitation. This limitation includes participation as a PI, coPI, Senior Researcher, Consultant, or in any role for which financial remuneration is requested.

IV. AWARD INFORMATION

- **Anticipated Type of Award:** Standard or Continuing Grant
- **Estimated Number of Awards:** 50
- **Anticipated Funding Amount:** $20,000,000 from the Directorate for Engineering and up to $3,000,000 additionally from other NSF Directorates/Offices, for awards of the following types:
    - Individual-Investigator Awards (up to $125,000 per year for 3 years),
    - Small-Team Awards (up to $250,000 per year for 3 years), and
    - Interdisciplinary-Research-Group Awards (up to $500,000 per year for up to 5 years).

Estimated program budget, number of awards, and average award size/duration are subject to the availability of funds, and the quality and appropriateness of proposals received. Awards relating to Environmental Sensors and Sensing Systems that are to be supported by the Directorate for Geosciences and the Office for Polar Programs will be limited to Small Teams and Interdisciplinary Research Groups.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

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.

The program solicitation contains supplements to the Grant Proposal Guide (GPG) proposal preparation guidelines.

Cover Sheet: See GPG Section II.C.

- Project Title. The project title for individual-investigator proposals must begin with "Sensors:" and follow with an informative title. Project titles for small-team and interdisciplinary-research-group proposals must begin with "SST" and "SIRG," respectively, followed by an informative title.
- Program selection. In order to facilitate proper assignment and review of proposals, **individual-investigator proposals must identify the NSF division and disciplinary program** closest to the subject matter of the proposed activities. **For all small-team and interdisciplinary group proposals, proposers must select "ECS - Sensor Small Teams" and "ECS - Sensor Interdisciplinary Research Group," respectively, as the division-program of interest.** Failure to do so may cause delays in processing.

Project Description: See GPG Section II.C.

- The Project Description must include an **explicit description of the engineering principles to be applied and the advances anticipated in engineering knowledge as an outcome of the work**.

Proposers are reminded to identify the program announcement/solicitation number (05-526) 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 not required in proposals submitted under this Program Solicitation.

C. Due Dates

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

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

March 03, 2005

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:

It is emphasized that this solicitation is not intended to support routine deployment and monitoring.

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:

- Filbert J. Bartoli, **Solicitation Coordinator**, Program Director, Directorate for Engineering, Division of Electrical & Communications Systems, 675 S, telephone: (703) 292-8339, fax: (703) 292-9147, email: fbartoli@nsf.gov
- Radhakishan Baheti, Program Director, Directorate for Engineering, Division of Electrical & Communications Systems, 675 S, telephone: (703) 292-8339, fax: (703) 292-9147, email: rbaheti@nsf.gov
- Patrick L. Brezonik, Program Director, Directorate for Engineering, Division of Bioengineering & Environmental Systems, 565 S, telephone: (703) 292-8320, fax: (703) 292-9098, email: pbrezoni@nsf.gov
- Maria K Burka, Program Director, Directorate for Engineering, Division of Chemical & Transport Systems, 525 N, telephone: (703) 292-7030, fax: (703) 292-9054, email: mburka@nsf.gov
- Dennis Conlon, Cyberinfrastructure and Sensors Program manager, Office of the Director, Office of Polar Programs, 755 S, telephone: (703) 292-4658, fax: (703) 292-9082, email: dconlon@nsf.gov
- Abhijit V Deshmukh, Program Director, Directorate for Engineering, Division of Design, Manufacture, & Industrial Innovation, 590 N, telephone: (703) 292-7061, fax: (703) 292-9056, email: adeshmuk@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
- George A. Hazelrigg, Group Leader, Directorate for Engineering, Division of Design, Manufacture, & Industrial Innovation, 550 S, telephone: (703) 292-7068, fax: (703) 292-9056, email: ghazelri@nsf.gov
- Janice M. Hicks, Program Officer, Directorate for Mathematical & Physical Sciences, Division of Chemistry, 1055 S, telephone: (703) 292-4956, fax: (703) 292-9037, email: jhicks@nsf.gov
- Alexandra Isern, Program Director, Directorate for Geosciences, Division of Ocean Sciences, 725 N, telephone: (703) 292-8583, fax: (703) 292-9085, email: aisern@nsf.gov
- Shih Chi Liu, Program Director, Directorate for Engineering, Division of Civil & Mechanical Systems, 545 S, telephone: (703) 292-8360, fax: (703) 292-9053, email: sliu@nsf.gov
- Robert E. O'Connor, Program Director, Directorate for Social, Behavioral & Economic Sciences, Division of Social and Economic Sciences, 995 N, telephone: (703) 292-7263, fax: (703) 292-9068, email: roconnor@nsf.gov
- Vittal S. Rao, Program Director, Directorate for Engineering, Division of Electrical & Communications Systems, 675 S, telephone: (703) 292-8339, fax: (703) 292-9147, email: vrao@nsf.gov
- Masayoshi Tomizuka, Program Director, Directorate for Engineering, Division of Civil & Mechanical Systems, 545 S, telephone: (703) 292-7012, fax: (703) 292-9053, email: mtomizuk@nsf.gov

For questions related to the use of FastLane, contact:

- FastLane Help Desk, National Science Foundation, telephone: 800-673-6188, email: 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.

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Facilitation Awards for Scientists and Engineers with Disabilities (FASED) 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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