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Smart Health and Wellbeing (SHB)

PROGRAM SOLICITATION
NSF 12-512

REPLACES DOCUMENT(S):
NSF 10-575

National Science Foundation

Directorate for Computer & Information Science & Engineering
Division of Computing and Communication Foundations
Division of Computer and Network Systems
Division of Information & Intelligent Systems

Directorate for Engineering

Directorate for Social, Behavioral & Economic Sciences

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

February 06, 2012

Type I: Exploratory Projects (EXP)

February 21, 2012

Type II: Integrative Projects (INT)

IMPORTANT INFORMATION AND REVISION NOTES

This document partially replaces the CISE Cross-Cutting FY 2011 solicitation with a stand-alone solicitation for the Smart Health and Wellbeing Program.

The Directorate for Engineering and the Directorate for Social, Behavioral, and Economic Sciences have been added as partners in this program.

Two types of projects, Exploratory Projects and Integative Projects, are being solicited. They are described in the solicitation. They differ in funding ranges and requirements from the Small, Medium and Large projects of the prior Cross-Cutting solicitation. CISE investments in SHB Type I and Type II projects complement the directorate's investments in the Expeditions in Computing Program, where projects are funded at levels up to $10,000,000 total for durations of up to 5 years.

Important Reminders

A revised version of the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG), NSF 11-1, was issued on October 1, 2010 and is effective for proposals submitted, or due, on or after January 18, 2011. Please be advised that the guidelines contained in NSF 11-1 apply to proposals submitted in response to this funding opportunity.

Cost Sharing: The PAPPG has been revised to implement the National Science Board's recommendations regarding cost sharing. Inclusion of voluntary committed cost sharing is prohibited. In order to assess the scope of the project, all organizational resources necessary for the project must be described in the Facilities, Equipment and Other Resources section of the proposal. The description should be narrative in nature and must not include any quantifiable financial information. Mandatory cost sharing will only be required when explicitly authorized by the NSF Director. See the PAPP Guide Part I: *Grant Proposal Guide (GPG)* Chapter II.C.2.g(xi) for further information about the implementation of these recommendations.

Data Management Plan: The PAPPG contains a clarification of NSF's long standing data policy. All proposals must describe plans for data management and sharing of the products of research, or assert the absence of the need for such plans. FastLane will not permit submission of a proposal that is missing a Data Management Plan. The Data Management Plan will be reviewed as part of the intellectual merit or broader impacts of the proposal, or both, as appropriate. Links to data management requirements and plans relevant to specific Directorates, Offices, Divisions, Programs, or other NSF units are available on the NSF website at: http://www.nsf.gov/bfa/dias/policy/dmp.jsp. See
Chapter II.C.2.j of the GPG for further information about the implementation of this requirement.

Postdoctoral Researcher Mentoring Plan: As a reminder, each proposal that requests funding to support postdoctoral researchers must include, as a supplementary document, a description of the mentoring activities that will be provided for such individuals. Please be advised that if required, FastLane will not permit submission of a proposal that is missing a Postdoctoral Researcher Mentoring Plan. See Chapter II.C.2.j of the GPG for further information about the implementation of this requirement.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Smart Health and Wellbeing (SHB)

Synopsis of Program:

Through the Smart Health and Wellbeing (SHB) Program, NSF seeks to address fundamental technical and scientific issues that would support much needed transformation of healthcare from reactive and hospital-centered to preventive, proactive, evidence-based, person-centered and focused on wellbeing rather than disease. The issues to be addressed include, but are not limited to, sensor technology, networking, information and machine learning technology, modeling cognitive processes, system and process modeling, and social and economic issues. Effective technology-based solutions must satisfy a multitude of constraints arising from clinical needs, social interactions, cognitive limitations, barriers to behavioral changes, heterogeneity of data, semantic mismatch and limitations of current cyberphysical systems.

The high degree of complexity and broad range of the problems require multidisciplinary teams of scientists and engineers to identify and address barriers limiting quality of life, independence for chronically ill and elder individuals, and other aspects of wellbeing. Fundamental technological advances are also needed to understand the impediments that prevent people from engaging in health-promoting life styles including diet and exercise and from participating in their healthcare decisions.

Proposers are invited to submit proposals in two project classes, which are defined as follows:

- Type I: Exploratory Projects (EXP) - $200,000 to $600,000 total budget with durations from two to three years; and
- Type II: Integrative Projects (INT) - $600,001 to $2,000,000 total budget with durations from four to five years

A more complete description of the project classes can be found in section *II. Program Description*, of this document.

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to points of contact.

- Misha (Michael) Pavel, Overall Point of Contact, for the SHB Solicitation, Directorate for Computer and Information Science and Engineering, Division of Information and Intelligent Systems, 1125N, telephone: (703) 292-8930, email: mpavel@nsf.gov
- Russell R. Barton, Directorate for Engineering, Division of Civil, Mechanical and Manufacturing Innovation, 550S, telephone: (703) 292-2211, email: rbarton@nsf.gov
- Theodore (Ted) Baker, Directorate for Computer and Information Science and Engineering, Division of Computer and Network Systems, 1175N, telephone: (703) 292-8608, email: tbaker@nsf.gov
- Fahmida N. Chowdhury, Directorate for Social, Behavioral, and Economic Sciences, Office of the Assistant Director, 905N, telephone: (703) 292-4672, email: fchowdhu@nsf.gov
- John H. Cozzens, Directorate for Computer and Information Science and Engineering, Division of Computing and Communication Foundations, 1115N, telephone: (703) 292-8910, email: jcozzens@nsf.gov
- Semahat S. Demir, Directorate for Engineering, Division of Chemical, Bioengineering, Environmental, and Transport Systems, 565S, telephone: (703) 292-7950, email: sdemir@nsf.gov
- Vasant G. Honavar, Directorate for Computer and Information Science and Engineering, Division of Information and Intelligent Systems, 1125N, telephone: (703) 292-8930, email: vhonavar@nsf.gov
- Sylvia Spengler, Directorate for Computer and Information Science and Engineering, Division of Information and Intelligent Systems, 1125S, telephone: (703) 292-8930, email: sspengle@nsf.gov
- Richard Voyles, Directorate for Computer and Information Science and Engineering, Division of Information and Intelligent Systems, 1125N, telephone: (703) 292-8930, email: rvoyles@nsf.gov

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

- 47.041 --- Engineering
- 47.070 --- Computer and Information Science and Engineering
- 47.075 --- Social Behavioral and Economic Sciences

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 10 to 18 This includes 6-10 awards for Type I Exploratory Projects (EXP) and 4-8 awards for Type II Integrative Projects (INT)

Anticipated Funding Amount: $15,000,000 in FY 2012, dependent upon the availability of funds.

Eligibility Information

Organization Limit:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

PI Limit:

Proposals may only be submitted by the above as lead institutions. However, collaborators and subawardees, particularly those in the health professions, may be employees of for-profit institutions which are U.S. commercial organizations.

Limit on Number of Proposals per Organization:

None Specified

Limit on Number of Proposals per PI: 2

An individual may participate as PI, Co-PI or Senior Personnel in no more than two proposals submitted in response to this solicitation. For example, an individual may participate as PI, co-PI or Senior Personnel in one Type I proposal and in a second Type II proposal or an individual may participate as PI, co-PI or Senior Personnel in two Type I proposals or two Type II proposals (but not both). These eligibility constraints will be strictly enforced in order to treat everyone fairly and consistently. In the event that an individual exceeds this limit, proposals received within the limit will be accepted based on earliest date and time of proposal submission (i.e. the first two proposals received will be accepted, and the remainder will be returned without review). No exceptions will be made.

The limit on the number of proposals per PI, Co-PI or Senior Personnel applies only to this solicitation.

Proposals submitted in response to this solicitation may not duplicate or be substantially similar to other proposals concurrently under consideration by other NSF programs.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- Letters of Intent: Not Applicable
- Preliminary Proposal Submission: Not Applicable
- Full Proposals:
  - Full Proposals submitted via FastLane: NSF Proposal and Award Policies and Procedures Guide, Part I: Grant Proposal Guide (GPG) Guidelines apply. The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg.
  - Full Proposals submitted via Grants.gov: NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov Guidelines apply (Note: The NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)

B. Budgetary Information

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

C. Due Dates

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

  February 06, 2012

  Type I: Exploratory Projects (EXP)

  February 21, 2012

  Type II: Integrative Projects (INT)

Proposal Review Information Criteria

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

Award Administration Information

Award Conditions: Standard NSF award conditions apply.

Reporting Requirements: Standard NSF reporting requirements apply.

TABLE OF CONTENTS

I. INTRODUCTION

Delivering high quality, economically efficient healthcare is rapidly becoming one of the key economic, societal and scientific challenges in the United States as well as globally. Despite escalating costs, the Nation's healthcare system is underperforming, based on indicators such as infant mortality, life expectancy and life-long healthcare costs per capita. The aging population, the prevalence of chronic diseases, and scarce resources will further stress the system. We are facing a future of increasing healthcare needs and a widening gap to the numbers of informal and professional caregivers to provide it.

The U.S. healthcare system needs to be fundamentally transformed from reactive care to proactive and preventive care, from experience-based to evidence-based medicine, and from clinic-centered care to patient-centered care and wellness that extends to the home, workplace, and community. Such transformation is necessary to move the focus from disease to health and wellbeing at the individual, system, and organizational level.

The need for a significant healthcare transformation has been recognized by numerous organizations and captured in a number of reports. For example, two influential 2010 reports from the President's Council of Advisors on Science and Technology (PCAST), *Realizing the Full Potential of Health Information Technology to Improve Healthcare for Americans: The Path Forward* http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-health-it-report.pdf and *Designing a Digital Future: Federally Funded Research and Development in Networking and Information Technology* http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-nitrd-report-2010.pdf describe near-term requirements as well as longer visions of the future healthcare. Similar visions for future healthcare and the need for further research have been identified in the 2009 National Research Council (NRC) report, *Computational Technology for Effective Health Care* http://www.nap.edu/catalog.php?record_id=12572, the 2011 Institute of Medicine (IOM) report *Digital Infrastructure for the Learning Health System* http://www.nap.edu/catalog.php?record_id=12912, the 2010 CCC white paper *Information Technology Research Challenges for Healthcare: From Discovery to Delivery* http://www.cra.org/ccc/docs/init/Information_Technology_Research_Challenges_for_Healthcare.pdf, and the 2005 joint National Academy of Engineering and IOM report, *Building a Better Delivery System* http://www.nap.edu/catalog.php?record_id=11378. In addition, the need to include environmental aspects influencing healthcare was recently emphasized in the 2010 Presidential Cancer Panel: http://deainfo.nci.nih.gov/advisory/pcp/pcp.htm.

One unifying theme of these visions involves technology enabling optimized care decisions by bringing all relevant evidence pertaining to the particular patient to the point of care anywhere and anytime and in user-appropriate forms for all members of the care team. The technical challenges include normalization and harmonization of electronic health records (EHRs); extraction and representation of data, information, and knowledge from diverse unstructured sources; large-scale data collection and predictive modeling; and new approaches for protecting privacy and security. Socio-cultural, economic, legal, political, and ethical challenges can amplify or mitigate technical challenges of achieving this vision.

Medical errors, operational inefficiencies and resulting adverse events are symptoms of the incomplete application of sound scientific and engineering principles to the design, implementation, operation, performance measurement, and optimization of healthcare systems, including human factors and usability considerations, workflow, and communication subsystems in many providers' facilities. Application of proven engineering systems analysis and optimization techniques can help improve information flow, minimize the frequency and the severity of these events, and improve operational effectiveness and efficiency of healthcare systems. A system rather than subsystem view will be necessary to achieve significant and lasting improvements.

Another emerging theme involves enabling individuals to participate in their care to transform health care systems from reactive to

preventive, from clinic-centric to patient-centric, and from disease-centered to wellness centered. Among the key components that improve a person's outcomes and quality of life are self-efficacy and social support, both of which may be enhanced by improved access to and use of health information, enabled by advances in sensors, computing, networking, and communication technology. Also key to patient participation in health/healthcare is an understanding of the socio-cultural, behavioral and economic factors underlying the acceptance and impact of technological advances.

A major issue in current healthcare is the variability and limited frequency of measurements and the lack of baseline data for each particular individual. For example, applying population norms to a specific individual is often inappropriate because of individual deviations from the mean in genetic or family background, socioeconomic status or medical history. One way to overcome the challenges associated with infrequent, clinic-based measurements is to replace them by unobtrusive, continuous sensing, monitoring and assessment, thereby creating individualized baselines.

Another key component of the healthcare transformation involves care for individuals with impaired functions, e.g., those with neurodegenerative diseases and aging populations. These issues may be addressed by novel devices and intelligent systems that relieve caregiver burden and improve quality of life by allowing the affected individuals to live more independently.

This solicitation is aligned with the visions (e.g. PCAST, NRC, IOM) calling for major changes in health and wellbeing as well as healthcare delivery and is aimed at the fundamental research to enable the change. Realizing the promise of disruptive transformation in health and healthcare will require well-coordinated, multi-disciplinary approaches that draw from the social, behavioral, and economic sciences, engineering, medicine, biology, and computer and information sciences.

II. PROGRAM DESCRIPTION

Consistent with the PCAST vision, the solicitation aims to complement the long-standing disease and application-focused research efforts with fundamental, innovative, and exploratory research that draws from multiple domains of science and engineering including social, behavioral, and economic sciences. Proposals can address computational, algorithmic, systemic, and device level issues as well as models of uptake, diffusion, and use of the resulting solutions among different demographic and social groups, as well as the role of appropriate incentives, the risk of potential disparities, and the associated legal and ethical considerations. Accordingly, this cross-cutting solicitation represents the collaboration of three NSF directorates: Computer and Information Science and Engineering (CISE), Engineering (ENG), and Social, Behavioral, and Economic Sciences (SBE).

The work to be funded by this solicitation must relate to a key health problem and must make a fundamental contribution to engineering, computer and information sciences, or social, behavioral and economic sciences. Traditional disease-centric medical, clinical, pharmacological, biological or physiological studies and evaluations are outside the scope of this solicitation. The research teams must include members with appropriate and demonstrable expertise in the major areas involved in the work. This solicitation aims to support research activities that complement rather than duplicate the core programs of the NSF directorates and the research efforts supported by other agencies such as the National Institutes of Health (including the National Library of Medicine), the Agency for Healthcare Research and Quality, and the National Institute of Standards and Technology.

Addressing the challenges will require fundamental research and the development of new tools and methods across many dimensions, some of which is called for below:

1. Digital Health Information Infrastructure: Pursue fundamental research to enable interoperable, distributed, federated, and scalable digital infrastructure, languages, and tools for effective sharing and use of electronic health record data, data representation for such including semantic metadata, and networked applications that access such data. Investigate aspects of a continuously extensible universal exchange language for current and future health and wellness data originating from diverse sources in multiple formats, supporting both syntax and semantics. Advance data methods for controlling and maintaining data integrity, provenance, security, privacy and reliability of original as well as aggregated data, providing trustworthy patient identification and authentication and access control protocols, and maintaining sensitivity to the legal, cultural and ethical issues associated with universally accessible digital health data (e.g., EHR) in the U.S. Advance systems methods for measuring and optimizing operations to improve quality and productivity of healthcare delivery systems. Explore the societal impacts of increasing medical/health information availability and use.

2. From Data to Knowledge to Decisions: Investigate methods and algorithms for aggregation of multi-scale clinical, biomedical, contextual, and environmental data about each patient (EHR, personal health records - PHR, etc.), and unified and extensible metadata standards, and decision support tools to facilitate optimized patient-centered evidence-based decisions. Integrate patient information with delivery systems performance and economic models to support operations management decisions. Develop robust knowledge representations and reasoning algorithms to support inferences based on individual or population health data, multiple sources of potentially conflicting information while complying with applicable policies and preferences. Develop innovative technology for the secondary use of health data to support assisted and automated discovery of reliable knowledge from aggregated population health records and predictive modeling and simulation of health and disease at multiple levels from cellular to individuals/patients to populations, along with robust validation and integration of empirical data into the models. Develop understanding of how families, communities, informal caregivers, professional medical teams and patients interpret care and treatment. Increase understanding of issues (technological, behavioral, socio-economic, value-driven actions, ethical, systemic) that interfere with patients' collaboration in care team and adherence to treatment and wellness regimens.

3. Empowering Individuals: Investigate underlying socio-economic and behavioral principles underlying patient participation in healthcare and wellness. Develop new approaches to empowering patients and healthy individuals to participate in their own health and treatment such as custom-educating, accessing and visualizing health data and knowledge, understanding how people participate in their own health treatment depending on socio-economic status, gender and ethnicity, and how different forms of education and presentation of data will contribute to better health care by teams, including patients, caregivers, and providers. Develop quantitative, predictive models of patients and individuals, including the understanding of how patients and caregivers understand "empowerment", when and where it is desirable, and the limits of such empowerment. Develop novel user-tailored and context-aware human-computer interfaces for a variety of tasks including patient, family and caregiver access to EHRs and PHRs. Examine how technology can contribute to shifting of public and private incentives toward patient-centric goals.

4. Sensors, Devices and Robotics: Investigate protocols and interface standards to enable interoperable, temporally synchronized, medical prosthetic and embedded devices and those devices for continuous capture, storage, and transmission of physiological state and environmental data. Develop and evaluate assistive technology systems and devices for improved health and healthcare; such systems might incorporate sensory inputs and computational intelligence ranging from internal and external sensors, wearable prosthetics, and cognitive orthotics to surgical-assist robots and social robots. Investigate sensors, analysis tools, and activators needed to assess and limit adverse environmental effects on health and wellbeing. Develop simulation and modeling methods and software tools that aid in the design and evaluation of sophisticated medical devices and how they communicate to

medical information systems in the clinic, home, and in and around the person.

These research areas are clearly not mutually exclusive and the proposed projects may address several of these. Proposals of collaborative projects with partners outside of the U.S. are also encouraged. In those cases, NSF may support the U.S. collaborator (including foreign travel jointly with NSF/OISE) provided that the foreign partner(s) secure funding from their corresponding countries.

Project Classes

Proposals submitted to this solicitation must be consistent with one of two project classes defined below. Proposals will be considered for funding within their project classes.

- Type I: Exploratory Projects (EXP) investigate the proof-of-concept or feasibility of a novel technology, processes, and approaches to promote smart health and wellbeing. These proposed projects with lower budgets are well suited to one or two investigators (PI and one co-PI or other Senior Personnel) and at least one student and/or postdoc. Each proposed project should include at least one collaborator from the health application domain(s). Collaborations with researchers in the application domains are strongly encouraged. EXP awards will be funded over a 2 or 3 year period ranging from $200,000 to $600,000. It is expected that few awards will be made at the upper end of this range. The proposed budget should be commensurate with the corresponding scope of work. Rationale must be provided to explain why a budget of the requested size is required to carry out the proposed work.

- Type II: Integrative projects (INT) undertake research addressing key application areas by solving problems in multiple scientific and engineering domains, incorporating at least two out of the three areas of CISE, ENG, and SBE. These projects are expected to advance understanding about how technology and engineering, combined with advancements in computer, behavioral and social science, would support transformations in healthcare and improve quality of life. Projects with this broader scope are expected to include several students and postdocs. INT project descriptions must be comprehensive and well-integrated, and should make a convincing case that the collaborative contributions of the project team will be greater than the sum of each of their individual contributions. Collaborations with researchers in the health application domains are required. Such collaborations typically involve multiple institutions but are not required to be so organized. Since the successes of collaborative research efforts are known to depend on thoughtful coordination mechanisms that regularly bring together the various participants of the project, a Collaboration Plan is required for each INT proposal. INT projects will be funded over a 4 or 5-year period up to a total of $600,001 to $2,000,000. It is expected that few awards will be made at the upper end of this range. The proposed budget should be commensurate with the corresponding scope of work. Rationale must be provided to explain why a budget of the requested size is required to carry out the proposed work.

Please see *Proposal Preparation Instructions* Section V.A for additional submission guidelines.

CISE investments in SHB Type I and Type II projects complement the directorate's investments in the Expeditions in Computing program, where projects are funded at levels of up to $10,000,000 total for durations of up to 5 years. The Expeditions solicitation can be accessed at http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503169&org=CISE&from=home .

III. AWARD INFORMATION

It is anticipated that $15 million will be available in FY 2012, dependent upon the availability of funds.

IV. ELIGIBILITY INFORMATION

Organization Limit:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

PI Limit:

Proposals may only be submitted by the above as lead institutions. However, collaborators and subawardees, particularly those in the health professions, may be employees of for-profit institutions which are U.S. commercial organizations.

Limit on Number of Proposals per Organization:

None Specified

Limit on Number of Proposals per PI: 2

An individual may participate as PI, Co-PI or Senior Personnel in no more than two proposals submitted in response to this solicitation. For example, an individual may participate as PI, co-PI or Senior Personnel in one Type I proposal and in a second Type II proposal or an individual may participate as PI, co-PI or Senior Personnel in two Type I proposals or two Type II proposals (but not both). These eligibility constraints will be strictly enforced in order to treat everyone fairly and consistently. In the event that an individual exceeds this limit, proposals received within the limit will be accepted based on earliest date and time of proposal submission (i.e. the first two proposals received will be accepted, and the remainder will be returned without review). No exceptions will be made.

The limit on the number of proposals per PI, Co-PI or Senior Personnel applies only to this solicitation.

Proposals submitted in response to this solicitation may not duplicate or be substantially similar to other proposals concurrently under consideration by other NSF programs.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via Grants.gov or via the NSF FastLane system.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the NSF Grant Proposal Guide (GPG). The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.
- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov. The complete text of the NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: (http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. Chapter II, Section D.4 of the Grant Proposal Guide provides additional information on collaborative proposals.

The following information SUPPLEMENTS (not replaces) the guidelines provided in the NSF Grant Proposal Guide (GPG).

Proposal Titles: Proposal titles must begin with the SHB acronym. The acronym should be followed with a colon, then the project class, followed by a colon and the title of your project. For example, if you are submitting a Type I proposal, then your title would be SHB:Type I(EXP):Title. If you submit a proposal as part of a set of collaborative proposals, the title of the proposal should begin with the SHB acronym followed by a colon, then the project class followed by a colon, then "Collaborative Research" followed by a colon, and the title. For example, if you are submitting a collaborative set of proposals describing a Type II project to the SHB program, the title of each would be SHB:Type II(INT):Collaborative Research:Title.

Proposals from PIs in institutions that have RUI (Research in Undergraduate Institutions) eligibility should have a proposal title that begins with SHB, followed by a colon then the project class, followed by a colon then “RUI”, followed by a colon and then the title, for example, SHB:TypeI(EXP):RUI:Title.

PIs submitting Grant Opportunities for Academic Liaison with Industry (GOALI) proposals should have a proposal title that begins with the SHB acronym, followed by a colon then the project class, followed by a colon then "GOALI", followed by a colon and then the title, for example, SHB:TypeI(EXP):GOALI:Title.

Project Summary: The Project Summary must include an explicit description of both the Intellectual Merit and Broader Impacts of the activities proposed, preferably in separate paragraphs titled "Intellectual Merit" and "Broader Impacts".

Please provide between 2 and 6 key words at the end of the Project Summary. CISE personnel will use this information in the merit review process. The key words should describe the main scientific/engineering areas explored in the proposal. Key words should be prefaced with "Key Words" followed by a colon and each key word set should be separated by semi-colons. Key words should be of the type used to describe research in a journal submission. They should be included at the end of the project summary and might appear, for example, as Key Words: assistive technology; social robots; mHealth; electronic health records; social computing; sensor networks.

Project Description:

All Proposals - Describe the research and education activities to be undertaken in 15 pages or less.

Type II (INT) Proposals - Since the success of collaborative research efforts are known to depend on thoughtful coordination mechanisms that regularly bring together the various participants of the project, all Type II proposals must include a Collaboration Plan. While the length of the Project Description for Type I proposals is limited to 15 pages, for Type II proposals, up to 3 additional pages are allowed for Collaboration Plans. Collaboration Plans should be included at the end of the Project Description in a section entitled "Collaboration Plan". The length of and degree of detail provided in the Collaboration Plan should be commensurate with the complexity of the proposed project. Where appropriate, the Collaboration Plan might include: 1) the specific roles of the project participants in all organizations involved; 2) information on how the project will be managed across all the investigators, institutions, and/or disciplines; 3) identification of the specific coordination mechanisms that will enable cross-investigator, cross-institution, and/or cross-discipline scientific integration (e.g., yearly workshops, graduate student exchange, project meetings at conferences, use of the grid for videoconferences, software repositories, etc.), and 4) specific references to the budget line items that support collaboration and coordination mechanisms. ***If a Type II proposal does not include a Collaboration Plan, that proposal will be returned without review.***

Supplementary Documents:

In the Supplementary Documents Section, upload the following information where relevant:

(1) List of Project Personnel and Partner Institutions (Note - In collaborative proposals, only the lead institution should provide this information)

Provide current, accurate information for all personnel and institutions involved in the project. NSF staff will use this information in the merit review process to manage conflicts of interest. The list should include all PIs, Co-PIs, Senior Personnel, paid/unpaid Consultants or Collaborators, Subawardees, Postdocs, and project-level advisory committee members. This list should be numbered and include (in this order) Full name, Organization(s), and Role in the project, with each item separated by a semi-colon. Each person listed should start a new numbered line. For example:

1. Mary Smith; XYZ University; PI

2. John Jones; University of PQR; Senior Personnel

3. Jane Brown; XYZ University; Postdoc

4. Bob Adams; ABC Inc.; Paid Consultant

5. Mary White; Welldone Institution; Unpaid Collaborator

6. Tim Green; ZZZ University; Subawardee

(2) Post Doctoral Mentoring Plan (if applicable)

Each proposal that requests funding to support postdoctoral researchers must include, as a supplementary document, a description of the mentoring activities that will be provided for such individuals. Please be advised that if required, FastLane will not permit submission of a proposal that is missing a Postdoctoral Researcher Mentoring Plan. See Chapter II.C.2.j (http://www.nsf.gov/pubs/policydocs/pappguide/nsf11001/gpg_2.jsp#IIC2j) of the GPG for further information about the implementation of this requirement.

(3) Data Management Plan (required)

Proposals must include a supplementary document of no more than two pages labeled "Data Management Plan". This supplementary document should describe how the proposal will conform to NSF policy on the dissemination and sharing of research results.

See Grant Proposal Guide (GPG) Chapter II.C.2.j for full policy implementation.

For additional information see: http://www.nsf.gov/bfa/dias/policy/dmp.jsp

(4) Other Specialized Information

RUI Proposals: PIs from predominantly undergraduate institutions should include a Research in Undergraduate Institutions (RUI) Impact Statement and Certification of RUI Eligibility in this Section.

GOALI proposals: PIs submitting GOALI proposals should include industry-university agreement letters on intellectual property in this section.

B. Budgetary Information

Cost Sharing: Inclusion of voluntary committed cost sharing is prohibited

C. Due Dates

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

  February 06, 2012

  Type I: Exploratory Projects (EXP)

  February 21, 2012

  Type II: Integrative Projects (INT)

D. FastLane / Grants.gov Requirements

- For Proposals Submitted Via FastLane:

  Detailed technical instructions regarding the technical aspects of 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 solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

  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. Further instructions regarding this process are

available on the FastLane Website at: https://www.fastlane.nsf.gov/fastlane.jsp.

- For Proposals Submitted Via Grants.gov:

  Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: http://www07.grants.gov/applicants/app_help_reso.jsp. In addition, the NSF Grants.gov Application Guide provides additional technical guidance regarding preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

  Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program where they will be reviewed if they meet NSF proposal preparation requirements. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with the oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal.

A. NSF Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board (NSB)-approved merit review criteria: intellectual merit and the broader impacts of the proposed effort. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two NSB-approved merit review criteria are listed below. 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 the reviewer is qualified to make judgements.

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, original, or potentially transformative concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

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

Examples illustrating activities likely to demonstrate broader impacts are available electronically on the NSF website at: http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf.

Mentoring activities provided to postdoctoral researchers supported on the project, as described in a one-page supplementary document, will be evaluated under the Broader Impacts criterion.

Additional Solicitation Specific Review Criteria

For Type II proposals, reviewers will be asked to:

- Comment on the extent to which the project scope justifies the level of investment requested, and the degree to which the Collaboration Plan adequately demonstrates that the participating investigators will work synergistically to accomplish the project objectives.

NSF staff also 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.

B. Review and Selection Process

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

Reviewers will be asked to 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.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF 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 deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director accepts the Program Officer's 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 Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

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 administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award 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 (GC-1); * or Research Terms and Conditions * and (5) any announcement or other NSF issuance that may be incorporated by reference in the award letter. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at http://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the NSF *Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer at least 90 days before the end of the current budget period. (Some programs or awards require more frequent project reports). Within 90 days after expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report will delay NSF review and processing of any future funding increments as well as any pending proposals for that PI. 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. Such reports provide information on activities and findings, project participants (individual and organizational), 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. Submission of the report via FastLane constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report must be prepared and

submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

VIII. AGENCY CONTACTS

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- Misha (Michael) Pavel, Overall Point of Contact, for the SHB Solicitation, Directorate for Computer and Information Science and Engineering, Division of Information and Intelligent Systems, 1125N, telephone: (703) 292-8930, email: mpavel@nsf.gov
- Russell R. Barton, Directorate for Engineering, Division of Civil, Mechanical and Manufacturing Innovation, 550S, telephone: (703) 292-2211, email: rbarton@nsf.gov
- Theodore (Ted) Baker, Directorate for Computer and Information Science and Engineering, Division of Computer and Network Systems, 1175N, telephone: (703) 292-8608, email: tbaker@nsf.gov
- Fahmida N. Chowdhury, Directorate for Social, Behavioral, and Economic Sciences, Office of the Assistant Director, 905N, telephone: (703) 292-4672, email: fchowdhu@nsf.gov
- John H. Cozzens, Directorate for Computer and Information Science and Engineering, Division of Computing and Communication Foundations, 1115N, telephone: (703) 292-8910, email: jcozzens@nsf.gov
- Semahat S. Demir, Directorate for Engineering, Division of Chemical, Bioengineering, Environmental, and Transport Systems, 565S, telephone: (703) 292-7950, email: sdemir@nsf.gov
- Vasant G. Honavar, Directorate for Computer and Information Science and Engineering, Division of Information and Intelligent Systems, 1125N, telephone: (703) 292-8930, email: vhonavar@nsf.gov
- Sylvia Spengler, Directorate for Computer and Information Science and Engineering, Division of Information and Intelligent Systems, 1125S, telephone: (703) 292-8930, email: sspengle@nsf.gov
- Richard Voyles, Directorate for Computer and Information Science and Engineering, Division of Information and Intelligent Systems, 1125N, telephone: (703) 292-8930, email: rvoyles@nsf.gov

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: fastlane@nsf.gov.

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: support@grants.gov.

IX. OTHER INFORMATION

The NSF Website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this Website by potential proposers is strongly encouraged. In addition, National Science Foundation Update is a free e-mail subscription service designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF Regional Grants Conferences. Subscribers are informed through e-mail when new publications are issued that match their identified interests. Users can subscribe to this service by clicking the "Get NSF Updates by Email" link on the NSF web site.

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this new mechanism. Further information on Grants.gov may be obtained at http://www.grants.gov.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 40,000 proposals each year for research, education and training projects, of which approximately

11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

Facilitation Awards for Scientists and Engineers with Disabilities provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See Grant Proposal Guide Chapter II, Section D.2 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

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

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

- Location: 4201 Wilson Blvd. Arlington, VA 22230
- For General Information (NSF Information Center): (703) 292-5111
- TDD (for the hearing-impaired): (703) 292-5090
- To Order Publications or Forms:

  Send an e-mail to: nsfpubs@nsf.gov

  or telephone: (703) 292-7827
- To Locate NSF Employees: (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004), and NSF-51, "Reviewer/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton
Reports Clearance Officer
Division of Administrative Services
National Science Foundation
Arlington, VA 22230