National Robotics Initiative (NRI)
The realization of co-robots acting in direct support of individuals and groups

PROGRAM SOLICITATION
NSF 16-517

REPLACES DOCUMENT(S):
NSF 15-505

National Science Foundation

Directorate for Computer & Information Science & Engineering
  Division of Information & Intelligent Systems

Directorate for Engineering

Directorate for Education & Human Resources

Directorate for Social, Behavioral & Economic Sciences

National Aeronautics and Space Administration

  Space Technology Mission Directorate, Game Changing Technology Program

National Institutes of Health

  National Institute of Biomedical Imaging and Bioengineering

  Eunice Kennedy Shriver National Institute of Child Health and Human Development

  National Eye Institute

  National Institute on Aging

  National Institute on Deafness and Other Communication Disorders

  National Institute of Neurological Disorders and Stroke

  National Institute of Nursing Research

  Office of Behavioral and Social Sciences Research

U.S. Dept. of Agriculture

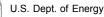National Institute of Food and Agriculture

Department of Defense

Defense Advanced Research Projects Agency

Air Force Office of Scientific Research

U.S. Dept. of Energy

  U.S. Department of Energy - Office of Environmental Management (EM)

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

March 07, 2016

January 12, 2017

Second Thursday in January, Annually Thereafter

IMPORTANT INFORMATION AND REVISION NOTES

This solicitation is a revision of NSF 15-505, the solicitation for the National Robotics Initiative (NRI). The corresponding National Institutes of Health (NIH) notification, NIH Guide Notice NOT-EB-15-008 (http://grants.nih.gov/grants/guide/notice-files/NOT-EB-15-008.html), is being updated in parallel with this solicitation.

Below are several important points for FY 2016 NRI submissions:

- The U.S. Department of Energy Office of Environmental Management (DOE/EM) has joined the NRI. For a detailed statement of their interests, see section II.A.2. Sponsoring Agency Mission Specific Research.

- The Air Force Office of Scientific Research (AFOSR) has provided its research interests relevant to the NRI. For details, see section II.A.2. Sponsoring Agency Mission Specific Research.

- In the context of NRI, The National Institutes of Health (NIH) is interested in proposals in the area of assistive robotics. NIH will not review proposals submitted on topics in surgical robotics, prosthetics, or exoskeletons, in response to the NRI solicitation. For a detailed statement of NIH's interests, see section II.A.2. Sponsoring Agency Mission Specific Research. In addition to hypothesis-driven research, NIH also supports non-hypothesis-driven applications, which includes technology-driven and problem-driven applications.

- The Defense Advanced Research Projects Agency (DARPA) has updated its research interests relevant to the National Robotics Initiative (NRI) program. For details, see section II.A.2. Sponsoring Agency Mission Specific Research.

- The research areas supported by NRI include those relating to autonomous operations of robots. This fact has been emphasized by adding a bullet on autonomy to the list of research areas listed in section II.A.1 of this solicitation.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised NSF Proposal & Award Policies & Procedures Guide (PAPPG) (NSF 16-1), which is effective for proposals submitted, or due, on or after January 25, 2016. Please be advised that proposers who opt to submit prior to January 25, 2016, must also follow the guidelines contained in NSF 16-1.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

National Robotics Initiative (NRI-2.0)
NRI 2.0: Ubiquitous Collaborative Robots

Synopsis of Program:

The goal of the National Robotics Initiative is to accelerate the development and use of robots in the United States that work beside or cooperatively with people. Innovative robotics research and applications emphasizing the realization of such co-robots working in symbiotic relationships with human partners is supported by multiple agencies of the federal government including the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), the National Institutes of Health (NIH), the U.S. Department of Agriculture (USDA), the U.S. Department of Energy (DOE), and the U.S. Department of Defense (DOD). The purpose of this program is to support the development of this next generation of robotics, to advance the capability and usability of such systems and artifacts, and to encourage existing and new communities to focus on innovative application areas. It will address the entire lifecycle from fundamental research and development to manufacturing and deployment. Questions concerning a particular project's focus, direction and relevance to a participating funding organization should be addressed to that agency's point of contact listed in section VIII of this solicitation.

Methods for the establishment and infusion of robotics in educational curricula and research to gain a better understanding of the long-term social, behavioral and economic implications of co-robots across all areas of human activity are important parts of this initiative. Collaboration between academic, industry, non-profit and other organizations is strongly encouraged to establish better linkages between fundamental science and technology development, deployment and use.

Only one class of proposals will be considered in response to this solicitation; there will not be separate competitions for small, medium, and large proposals. Please refer to section III of this solicitation for budget size information.

Cognizant Program Officer(s):

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

For a full listing of agency contacts see Section VIII. of this solicitation.

- Jeff Trinkle, CISE/IIS, telephone: (703) 292-8327, email: jtrinkle@nsf.gov

- Ephraim P. Glinert, CISE/IIS, telephone: (703) 292-8930, email: eglinert@nsf.gov

- Tatiana Korelsky,CISE/IIS, telephone: (703) 292-8930, email: tkorelsk@nsf.gov

- Hector Munoz-Avila, CISE/IIS, telephone: (703) 292-8930, email: hmunoz@nsf.gov

- Reid Simmons, CISE/IIS, telephone: (703) 292-4767, email: resimmon@nsf.gov

- Jie Yang, CISE/IIS, telephone: (703) 292-4768, email: jyang@nsf.gov

- Jack Snoeyink, CISE/CCF, telephone: (703) 292-8910, email: jsnoeyin@nsf.gov

- Ralph Wachter, CISE/CNS, telephone: (703) 292-8950, email: rwachter@nsf.gov

- Alexander Leonessa, ENG/CBET, telephone: (703) 292-2678, email: aleoness@nsf.gov

- Jordan M. Berg,ENG/CMMI, telephone: (703) 292-5365, email: jberg@nsf.gov

- Radhakishan Baheti,ENG/ECCS, telephone: (703) 292-8339, email: rbaheti@nsf.gov

- David L. Haury, EHR/DRL, telephone: (703) 292-5102, email: dhaury@nsf.gov

- Frederick M. Kronz,SBE/OAD, telephone: (703) 292-7283, email: fkronz@nsf.gov

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

- 10.310 --- USDA-NIFA Agriculture and Food Research Initiative
- 12.800 --- Air Force Office of Scientific Research
- 43.001 --- National Aeronautics and Space Administration (Science)
- 43.008 --- National Aeronautics and Space Administration (Education)
- 47.041 --- Engineering
- 47.070 --- Computer and Information Science and Engineering
- 47.075 --- Social Behavioral and Economic Sciences
- 47.076 --- Education and Human Resources
- 81.049 --- Office of Science Financial Assistance Program
- 81.104 --- Environmental Remediation and Waste Processing and Disposal
- 93.173 --- National Institute on Deafness and Other Communication Disorders
- 93.286 --- National Institute of Biomedical Imaging and Bioengineering
- 93.361 --- National Institute of Nursing Research
- 93.853 --- National Institute of Neurological Disorders and Stroke
- 93.865 --- Eunice Kennedy Shriver National Institute of Child Health and Human Development
- 93.866 --- National Institute on Aging
- 93.867 --- National Eye Institute

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant or Cooperative Agreement or contract vehicles as determined by the supporting agency

Estimated Number of Awards: 25 to 70

per year, subject to availability of funds

Anticipated Funding Amount: $30,000,000 to $50,000,000

per year, subject to availability of funds

Eligibility Information

Who May Submit Proposals:

The categories of proposers eligible to submit proposals to the National Science Foundation are identified in the Grant Proposal Guide, Chapter I, Section E.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 2

An investigator may participate as PI or co-PI in **no more than two proposals** submitted in response to this solicitation per deadline. This limit does not apply to other senior personnel.

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.**

Proposals submitted in response to this solicitation may not duplicate or be substantially similar to other proposals concurrently under consideration by other NSF, NASA, NIH, USDA, DOE, or DOD programs or study sections. Duplicate or substantially similar proposals will be returned without review, including those substantially similar to previously declined proposals without revisions to address concerns raised by reviewers.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required

- **Preliminary Proposal Submission:** Not required

- **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:**

   For NSF, Grant Proposal Guide (GPG) guidelines apply.

   For DOD, DOE, and NASA, contact the cognizant program officer. See Section VIII for the contact information.

   For awards made by USDA/NIFA: Section 715 of the Consolidated and Further Continuing Appropriations Act, 2015 (Pub. L. 113-235) limits indirect costs to 30 percent of the total Federal funds provided (or 42.857 percent of total direct costs) under each award. Similar language may be included in the FY 2016 appropriation; therefore, when preparing budgets, you should limit your request for the recovery of indirect costs to the lesser of your institution's official negotiated indirect cost rate or the equivalent of 30 percent of total Federal funds awarded. See Part V section 7.9 of the NIFA Grants.gov Application Guide for further indirect cost information. See webpage at http://nifa.usda.gov/indirect-costs for options.

- **Other Budgetary Limitations:**

   Not Applicable

C. Due Dates

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

   March 07, 2016

   January 12, 2017

   Second Thursday in January, Annually Thereafter

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:

Additional award conditions apply. Please see the full text of this solicitation for further information.

Reporting Requirements:

Additional reporting requirements apply. Please see the full text of this solicitation for further information.

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I. INTRODUCTION

The goal of the National Robotics Initiative (NRI) is to accelerate the development and use of robots in the United States that work beside or cooperatively with people. Innovative robotics research and applications emphasizing the realization of such co-robots working in symbiotic relationships with human partners is supported by multiple agencies of the federal government including the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), the National Institutes of Health (NIH), the U.S. Department of Agriculture (USDA), the U.S. Department of Energy (DOE), and the U.S. Department of Defense (DOD).

This solicitation describes the goals and features of this National Robotics Initiative with particular attention to fundamental research and education by academia and industry built on open platforms, enabling demonstration systems and transfer for commercial development. Proposers more focused on development activities should consider Small Business Innovative Research (SBIR), Small Technology Transfer Research (STTR), and other related solicitations from NSF and partner agencies. Considerations that apply to basic research grants are outlined in the Program Description in section II.A. More detailed information on the domain-specific interests of NASA, NIH, USDA, DOE, and DOD is described in section II.A.2. Within NSF, NRI is administered jointly by the Directorate for Computer and Information Science and Engineering and the Directorate for Engineering. Supporting Directorates include the Directorate for Education and Human Resources and the Directorate for Social, Behavioral & Economic Sciences. Within NASA, NRI Phase I is administered by the Office of the Chief Technologist, with sponsoring Directorates in Science, Exploration, Space Operations, and Aeronautics Research. Within the NIH, NRI is led by the National Institute of Biomedical Imaging and Bioengineering, and is supported by multiple Institutes and Centers of the NIH. Within USDA, NRI is led by the National Institute of Food and Agriculture (NIFA). Within DOD, NRI is led by the Deputy Assistant Secretary of Defense for Research, and is supported by multiple departments and agencies. Within DOE, NRI is led by the Assistant Secretary for Environmental Management and is supported by multiple offices and agencies. Contacts for these and related activities at other sponsoring agencies can be found in section VIII of this document.

Over the past ten years, tremendous advancements in robotics technology have enabled a new generation of products in industries as diverse as manufacturing, logistics, medicine, healthcare, military, agriculture, and consumer products. It is becoming increasingly evident that these early, next-generation products are harbingers of numerous, large-scale, and global robotics technology markets likely to develop in the coming decades. Additionally, robotics science and technology together with the science of learning have the potential to play a very important role in Science, Technology, Engineering, and Mathematics (STEM) education as a unique, integrative discipline that brings together basic science, applied engineering, and creative thinking.

The U.S. robotics industry largely collapsed in the 1980s, with a substantial market share decline to below 10% of global sales. In the last 20 years this market has revived, with the industrial robot manipulators of the 1980s now being augmented with new and different forms of robots. Surgical robots, sentry robots, and household robots emerged as new sub-markets presently exceeding the industrial robot sector. Although the industrial robots for manufacturing (e.g., for welding, painting, handling) are still dominated by foreign industry, new markets for service robots were created by U.S. inventors, U.S. Government initiatives, and U.S. investors and are now dominated by U.S. industry. One of the key discriminators between industrial robots and these new robotic systems is the elimination of the requirement of complete isolation of the industrial robot from humans; such large, fast and dangerous machines are best kept away from areas where people work. The new markets focus on robots that work beside, or cooperatively with, people to extend or augment human capacities.

To assess the opportunities and challenges for a national robotics initiative, over 140 robotics experts from industry, laboratories, and universities from across the country joined forces to produce a definitive report entitled *A Roadmap for US Robotics- From Internet to Robotics* (http://www.us-robotics.us/reports/CCC%20Report.pdf) that was updated in 2013 (http://robotics-vo.us/sites/default/files/2013%20Robotics%20Roadmap-rs.pdf). Other informative reference reports include the *Office of the Secretary of Defense Unmanned Systems Roadmap (2009-2034)* (http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA522247) and the *WTEC Panel Report on International Assessment of Research and Development In Robotics* (http://www.wtec.org/robotics/report/screen-robotics-final-report.pdf). These reports suggest ways in which robots in the future can serve as our *co-workers*, *co-defenders*, *co-explorers,* and *co-inhabitants*.

II. PROGRAM DESCRIPTION

The primary purposes of the National Robotics Initiative (NRI) are to provide leadership in research fundamental to the development of the next generation of robots and co-robots, to advance the capability and usability of such systems and artifacts, and to encourage existing and new communities to focus on innovative application areas where robots collaborate productively with humans. The NRI looks to stimulate partnering arrangements necessary to create next-generation operational systems in such areas as manufacturing, space and undersea exploration, healthcare and rehabilitation, military and homeland security, civil and environmental infrastructure protection, food production, processing, and distribution, assistive devices for improving independence and quality of life, and safer driving. It covers the entire life cycle from fundamental research and development to industry manufacturing and deployment. Methods for the establishment and infusion of robotics in educational curricula and research to gain a better understanding of the long-term social, behavioral and economic implications of co-robots across all areas of human activity are important parts of this initiative. The scope of the application domains perceived as worthy and viable adopters of this technology include robotic systems that serve as co-workers, co-inhabitants, co-explorers, and co-defenders.

Collaboration among academic, industry, non-profit and other organizations is strongly encouraged to establish better linkages between fundamental science and technology development and use, through partnerships among researchers, applications developers, users and industry. While the NRI encourages projects that include some aspects of technology development, fundamental research should dominate. Proposers focused on developmental work are encouraged to consider submission to SBIR and STTR programs.

II.A.1. Research and Application Areas

The co-robot theme of the NRI recognizes the emerging analytical, computational, mechanical, electrical, and cognitive technologies that will make the next generation of robotic systems able to safely co-exist in close proximity to humans in the pursuit of mundane, dangerous, precise or expensive tasks. Co-robots will need to establish a symbiotic relationship with their human partners, each leveraging their relative strengths in the planning and performance of tasks. Co-robots will be distinguished from robots of the past by their new levels of environmental modeling, situational understanding, and resourcefulness due, in part, to the use of real-world data in real time. As research advances, co-robots will operate with ever-increasing levels of intelligence, safety, productivity, and autonomy in unstructured, human-dominated environments. This will ultimately manifest in levels of robot intelligence and adaptability seen only in animals and humans. Despite the vastly improved capabilities for broad diffusion, access, and use (and hence, to achieve societal impacts), co-robots must be relatively cheap, easy to use, and available everywhere.

As the U.S. population ages and becomes more culturally and linguistically diverse, co-robots may serve to increase the efficiency, productivity and safety of individuals in all activities and phases of life, and their ubiquitous deployment has the potential to measurably improve the state of national health, education and learning, personal and public safety, security, the character and composition of a heterogeneous workforce, and the economy, more generally. Widespread deployment may also pose ethical issues and exacerbate disparities among social, linguistic and demographic groups. Thus, in addition to fundamental research issues in analytical, computational, mechanical, electrical, and cognitive technologies, basic research in social, economic, and behavioral sciences, jointly with computer science, mathematics, and engineering, is a critical element in understanding and modeling both the individual and aggregate human/co-robot interactions.

To achieve the goals of the NRI program, funding will be available to support basic research in robotics science and technology as well as research and development in shared infrastructures that support basic research. While disciplinary research is important, the NRI program encourages cross-disciplinary projects with an emphasis on human-robot interaction. The list below is a sampling of basic research topics relevant to co-robots. Some topics will appear in multiple categories. This list is by no means exhaustive. Proposers are encouraged to incorporate other topics that support the co-robot theme into their proposals. However, proposers are reminded that NRI proposals must show a compelling connection to co-robotics.

- Autonomy: principles, computational methods, and architectures for enhancing intelligent perception and decision-making by single agents and teams of agents in unstructured environments; examples include human interaction with unmanned systems for supervision, collaborative control, and peer-to-peer collaboration.

- Social, Behavioral, and Economic: research to understand long-term social, behavioral, and economic implications of co-robots across all areas of human activity, including uptake, diffusion, and use among different demographic and social groups, including appropriate incentives and potential disparities and ethical implications; workforce participation among various diverse groups, including the elderly and non-native English speakers.

- Sensing and Perception: sensor/biosensor systems and networks; real-time environmental sensing systems with high spatial and temporal resolution and target specificity; object perception in clutter and various lighting conditions; sensors capable of discriminative monitoring of multiple agents such as chemical and biological threat agents, biomarkers and metabolites, and plant pathogens; sensors for food quality; strategies to improve perception; enhanced immersive interfaces using multi-model displays; real-time estimation of human physical and emotional state; real-time prediction of human intent; and methods for object recognition and human activity monitoring.

- Modeling and Analysis: models of physical human-robot interactions for collaborative tasks (such as assembly) and associated performance metrics; verifiable simulation models and benchmarking; engineering and human-factors models of dynamic interactive human-robot teams; models of multi-modal interfaces and operator skill development; formal models that support tasks execution with success guarantees for human-robot systems; new geometric and physical models that capture uncertainty and allow efficient construction of robust task plans; and social, behavioral, and economic models to support analysis and prediction of long-term impacts of co-robots.

- Design and Materials: physical co-robot designs that enhance the safety and comfort of the human during collaborative task execution; compliant actuation methods; novel approaches and mechanisms for actuation and robot mobility; soft structures with embedded power, actuation, sensing, and computation; system-level design and engineering; optimization of kinematic and dynamic properties of co-robots; miniaturization of sensors and robots; manufacturability, cost, and life-cycle analysis; and wearable robots and smart clothing capable of biometric monitoring and first aid.

- Communication and Interfaces: research in human cognition, communication, and natural language processing; language understanding and production; communication through physical contact and brain-machine interfaces; computational algorithms and architectures for analyzing, understanding, and generating speech and other communicative forms such as gestures and haptic displays; interaction of communicative forms; and dialogue, conversation, and cross-language capabilities.

- Planning and Control: motion or task planning methods with success guarantees; provably correct planning methods;

models and algorithms to efficiently represent the structure of search spaces to speed planning; generation of legible motions; optimal control of hybrid systems including human-robot systems; real-time planning with kinematic and dynamic models; human-guided planning; fault-tolerant planning; real-time fault diagnosis and replanning; continuous calibration and adaptation of kinematic and dynamic models; formal methods for planning; stability of hybrid local-central controllers such as both that arise in exoskeletons and smart prosthetics; controllers that mimic human learning, reasoning, and action planning; and stability of human-robot co-learning for interfaces where the robot's controller adapts to human control inputs.

- Artificial Intelligence: mechanisms of human reasoning and action planning; problem-solving architectures that integrate reasoning, perceptual, motor, and natural language capabilities; models of human cognition and acquisition of contextual knowledge; systems that integrate robotic and AI planning with learning and navigation for human-robot teams; research in specialties supporting the expansion of robot capabilities such as multi-agent systems, human and machine cognition, and developmental science; and knowledge representation.

- Cognition and Learning: machine cognition and cognitive prediction; models of human or animal cognition; cognitive prostheses that extend human cognitive capabilities; shared mental models for human-robot teams; systems that learn from personal experience or from other robots' experiences; cognitive prostheses; hybrid architectures that integrate different methods such as deductive, probabilistic, case-based, and symbolic reasoning; and general-purpose learning algorithms possibly using universal nonlinear function approximators or extensions to nonsmooth function approximators.

- Algorithms and Hardware: design of data structures, algorithms, and computing hardware including GPUs and FPGAs for all topics above to achieve real-time, interactive performance; and methods that support scaling up of problem sizes, for example, a single operator controls very large teams of robots.

- Application-Inspired: new types of sensors needed for new types of applications; research topics peculiar to healthcare, marine, surveillance, mining, household, agriculture, and nano-robots; and neural interfaces, signal processing, and control methods for intelligent prosthetic devices.

- Platform-Specific: issues peculiar to specific platforms and operating domains including micro- and nano-robots, humanoid robots, networked multi-robot teams, Robot Operating Systems (ROS), exoskeletons, prosthetic devices, households; and assembly lines.

- Assistive Technologies: enabling humans to amplify or compensate for their capabilities, with systems that interpret their intent, make context based decisions, and allow people to operate beyond their diminished or normal physical, cognitive or sensory capabilities, including prosthetics and exo-skeletal augmentation; and methods to use new environmental monitoring technologies and to make decisions to improve human quality of life.

- STEM Education: Research on robotic technologies that will enable the development of interactive and adaptive learning environments for learners of all ages, across all domains; and preparation of the next generation of researchers to confront new challenges in data-enabled robotic technologies and science (e.g., co-robot systems that support experimental workflow design, data ubiquity, and personalized learning).

The list below is a sampling of applied research and development topics in shared infrastructures that support basic research. This list is by no means exhaustive. Proposers are encouraged to incorporate other topics that support the co-robot theme into their proposals.

- Establish open system robotics architectures and common hardware and software platforms enabling the technical community to build upon and interface to a layered capability or functional model and set of protocols.

- Establish competitions among funded projects for best performance of tasks to be defined by the participating program officers and managers. Competing teams may be comprised of individuals or groups with the option of partnering with unfunded collaborators from academia or industry. Establish simulation-based software systems to support virtual competitions and STEM education.

- Create a repository of software, hardware and data to encourage sharing of results and coordination of efforts on hardware and software, and contributions from users and "citizen engineers," and create the cyberinfrastructure to enable cloud robotics. Data will include standard test sets and specifications for common performance measures of algorithms and systems to encourage use of domain-specific metrics.

- Create physical and virtual testbeds for integration of the outputs of multiple activities and their testing, demonstration, and evaluation on high-level and complex tasks. Virtual testbeds should be validated for a suite of benchmark problems.

- Transfer new platforms or functional capabilities to agency mission applications and facilitate agency-specific technology demonstrations of robotic systems over the period of the initiative.

- Produce empirical findings that contribute to knowledge about the use of robotics to facilitate STEM learning across the K-16 continuum, with particular emphasis being placed on means to stimulate and motivate participation in STEM careers and broaden participation in them.

- Coordinate with a separately funded companion effort to generate such advances leading to commercial products and services through the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs and independent business plan competitions.

- Sponsor a range of projects from one or more investigators to multi-faceted collaborative efforts that may include academic and industrial scientists in the core technologies; domain application specialists; educators; and social, behavioral and economic scientists.

II.A.2. Sponsoring Agency Mission Specific Research

NSF will consider for funding proposals addressing any of the areas described above in section II.A.1., as well as those described below in sections II.B and II.C and all others needed to achieve the co-robot vision. NSF strongly encourages potentially transformative research in core robotic technologies and education.

NASA encourages robotics research and technology development to enhance NASA's aeronautics and space missions. NASA seeks innovative proposals that will significantly: (1) extend exploration capabilities beyond human spaceflight limitations; (2) reduce risk and cost in human spaceflight and on-orbit assembly; (3) improve science, exploration mission operations, and launch systems performance; (4) increase the performance of autonomous robotic missions; (5) enable robots and autonomy to be used as a force

multiplier; and/or (6) improve autonomy and safety for operating unmanned aerial vehicles.

NASA's top level goals are to:

- Create and capture new markets for the U.S. robotics industry.

- Invent new robotic systems for assisting astronauts in dangerous and expensive missions.

- Develop innovative robotic explorers for missions beyond human craft, extending human reach.

The critical technologies needed to address these needs are summarized in the NASA Space Technology Roadmaps and in particular the Roadmap for Technology Area 4 (Robotics, Tele-Robotics and Autonomous Systems):

- Sensing & perception: Space-relevant sensors (environment, hazards, etc). Computationally efficient and infrastructure-free navigation (localization, hazard avoidance, etc). Tactile and force perception for equipment deployment, sampling, repair, etc.

- Mobility: Systems to improve the transport of crew, instruments, and payloads on planetary surfaces, asteroids, and in-space. This includes active suspension, grappling/anchoring, legged locomotion, free flying and other transport modes.

- Manipulation: Systems to improve handling and maintenance of payloads and assets. Fusing vision, tactile and force control for manipulation. Exceeding human-like dexterous manipulation. Mobile manipulation that is safe for working with and near humans.

- Human-system interaction: Systems that enable crew and ground controllers to better operate, monitor and supervise robots. This includes robot user interfaces, automated performance monitoring, ground data system tools, command planning and sequencing, real-time visualization/notification, and techniques for expressing intent between humans and robots.

- Autonomy: Software and systems to enable operations of robotic systems in dynamic and uncertain environments with various levels of human interaction. This includes planning and scheduling, robust execution and reasoning, integrated system health management and validation/verification.

- System engineering: Robot software and hardware architectures that improve operational robustness and longevity, facilitate maintainability and upgradeability, and reduce costs associated with integration and test.

NASA's need to assist humans in space is well aligned with the safety, productivity, interface, and other challenges that co-workers and co-explorers have in common. NASA is particularly interested in robotic technologies that increase the productivity of human explorers and that allow humans to amplify their capabilities. NASA's future includes robots that perform pre-cursor work to help prepare for future human activity; robots that go into space with humans as our assistants; robots that work after humans on tasks that complete, complement, or supplement human activity, and robots that are sent to explore beyond the reach of human missions.

More information about NASA's Technology Roadmaps can be found at the following NASA website (look for Technology Area TA04, Robotics, Tele-robotics and Autonomous Systems): http://www.nasa.gov/offices/oct/strategic_integration/technology_roadmap.html. More information about NASA's involvement in the National Robotics Initiative can be found at the following NASA website: http://www.nasa.gov/robotics. More information on NASA solicitations can be found at the following NASA website: http://www.nasa.gov/offices/oct/home/solicitations.html.

The **NIH** encourages robotics research and technology development to enhance health, lengthen life and reduce illness and disability. The NIH also supports non-hypothesis driven applications, which include technology-driven and problem-driven applications. NIH supports technology that is needs-driven. Specifically, the participating NIH institutes on this solicitation are interested in targeting this solicitation to support the development of assistive robotic technology to achieve functional independence in humans; improve quality of life; assist with behavioral therapy and personalized care; and promote wellness/health. The most significant challenges will be in addressing safety issues, especially for applications to be used in home-based and long-term care settings where integration of complex systems will be required. Additionally, these assistive robots need to quickly adapt to changes of the user and the environment. Human assistive devices should be designed to assist healthcare providers as well as the individuals needing care. Development of robotic applications is important to NIH because of their potential significant impact on healthcare in the future. Human assistive devices will revolutionize healthcare in the next 20 years as much as personal electronics have changed our daily lives in the past two decades. Affordable and accessible robotic technology can facilitate wellness and personalized healthcare. Continual health assessment and personalized intervention have the potential to offset the shrinking size of the healthcare workforce and the growing elderly and disabled population. In the future, assistive robotics will enable people to engage in all aspects of human life with endurance and dignity.

Examples of assistive robotic technology development include, but are not limited to:

- Home care and long-term personalized care robots.

- Robotic wellness/health promotion and maintenance.

- Robotic behavioral therapy.

- Robotic aids for mobility, manipulation, human communication and cognition, vision for non-sighted persons.

- Assistive robotics to eliminate health disparities across populations.

When developing appropriate assistive co-robotic technologies, applicants should consider the following basic characteristics: effectiveness, affordability, cultural acceptability, and accessibility to those who need them. Applicants should describe how these technologies will address the healthcare needs of the end user (healthy individuals, persons with disabilities, and or health disparity populations). The proposer should compellingly describe the healthcare problem being addressed and the technology solution being proposed. It is strongly encouraged that a healthcare expert be included on the research team (as a consultant or collaborator, as appropriate).

The robotic applications promoted in this solicitation are for **non-operative settings**. The NIH is still interested in supporting robotics for surgical health interventions, robotic exoskeletons, and prosthetics, however, not in response to this solicitation. Applicants interested in this area should send inquiries to the NIH program contacts listed in the update to the NIH Guide Notice NOT-EB-15-008, http://grants.nih.gov/grants/guide/notice-files/NOT-EB-15-008.html.

The **USDA/NIFA** encourages robotics research, applications, and education to enhance agricultural production, processing, and distribution systems that benefit consumers and rural communities. These robotics efforts address USDA goals (http://www.usda.gov/documents/usda-strategic-plan-fy-2014-2018.pdf), including: protecting agricultural health to ensure access to safe, plentiful, and nutritious food (Goal 4.4), increasing agricultural opportunities by supporting a competitive agricultural system (Goal 1.1), contributing to clean and abundant water by protecting and enhancing water resources (Goal 2.3), and ensuring that U.S. agricultural resources contribute to global food security (Goal 3.1). The USDA/REE Action Plan is also supported through the following goals (http://www.ree.usda.gov/ree/news/USDA_2014_REE_Action_Plan_08-2014_Final.pdf): sustainable intensification of agricultural production, sustainable use of natural resources, and education and science literacy. Furthermore, NIFA Science goals are supported, including (http://nifa.usda.gov/about/pdfs/strat_plan_2014.pdf): advancing our Nation's ability to achieve global food security and fight hunger, optimizing the production of goods and services from working lands while protecting the Nation's natural resource base and environment, and ensuring the development of human capital, communities, and a diverse workforce. In the process, it is expected that projects will engage academia, industry, stakeholders/users, students, and other organizations to identify fundamental research needs and to conduct both basic and applied research, while providing training for the next generation of scientists, engineers, and technologists. Projects involving the following topics are particularly desired, although other robotics topics will be considered:

High-Throughput Robotic Technologies. Examples include the following areas:

- Automated systems for inspection, sorting, processing, or handling of animal or plant products (including forest products) in post-harvest, processing, or product distribution environments.

- Automated systems for planting, scouting, spraying, culturing, irrigating, and harvesting plant crops (including forests) to decrease costs, improve efficiency, or reduce inputs of water, fertilizer, or chemicals.

- Improved robotics for inspection, monitoring, culturing, sorting, and handling of plants and flowers in controlled environment facilities and nurseries, or for handling (e.g., sorting, vaccinating, deworming) large numbers of live animals.

- Multi-modal and rapid sensing systems for detecting defects, ripeness, physical damage, microbial contamination, size, shape, and other quality attributes of plant or animal products (including forest products), or for monitoring air or water quality.

Multi-Agent Command, Coordination, and Communication. Examples include the following areas:

- High-level task planning, execution, and control systems for spatially distributed autonomous or semi-autonomous robots that operate in concert with human co-workers.

- Communication protocols and standards for inter-agent coordination and unattended collaboration.

- Distributed intelligence and fault tolerance that will allow high-level task completion despite failure of one or more agents or temporary loss of human attention.

DOD/DARPA sponsors robotics research and robotics technology development to protect lives and improve productivity. DARPA efforts include basic research that seeks to explain the frontiers of understanding, but is also inspired by considerations of use. For the purposes of this solicitation, DARPA is interested in human-robot interaction. Examples include the following areas:

- Models of robot-human information exchange, behavior and states for more natural human-robot information exchange.

- Develop shared (robot and human) mental models, concepts of team situation awareness, and practical notions of trustworthiness for robotic systems.

- Explore multi-model human-robot interaction capabilities, such as natural language, gesture, tactile displays, auditory understanding, and interactive representations of the robot "mental model."

- Model social dynamics supporting context for perception, tactical movement, and socially conscious behaviors.

- Introduce new techniques for measuring system performance and effectiveness encompassing the human-machine system (not just the robot).

DARPA strongly encourages efforts that make models and simulations available as open source.

DOD/AFoSR encourages basic research in robotics to support the United States Air Force's (USAF's) broad vision for the use of autonomous systems to achieve capability increases and cost savings via increased manpower efficiencies, increased capability, and reduced manpower needs. According to this vision, the value of autonomous and robotics systems is not to replace Airmen, but to build human-robot teams that complement each other and extend the team's capability to perform a mission. Central to the goal of effective human-robot teaming is the establishment of trust between humans and robots. Research is needed to investigate behaviors, processes and capabilities that support properly calibrated human-robot trust. Examples of research areas on trusted human-robot teaming include the following: (1) investigating socially-designed cues such as humanoid appearance, voice, personality, and other social elements on human trust and overall human-robot team performance, (2) physical "embodiment" features versus non-physical features to determine which have the most influence on human trust and performance, (3) sensing of human intent, cognitive and affective states, such as workload, stress, fatigue and fear, (4) modeling the processes of high performing human teams, such as teammate monitoring, backup behavior, joint attention, shared mental models, coordination and negotiation, (5) dynamic modeling of the human-robot partnerships to allow continuous improvement of joint performance in real-world applications, (6) investigations regarding the effectiveness of various models of human-robot interaction, such as delegation and supervisory control, (7) practical methods for robotic systems to sense and measure trust and changes in trust over time, (8) investigations of the impact of culture and cross-cultural interactions on reliance and human-machine cooperation. Interdisciplinary research and research in collaboration with government labs (e.g., Air Force Research Lab (AFRL)) is especially encouraged.

DOE/EM encourages robotics research and robotics technology development for: (1) handling of high-hazard, high-consequence materials and waste; (2) performing worker/operator tasks that are dirty (contaminated, toxic, nuisance), dull (routine, labor-intensive, repetitive, mundane), and dangerous (pose significant occupational hazards); (3) easing the performance of worker/operator tasks that are physically demanding on or stressful to human body or are otherwise ergonomically challenging; (4) performing tasks that

are beyond human abilities; (5) improving the ability to respond to and recover from unplanned events or operational emergencies; and (6) improving the safety, quality, efficiency, and productivity of facility operations.

"Radiation hardened systems" refers to systems that are immune or unaffected by the effects of ionizing radiation or radioactivity. "Radiation tolerant systems" refers to systems that are resistant to the effects of ionizing radiation or radioactivity to certain threshold limits.

Topics and areas of academic, scientific, and engineering pursuit for the application of DOE/EM robotics technologies include, but are not limited to:

- Remote Access
  - Radiation hardened systems and radiation tolerant systems that provide remote entry into areas and spaces that are otherwise inaccessible or prohibit direct access by workers due to:

    § Unsafe, unstable, or unknown physical or structural conditions;

    § Configurations that are hard to reach or beyond reach without taking extraordinary mechanical measures;

    § The presence or potential presence of radiological, chemical, biological, or physical hazards that will or may result in unacceptable occupational exposure or increased health or safety risk; and

    § Other conditions that preclude safe entry or are otherwise uninhabitable such as areas or spaces that have or potentially have: oxygen-deprived environments or other conditions of poor air quality; explosive gases, materials or devices; extreme temperatures; extreme pressures; poor or no visibility or direct line of sight due to lack of lighting or obstructions; and submerged or substantially liquid-covered surfaces.

- Non-Destructive Testing and Evaluation
  - Radiation hardened/tolerant acoustic, optical, radiographic, thermographic, electromagnetic, and other tooling and methods for non-destructive sensing, detecting, monitoring, measuring, characterizing, and assaying a wide variety of radiological, chemical, environmental, and physical parameters.
- Imaging, Surveying, Mapping, and 3D Rendering
  - Radiation hardened/tolerant tooling and methods for the generation of graphical depictions and representations as well as virtual replications, simulations and models of the real world.
- Manipulation and End-Effectors
  - Radiation hardened/tolerant systems for remotely performing tasks in harsh environments or work conditions to keep occupational exposure to hazards as low as reasonably achievable (ALARA).
- Worker Assistance
  - Wearable and prosthetic-like radiation hardened/tolerant robotic devices (a.k.a., co-robots) that improve worker health and safety, enhance worker performance and endurance, or compensate for physical limitations of extremities by relieving physical stresses on the body and avoiding occupational injuries such as those caused by: repetitive and forceful exertions and motions; frequent, heavy, or overhead lifts or tasks; ergonomically incorrect work positions; use of vibrating (shock-inducing) equipment; and muscle fatigue.
- Heavy Operations
  - Radiation hardened/tolerant systems for performing tasks that are beyond worker capability and require substantially greater strength, dexterity, reach and access, or capacity.
- Task Automation
  - Radiation hardened/tolerant systems for more efficiently performing routine or repetitive tasks and operations such that worker interface is needed only for performance monitoring and quality control.

All sponsor-targeted proposals:

Those proposals that are targeting a specific agency sponsorship should indicate so in the last line of the last box of the Project Summary, e.g., "Requested funding agency:" followed by that agency's abbreviated name, "NSF," "NASA," "NIH," "USDA," "DOE," or "DOD," but only if they have previously communicated with a program officer from that agency and received permission or instruction to do so. Those not so designated will be considered for funding by all of the joint sponsoring agencies.

II.B. Testbeds and Applications

This initiative also aims to fund the development of co-robot testbeds for technology testing, demonstration and validation, and as prototype resources for domain communities - technical and non-technical. Support will be provided for development and implementation of co-robot applications, which demonstrate new technologies and are sufficiently robust and stable to serve identifiable research communities and encourage collaborative work environments. Applications projects are expected to result in *enduring* environments for research, particularly integration of outputs from multiple projects, learning, and advancing public awareness.

Example activities are:

- Integration of functional components into useful systems to serve specific application domains and identifying unique functional and performance requirements, technical and design issues, and metrics of performance and utility.

- Applications that enhance the general functionality of existing and future co-robot systems by providing new concepts and tools for their development and evaluation.

- Specialized co-robot applications designed for specific knowledge domains and communities (manufacturing, defense, healthcare, agriculture, assistive technology, etc.).

- High-risk, "breakthrough" applications capable of providing new conceptual paradigms for co-robots and alter work and social practices on a grand scale.

To facilitate the advancement of robotics technologies for nuclear applications, DOE/EM is establishing the capability for "radioactive" testbeds, which are existing DOE/EM nuclear facilities and assets that are utilized as physical platforms for researchers and technologists to demonstrate innovative tooling, treatment technologies, and other technical solutions. These rad testbeds would provide researchers and technologists with the unique opportunity to conduct research and technology demonstrations in spaces and areas that (1) having radiation fields; (2) are contaminated with surface and/or fixed radioactivity; (3) are inaccessible, inhabitable, or not safe for worker entry; and/or (4) are under conditions and configurations of nuclear facilities that are difficult or too expensive to replicate or mock-up. Researchers and technologists would also be given the opportunity to use, albeit in small amounts, radioactive wastes and nuclear materials for research and technology demonstrations. DOE/EM encourages the utilization of rad testbeds,

particularly when mature technologies originally intended for non-nuclear applications are proposed for nuclear applications.

II.C. Planning Testbeds and Applications for K-16 Education

To explore the linking of robotics research efforts and testbeds for K-16 education, NSF's Directorate for Education and Human Resources will provide funding at the lower end of the funding range for planning, study and prototyping projects (refer to section III). Successful applicants are expected to demonstrate high potential to advance K-16 science, technology, engineering, and mathematics (STEM) education. Due to limited funds and the multi-agency nature of this solicitation, **education-focused proposals are discouraged at the higher end of the funding range.**

Example activities are:

- Design of innovative robotic technologies as tools for enhancing STEM learning in formal and informal learning environments.

- Applications that further the development of co-robot systems that support personalized learning.

- Design, implementation, and rigorous study of robotics competitions impact on student engagement, motivation to learn STEM content, and STEM career motivation.

II.D. Infrastructure Requirements and Support

II.D.1. Sharing Plan for software and robotics operating system

A dissemination plan for using and sharing software and the robotics operating system, with appropriate timelines, must be included in the proposal. This should be included in the Supplementary Data Management Plan document. There is no prescribed single license for a robotics operating system produced through grants, contracts and agreements corresponding to this announcement. However, the government does have goals for software dissemination and sharing of the robotics operating systems, and reviewers will be instructed to evaluate the dissemination plan relative to these goals:

- The software and robotics operating system should be easily accessible to researchers and educators in the non-profit sector, such as institutions of education, research institutions, and government laboratories, and available to cooperating commercial entities.

- The terms of software and robotics operating system availability should permit the dissemination and commercialization of enhanced or customized versions of the software, or incorporation of the software or pieces of it into other software robotics systems.

- To preserve utility to the community, the software and robotics operating system should be transferable such that another individual or team can continue or enhance development in the event that the original investigators are unwilling or unable to do so.

- The terms of software and robotics operating system availability should include the ability of researchers to modify the source code and to share modifications with others. An applicant should take responsibility for creating the original and subsequent official versions of a piece of software.

- To further enhance the potential impact of their software and robotics operating system, applicants may consider proposing a plan to manage and disseminate the improvements or customizations of their tools and resources by others. This proposal may include a plan to incorporate the enhancements into the official core software, may involve the creation of an infrastructure for plug-ins, or may describe some other solution.

The adequacy of the sharing plans described in the Data Management Plan for the software and robotics operating system will be considered by program staff when making recommendations about funding proposals. Any plans for dissemination of software and the robotics operating systems represent a commitment by the institution (and its subcontractors as applicable) to support and abide by the plan. The final version of any accepted software and robotics operating systems sharing plans will become a condition of the award grant, contract or agreement. The effectiveness of software and robotics operating system sharing may be evaluated as part of the administrative review of each award.

II.D.2. Support for common robot platforms

Proposers may include requests for funding the acquisition of robot platforms required to conduct their research, implementation, development and educational activities. The use of a small number of common platforms for the research to be conducted by all the awardees will facilitate software development and robot operating system enhancement and its sharing. Budgets may allow for platforms costing up to $200,000 each. Supplemental funding may be requested for additional platforms should the nature of the research justify it. NSF will consider such supplemental requests only from its awardees.

Reviewers will be instructed to evaluate the proposed platform acquisitions and their utility to the proposed research and the NRI goals more broadly. The adequacy of the robotic platform acquisition justification will be considered when making recommendations about funding proposals. In making such considerations, prior to funding, program staff may negotiate modifications of the acquisition plans with the Principal Investigator before recommending funding of a proposal.

II.E. Principal Investigator Meetings

We anticipate annual PI meetings of research investigators, testbed, application and education developers, industrial partners and sponsoring agency representatives. Budgets should account for such trips to both the U.S. east coast region and the U.S. west coast region for each of the project principal investigators and other team members as appropriate from all collaborating institutions. These meetings will be highlighted by technology demonstrations and progress reports, and will provide a forum for all to propose and discuss high-risk, high-return ideas and challenges emanating from academia, industry and government.

III. AWARD INFORMATION

All awards made under this solicitation by NSF, NASA, NIH, DOE, USDA, and DOD will be as grants or cooperative agreements or other contract vehicles as determined by the supporting agency. All awards made under this solicitation by USDA/NIFA will be standard grants. A standard grant is an award instrument by which the agency agrees to support a specified level of effort for a

predetermined project period without the announced intention of providing additional support at a future date.

Although there is only one class of proposals, agency requirements and funding mechanisms dictate two ranges of consideration on this solicitation, by agency:

- **NIH** and **USDA/NIFA** will consider projects comprising one or more investigators with budgets ranging from approximately $100,000 to $250,000 per year in **direct costs**, with durations of one to three years.

Proposals of $250,000 or more in direct costs per year will not be accepted by NIH or USDA/NIFA. Applicants who wish to submit a proposal to NIH of more than $250,000 in direct costs for any year should contact the program staff of an NIH Institute/Center directly for alternate proposal mechanisms.

- **NSF, NASA, DOE,** and **DOD** will consider projects comprising one or more investigators with budgets ranging from approximately $100,000 to $1,000,000 per year in **total costs** (direct and indirect) averaged over the duration of the project, with durations of one to three years. It is expected that the bulk of awards will be made at the smaller end of the range.

The number of awards will depend on the quality of proposals received, the availability of funds, considerations for creating a balanced overall program, and the degree to which **meaningful collaboration across institutions** is realized within the larger proposals. (See the NRI website for more information, http://www.nsf.gov/nri.) Innovative methods of collaboration across geographic boundaries are encouraged.

Upon conclusion of the review process, meritorious research proposals may be recommended for funding by one of NSF, NASA, NIH, DOD, DOE, or USDA/NIFA, determined at the option of the agencies, not the proposer. Subsequent grant administration procedures will be in accordance with the individual policies of the awarding agency, and may require submission of a revised proposal that meets the administrative requirements of the funding agency. (See section V.B. for additional information on agency-specific processes.)

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

> The categories of proposers eligible to submit proposals to the National Science Foundation are identified in the Grant Proposal Guide, Chapter I, Section E.

Who May Serve as PI:

> There are no restrictions or limits.

Limit on Number of Proposals per Organization:

> There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 2

> An investigator may participate as PI or co-PI in **no more than two proposals** submitted in response to this solicitation per deadline. This limit does not apply to other senior personnel.

> 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.**

> Proposals submitted in response to this solicitation may not duplicate or be substantially similar to other proposals concurrently under consideration by other NSF, NASA, NIH, USDA, DOE, or DOD programs or study sections. Duplicate or substantially similar proposals will be returned without review, including those substantially similar to previously declined proposals without revisions to address concerns raised by reviewers.

Additional Eligibility Info:

> **For USDA/NIFA:** Eligible applicants for the grant program implemented under this subpart include: (1) State agricultural experiment stations; (2) colleges and universities (including junior colleges offering associate degrees or higher); (3) university research foundations; (4) other research institutions and organizations; (5) Federal agencies, (6) national laboratories; (7) private organizations or corporations; (8) individuals who are U.S. citizens, nationals, or permanent residents; and (9) any group consisting of 2 or more entities identified in (1) through (8). Eligible institutions do not include foreign and international organizations.

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.

See Chapter II.C.2 of the GPG for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the GPG instructions.

The following information supplements the Grant Proposal Guide or NSF Grants.gov Application Guide.

Proposal Titles: Proposal titles must begin with NRI, followed by a colon, then the title. If you submit a proposal as part of a set of collaborative proposals, the title of the proposal should begin with NRI 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, the title of each proposal would be **NRI: Collaborative Research: Title**. Proposals from institutions that have RUI (Research in Undergraduate Institutions) eligibility should have a proposal title that begins with NRI, followed by a colon, then "RUI" followed by a colon, then "Collaborative Research" (if applicable) followed by a colon and then the title; for example, **NRI: RUI: Collaborative Research: Title**.

Project Summary (4600-character limit): At the top of the Overview text box, enter the title of the NRI project, the name of the PI and the lead institution. Provide an overview description of the NRI project, including its research and education goals, and the community (communities) that will be impacted by its results. In separate statements, provide a succinct overview of the project in the first box, a summary of the intellectual merit in the "intellectual merit" box, and broader impacts of the proposed project in the "broader impacts" box. Those proposals that are targeting a specific agency sponsorship should indicate so in the last line of the last box, e.g., "Requested funding agency:" followed by that agency's abbreviated name, "NSF," "DOD," "NASA," "NIH," "DOE," or "USDA" but only if they have previously communicated with a program officer from that agency and received permission or instruction to do so. Those not so designated will be considered for funding by all of the joint sponsoring agencies.

Full proposals that do not address the intellectual merit and broader impacts of the proposed project in separate statements may not be accepted or may be returned without review.

Project Description: 15-page limit for all proposals. **The Coordination Plan must be submitted as a Supplementary Document for this solicitation; see below.**

Supplementary Documents: Supplementary documents are limited to the specific types of documentation listed in the GPG, with the following exceptions:

Coordination Plan. Highly collaborative and multi-disciplinary proposals involving more than three PIs must include a Coordination Plan. **The Coordination Plan must be submitted as a Supplementary Document and cannot exceed two pages.** The Coordination Plan must be labeled "Coordination Plan" and must include: 1) the specific roles of the collaborating PIs, Co-PIs, other Senior Personnel and paid consultants at all organizations involved; 2) how the project will be managed across institutions and disciplines; 3) identification of the specific coordination mechanisms that will enable cross-institution and/or cross-discipline scientific integration (e.g., workshops, graduate student exchange, project meetings at conferences, use of videoconferencing and other communication tools, software repositories, etc.); and 4) specific references to the budget line items that support these coordination mechanisms.

Documentation of collaborative arrangements of significance to the proposal through letters of collaboration. Any substantial collaboration with individuals not included in the budget or not employed by the submitting institution(s) should be described and documented with a letter from each collaborator, which should be provided in the supplementary documentation section. Letters of collaboration that promise access to facilities or resources (such as data sets or databases) should also be provided. **General letters of support are not allowed by the GPG.**

Human Subjects Protection. Proposals involving human subjects should include a supplementary document of no more than two pages in length summarizing potential risks to human subjects; plans for recruitment and informed consent; inclusion of women, minorities, and children; and planned procedures to protect against or minimize potential risks.

Applications seeking funding from the NIH and that involve human subjects but does not involve one of the six categories of research that are exempt under 45 CFR Part 46, the application must address the following five criteria: 1) risk to subjects, 2) adequacy of protection against risks, 3) potential benefits to the subjects and others, 4) importance of the knowledge to be gained, and 5) data and safety monitoring for clinical trials. (see http://grants.nih.gov/grants/funding/424/SupplementalInstructions.pdf#Part_II.)

For research that involves human subjects and meets the criteria for one or more of the six categories of research that are exempt under 45 CFR Part 46, the committee will evaluate: 1) the justification for the exemption, 2) human subjects involvement and characteristics, and 3) sources of materials.

Inclusion of Women, Minorities, and Children must be addressed for all proposals that involve human subjects. When the proposed project involves clinical research, the committee will evaluate the proposed plans for inclusion of minorities and members of both genders, as well as the inclusion of children (http://grants.nih.gov/grants/funding/women_min/women_min.htm; http://grants.nih.gov/grants/funding/children/children.htm). Applicants proposing research involving human subjects must provide a Planned Enrollment Report (http://grants.nih.gov/grants/funding/phs398/PlannedEnrollmentReport.docx). The Planned Enrollment Report, if included, does not count against the two-page limitation.

For more information please go this website: http://grants.nih.gov/grants/policy/hs/.

Vertebrate Animals. Proposals involving vertebrate animals should include a supplementary document of no more than two pages in length. The committee will evaluate the involvement of live vertebrate animals as part of the scientific assessment according to the following five points: 1) proposed use of the animals, and species, strains, ages, sex, and numbers to be used; 2) justifications for the use of animals and for the appropriateness of the species and numbers proposed; 3) adequacy of veterinary care; 4) procedures for limiting discomfort, distress, pain and injury to that which is unavoidable in the conduct of scientifically sound research including the use of analgesic, anesthetic, and tranquilizing drugs and/or comfortable restraining devices; and 5) methods of euthanasia and reason for selection if not consistent with the AVMA Guidelines on Euthanasia.

Please note, proposals seeking funding from the NIH that include human and/or vertebrate animal studies will be barred from funding if these sections are excluded from the proposal, or if the reviewers evaluate the submitted descriptions as unacceptable (see review criteria below).

Data Management Plan. All proposals must include a supplementary document no more than two pages in length describing plans for data management and sharing of the products of research, which may include (see sections II.D and VI.A):

- The types of data, samples, physical collections, software, curriculum materials, and other materials to be produced in the course of the project;

- The standards to be used for data and metadata format and content (where existing standards are absent or deemed inadequate, this should be documented along with any proposed solutions or remedies);

- Policies for access and sharing including provisions for appropriate protection of privacy, confidentiality, security, intellectual property, or other rights or requirements;

- A dissemination plan for using and sharing software and the robotics operating system, with appropriate timelines, must be included; and

- Sustainability plan beyond the term of the award.

List of Project Personnel. Include a list of the PI, co-PIs and all other senior personnel, consultants, subcontractors and collaborators (paid and unpaid). List name, affiliation, and role in a concise list. It is not necessary to include students or postdocs not listed as co-PIs.

Postdoctoral Researcher Mentoring Plan (if applicable) See Chapter II.C.2.j. of the Grant Proposal Guide (GPG) for further information about the implementation of this requirement.

Proposals that do not comply with these requirements will be returned without review.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Indirect Cost (F&A) Limitations:

For NSF, Grant Proposal Guide (GPG) guidelines apply.

For DOD, DOE, and NASA, contact the cognizant program officer. See Section VIII for the contact information.

For awards made by USDA/NIFA: Section 715 of the Consolidated and Further Continuing Appropriations Act, 2015 (Pub. L. 113-235) limits indirect costs to 30 percent of the total Federal funds provided (or 42.857 percent of total direct costs) under each award. Similar language may be included in the FY 2016 appropriation; therefore, when preparing budgets, you should limit your request for the recovery of indirect costs to the lesser of your institution's official negotiated indirect cost rate or the equivalent of 30 percent of total Federal funds awarded. See Part V section 7.9 of the NIFA Grants.gov Application Guide for further indirect cost information. See webpage at http://nifa.usda.gov/ indirect-costs for options.

Budget Preparation Instructions:

Budgets should include travel funds to attend annual NRI Principal Investigators' meetings.

For DOE/EM proposals, budgets should include travel estimates for at least two site visits to DOE/EM field offices and/or DOE national laboratories each year.

C. Due Dates

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

    March 07, 2016

    January 12, 2017

    Second Thursday in January, Annually Thereafter

D. FastLane/Grants.gov Requirements

For Proposals Submitted Via FastLane:

To prepare and submit a proposal via FastLane, see detailed technical instructions 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.

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://www.grants.gov/web/grants/applicants.html. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical 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.

Proposers that submitted via FastLane are strongly encouraged to use FastLane to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. 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 either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with 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. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in the GPG as Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: http://nsf.gov/bfa/dias/policy/merit_review/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Empowering the Nation Through Discovery and Innovation: NSF Strategic Plan for Fiscal Years (FY) 2011-2016*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the core strategies in support of NSF's mission 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 variety of learning perspectives.

Another core strategy in support of NSF's mission is broadening opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which 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.

A. Merit Review Principles and Criteria

The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind

the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (GPG Chapter II.C.2.d.i. contains additional information for use by proposers in development of the Project Description section of the proposal.) Reviewers are strongly encouraged to review the criteria, including GPG Chapter II.C.2.d.i., prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
    1. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
    2. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

Additional Solicitation Specific Review Criteria

In general, group and multi-institutional proposals requiring significant resources to generate artifacts are expected to show their potential for novel functionalities and features, identifiable user clienteles, interoperability, scaling, extensibility, and durability, and a detailed description of how these advancements may be made available for commercial support and exploitation. These proposals should, as appropriate, include active participation from client groups, technology vendors, and potential commercial enterprises or application beneficiaries. The proposals will also be evaluated based on:

- Infrastructure planning and software sharing

The dissemination plan for using and sharing software and the robotics operating system, with appropriate timelines, will be assessed for its potential effectiveness and impact on other projects and the NRI overall. Reviewers will also be instructed to evaluate the proposed platform acquisitions and their utility to the proposed research and the NRI goals more broadly. Both of these are described in section II.D.

- Survivability

Credibility of the plan for continuing the development and transferring the artifacts and know-how after the expiration of research funding.

- Impact

Potential for general impact on the development of techniques, environments or paradigms that will advance the utilization of co-robots.

- Collaboration and Management

The extent to which the group is integrated and has a common focus; the quality of management and collaboration plans.

- Education and Training

The degree to which research and education are integrated and activities involve participation and training of students. Reviewers will assess the potential for involvement of motivated populations of young roboticists in accomplishing the research goals.

Subsequent to the uniform panel reviews, a process of selection by the supporting agencies will be conducted. When considering their funding choices appropriate to the interests and goals described in the solicitation, each agency may apply and prioritize the criteria to highlight the specific objectives of their programs and activities, although all of the following are considered by each of the supporting agencies when applicable.

Additional NASA and DOD Review Criteria

There are no additional review criteria for NASA and DOD.

Additional USDA/NIFA Review Criteria

Adequacy of Facilities. Reviewers will assess the adequacy of the necessary research infrastructure capacity for the performing organization to conduct the proposed work.

Relevance. The extent to which the proposed research meets USDA/NIFA goals and advances the sciences related to agriculture and food systems will be evaluated.

Additional DOE Review Criteria

Programmatic Relevance. Reviewers will assess relevancy to the DOE nuclear cleanup mission. DOE/EM is engaged in protecting the environment and the health and safety of local constituents by cleaning up the environmental legacy of the Cold War. To achieve this in the safest, fastest and most economical manner, DOE/EM has established a goal to accelerate cleanup of the nuclear weapons manufacturing and testing sites. This acceleration will necessitate the identification, evaluation, development, demonstration and implementation of innovative, transformational technologies and approaches which can improve on the current baseline of activities. It will also require the active utilization of lessons learned from within the complex and internationally in order to avoid costly schedule delays, as well as the development of human capital development programs to assure a sufficient supply of trained environmental professionals over the entire period of performance of DOE/EM activities.

Radioactive and/or Hazardous Waste. When radioactive test beds are utilized, reviewers will assess whether materials or procedures will potentially generate orphan waste (i.e., no known disposition path) or other radioactive and/or hazardous waste streams, and if needed, determine whether treatment, storage and/or disposal is beyond current DOE facility capabilities.

Occupational Exposure to Ionizing Radiation. When radioactive testbeds are utilized, reviewers will assess whether the work will require monitoring for occupational exposure to ionizing radiation.

Nuclear Facility Safety Authorization Basis. When radioactive test beds are utilized, reviewers will assess whether the work may potentially require an unreviewed safety question determination.

Standard NIH Review Criteria

The mission of the NIH is to support science in pursuit of knowledge about the biology and behavior of living systems and to apply that knowledge to enhance health, lengthen life and reduce illness and disability. **While many of the NIH and NSF review criteria are based on the same standards of scientific evaluation, some scoring mechanisms and programmatic emphases vary.** For example:

- All proposals under consideration by NIH will be scored by their respective review panels using the NIH 1-9 scoring system, which does not include consideration of broader impacts.
- Proposers should pay particular attention to NIH clinical evaluation standards represented by criteria for human protections, inclusion of women, minorities, and children in the study population, and animal subjects' protections, as well as biohazards (see human and animal items below).

In general, NIH funding priorities will be directed toward proposals that best address the following criteria that are used by NIH:

Overall Impact - Reviewers will provide an overall impact/priority score to reflect their assessment of the likelihood for the project to exert a sustained, powerful influence on the research field(s) involved, in consideration of the following review criteria and additional review criteria (as applicable for the project proposed). An application does not need to be strong in all categories to be judged likely to have major scientific impact.

Significance - Does the project address an important problem or a critical barrier to progress in the field? If the aims of the project are achieved, how will scientific knowledge, technical capability, and/or clinical practice be improved? How will successful completion of the aims change the concepts, methods, technologies, treatments, services, or preventative interventions that drive this field?

Investigator(s) - Are the PD(s)/PI(s), collaborators, and other researchers well suited to the project? If Early Stage Investigators or New Investigators, or in the early stages of independent careers, do they have appropriate experience and training? If established, have they demonstrated an ongoing record of accomplishments that have advanced their field(s)? If the project is collaborative or multi-PD/PI, do the investigators have complementary and integrated expertise; are their leadership approach, governance and organizational structure appropriate for the project?

Innovation - Does the application challenge and seek to shift current research or clinical practice paradigms by utilizing novel theoretical concepts, approaches or methodologies, instrumentation, or interventions? Are the concepts, approaches or methodologies, instrumentation, or interventions novel to one field of research or novel in a broad sense? Is a refinement, improvement, or new application of theoretical concepts, approaches or methodologies, instrumentation, or interventions proposed?

Approach - Are the overall strategy, methodology, and analyses well-reasoned and appropriate to accomplish the specific aims of the project? Are potential problems, alternative strategies, and benchmarks for success presented? If the project is in the early stages of development, will the strategy establish feasibility and will particularly risky aspects be managed?

If the project involves clinical research, are the plans for 1) protection of human subjects from research risks, and 2) inclusion of minorities and members of both sexes/genders, as well as the inclusion of children, justified in terms of the scientific goals and research strategy proposed?

Environment - Will the scientific environment in which the work will be done contribute to the probability of success? Are the institutional support, equipment and other physical resources available to the investigators adequate for the project proposed? Will the project benefit from unique features of the scientific environment, subject populations, or collaborative arrangements?

Where applicable, the following items will also be considered:

Protections for Human Subjects. For research that involves human subjects but does not involve one of the six categories of research that are exempt under 45 CFR Part 46, the committee will evaluate the justification for involvement of human subjects and the proposed protections from research risk relating to their participation according to the following five review criteria: 1) risk to subjects, 2) adequacy of protection against risks, 3) potential benefits to the subjects and others, 4) importance of the knowledge to be gained, and 5) data and safety monitoring for clinical trials.

For research that involves human subjects and meets the criteria for one or more of the six categories of research that are exempt under 45 CFR Part 46, the committee will evaluate: 1) the justification for the exemption, 2) human subjects involvement and characteristics, and 3) sources of materials.

Inclusion of Women, Minorities, and Children. When the proposed project involves clinical research, the committee will evaluate the proposed plans for inclusion of minorities and members of both genders, as well as the inclusion of children.

Vertebrate Animals. The committee will evaluate the involvement of live vertebrate animals as part of the scientific assessment according to the following five points: 1) proposed use of the animals, and species, strains, ages, sex, and numbers to be used; 2) justifications for the use of animals and for the appropriateness of the species and numbers proposed; 3) adequacy of veterinary care; 4) procedures for limiting discomfort, distress, pain and injury to that which is unavoidable in the conduct of scientifically sound research including the use of analgesic, anesthetic, and tranquilizing drugs and/or comfortable restraining devices; and 5) methods of euthanasia and reason for selection if not consistent with the AVMA Guidelines on Euthanasia.

Biohazards. Reviewers will assess whether materials or procedures proposed are potentially hazardous to research personnel and/or the environment, and if needed, determine whether adequate protection is proposed.

Budget. The reasonableness of the proposed budget and the requested period of support in relation to the proposed research will be assessed.

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by the process below.

A uniform review process will be conducted by NSF for all proposals received responding to this program solicitation. Multiple review panels of experts in the field and additional *ad hoc* reviewers as needed will be assembled. The number and topical clustering of panels will be determined according to the number and topical areas of the proposals received.Staff members from the other supporting agencies will be assigned to work cooperatively with NSF staff on each panel, as appropriate to the category of funding requested. Reviewers will be asked to formulate a recommendation to either support or decline each proposal. A summary rating and accompanying narrative will be completed and submitted by each reviewer. In all cases, reviews are treated as confidential documents. The Program Officer(s) assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

Upon conclusion of the review process, meritorious proposals may be recommended for funding by one of the participating agencies, the choice to be determined at the option of the agencies, not the proposer. Those not so designated will be considered for funding by all of the joint sponsoring agencies. Subsequent grant administration procedures will be in accordance with the individual policies of the awarding agency.

NSF Process: Those proposals selected for funding by NSF will be handled in accordance with standard NSF procedures. This process begins with NSF drafting and releasing the joint-agency solicitation, which includes program requirements.

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.

NASA Process: For those proposals that are selected for funding consideration by NASA, an NSF official will transfer the proposals and reviews directly to NASA. Applicants will not be allowed to increase the proposed budget or change the scientific content of the proposal that has been transferred to NASA for funding consideration. These applications, along with the summary statements generated based on the review, will be used to make the funding recommendations.

NIH Process: For those proposals that are selected for potential funding by participating NIH Institutes or Centers, the PI will be required to resubmit the proposal in an NIH-approved format directly to the Center for Scientific Review (http://www.csr.nih.gov/) of the NIH. PIs invited to resubmit to NIH will receive further information on resubmission procedures from NIH. An applicant will not be allowed to increase the proposed budget or change the scientific content of the proposal in the resubmission to the NIH as an NIH application. For NSF Collaborative Proposals converting to the NIH subcontract mechanism, the overhead charged by Institution A on the subcontract to Institution B (on the first $25,000) would be deducted from the direct costs (approximately $12,500) so that the total costs are not increased. These NIH applications will be entered into the NIH IMPAC II system. The results of the review will be presented to the involved Institutes' or Centers' National Advisory Councils for the second level of review. Subsequent to the Council reviews, NIH Institutes and Centers will make their funding determinations and selected awards will be made. Subsequent grant administration procedures for NIH awardees, including those related to New and Early Stage Investigators (http://grants.nih.gov/grants/new_investigators/index.htm), will be in accordance with the policies of NIH. Applications selected for NIH funding will use the NIH funding mechanisms.

Proposals that are funded by the NIH are expected to be renewed as competing continuing applications. Principal Investigators should contact their NIH Program Officer for additional information. For informational purposes, NIH Principal Investigators may wish to consult the NIAID web site, "All About Grants," which provides excellent generic information about all aspects of NIH grantsmanship, including competitive renewals (http://funding.niaid.nih.gov/researchfunding/grant/pages/aag.aspx).

USDA/NIFA Process: USDA/NIFA will make final funding decisions based on the results of the peer review process. Applications selected for funding by NIFA will be forwarded to the USDA/NIFA Awards Management Division for award processing in accordance with the USDA/NIFA procedures.

DOD Process: DOD will make final funding decisions based on the results of the peer review process. Applications selected for funding by DOD will be forwarded to the DOD Awards Management Division for award processing in accordance with the DOD procedures.

DOE Process: DOE/EM will make final funding decisions based on the results of the peer review process. Applications selected for funding by DOE/EM will be forwarded to the EM Consolidated Business Center for award processing in accordance with the DOE/EM procedures.

Additional Review Details

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will be completed and submitted by each reviewer. 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 strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

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. After an administrative review has occurred, Grants and Agreements Officers perform 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.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, 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.

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 evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. 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 strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

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. After an administrative review has occurred, Grants and Agreements Officers perform 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.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, 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.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award will be made through use of standard processes of the relevant funding agencies. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. (See Section VI.B. for additional information on the review process).

B. Award Conditions

NSF:

An NSF award consists of: (1) the award notice, 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 notice; (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 notice. 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.

Special Award Conditions:

Attribution of support in publications must acknowledge the joint program, as well as the funding organization and award number, by including the phrase, "as part of the NSF/NASA/NIH/USDA-NIFA/DOE/DOD National Robotics Initiative."

The final version of any accepted software and robotics operating systems sharing plans will become a condition of the award grant, contract or agreement. The effectiveness of software and robotics operating system sharing may be evaluated as part of the administrative review of each award.

DOD, NIH and NASA:

Contact the cognizant organization program officer for additional information.

USDA/NIFA Award Administration and Conditions:

Within the limit of funds available for such purpose, the NIFA awarding official shall make grants to those responsible, eligible applicants whose applications are judged most meritorious under the procedures set forth in this solicitation. The date specified by the NIFA awarding official as the effective date of the grant shall be no later than September 30 of the federal fiscal year in which the project is approved for support and funds are appropriated for such purpose, unless otherwise permitted by law. The project need not be initiated on the grant effective date, but as soon thereafter as practical so that project goals may be attained within the funded project period. All funds granted by NIFA under this solicitation may be used only for the purpose for which they are granted in accordance with the approved application and budget, regulations, terms and conditions of the award, applicable federal cost principles, USDA assistance regulations, and NIFA General Awards Administration Provisions at 7 CFR part 3430, subparts A through E.

The award document will provide pertinent instructions and information including, at a minimum:

1. Legal name and address of performing organization or institution to which the director has issued an award under the terms of this request for applications;
2. Title of project;
3. Name(s) and institution(s) of PDs chosen to direct and control approved activities;
4. Identifying award number and the Federal Agency Identification Number assigned by NIFA;
5. Project period, specifying the amount of time NIFA intends to support the project without requiring recompetition for funds;
6. Total amount of financial assistance approved for the award;
7. Legal authority(ies) under which the award is issued;
8. Appropriate Catalog of Federal Domestic Assistance (CFDA) number;
9. Applicable award terms and conditions (see http://www.nifa.usda.gov/business/awards/awardterms.html to view NIFA award terms and conditions);
10. Approved budget plan for categorizing allocable project funds to accomplish the stated purpose of the award; and
11. Other information or provisions deemed necessary by NIFA to carry out its respective awarding activities or to accomplish the purpose of a particular award.

Changes in Project Plans

a. The permissible changes by the grantee, PD(s), or other key project personnel in the approved project grant shall be limited to changes in methodology, techniques, or other similar aspects of the project to expedite achievement of the project's approved goals. If the grantee or the PD(s) is uncertain as to whether a change complies with this provision, the question must be referred to the Authorized Departmental Officer (ADO) for a final determination. The ADO is the signatory of the award document, not the program contact.

b. Changes in approved goals or objectives shall be requested by the grantee and approved in writing by the ADO prior to effecting such changes. In no event shall requests for such changes be approved which are outside the scope of the original approved project.

c. Changes in approved project leadership or the replacement or reassignment of other key project personnel shall be requested by the grantee and approved in writing by the ADO prior to effecting such changes.

d. Transfers of actual performance of the substantive programmatic work in whole or in part and provisions for payment of funds, whether or not Federal funds are involved, shall be requested by the grantee and approved in writing by the ADO prior to effecting such transfers, unless prescribed otherwise in the terms and conditions of the grant.

e. Changes in Project Period: The project period may be extended by NIFA without additional financial support, for such additional period(s) as the ADO determines may be necessary to complete or fulfill the purposes of an approved project, but in no case shall the total project period exceed five years. Any extension of time shall be conditioned upon prior request by the grantee and approval in writing by the ADO, unless prescribed otherwise in the terms and conditions of a grant.

f. Changes in Approved Budget: Changes in an approved budget must be requested by the grantee and approved in writing by the ADO prior to instituting such changes if the revision will involve transfers or expenditures of amounts requiring prior approval as set forth in the applicable Federal cost principles, Departmental regulations, or grant award.

Responsible and Ethical Conduct of Research

See http://nifa.usda.gov/responsible-and-ethical-conduct-research for further information.

C. Reporting Requirements

NSF:

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 no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following 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 all identified PIs and co-PIs on a given award. 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 Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also 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.

More comprehensive information on NSF Reporting Requirements 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.

Additional data may be required for NSF sponsored Cooperative Agreements.

Proposals which are initially funded at a level exceeding $1,000,000 per year for three or more years will be evaluated based on the proposed work plan by teams of experts periodically through the term of the project to determine performance levels. Funding for the balance of the project term may be revised based on this evaluation. All publications, reports, data and other output from all awards must be prepared in digital format and meet general requirements for storage, indexing, searching and retrieval.

The final version of any accepted software and robotics operating systems sharing plans will become a condition of the award grant, contract or agreement. The effectiveness of software and robotics operating system sharing may be evaluated as part of the administrative review of each award.

DOD, NIH, DOE, and NASA:
Contact the cognizant organization program officer for additional information.

USDA/NIFA:

Expected Program Outputs and Reporting Requirements

The output and reporting requirements are included in the award terms and conditions (see http://www.nifa.usda.gov/business/awards/awardterms.html for information about NIFA award terms). If there are any program or award-specific award terms, those, if any, will be identified in the award.

Other USDA/NIFA Requirements: Several federal statutes and regulations apply to grant applications considered for review and to project grants awarded under this program. These may include, but are not limited to, the ones listed on the NIFA web page: http://nifa.usda.gov/federal-regulations.

NIFA Federal Assistance Policy Guide—a compendium of basic NIFA policies and procedures that apply to all NIFA awards, unless there are statutory, regulatory, or award-specific requirements to the contrary is available at http://nifa.usda.gov/policy-guide.

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:

- Jeff Trinkle, CISE/IIS, telephone: (703) 292-8327, email: jtrinkle@nsf.gov

- Ephraim P. Glinert, CISE/IIS, telephone: (703) 292-8930, email: eglinert@nsf.gov

- Tatiana Korelsky, CISE/IIS, telephone: (703) 292-8930, email: tkorelsk@nsf.gov

- Hector Munoz-Avila, CISE/IIS, telephone: (703) 292-8930, email: hmunoz@nsf.gov

- Reid Simmons, CISE/IIS, telephone: (703) 292-4767, email: resimmon@nsf.gov

- Jie Yang, CISE/IIS, telephone: (703) 292-4768, email: jyang@nsf.gov

- Jack Snoeyink, CISE/CCF, telephone: (703) 292-8910, email: jsnoeyin@nsf.gov

- Ralph Wachter, CISE/CNS, telephone: (703) 292-8950, email: rwachter@nsf.gov

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- Jordan M. Berg, ENG/CMMI, telephone: (703) 292-5365, email: jberg@nsf.gov

- Radhakishan Baheti, ENG/ECCS, telephone: (703) 292-8339, email: rbaheti@nsf.gov

- David L. Haury, EHR/DRL, telephone: (703) 292-5102, email: dhaury@nsf.gov

- Frederick M. Kronz, SBE/OAD, telephone: (703) 292-7283, email: fkronz@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.

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Department of Energy, Office of Environmental Management

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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, "NSF Update" is

an information-delivery system 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 Grants Conferences. Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on NSF's website.

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

NATIONAL SCIENCE FOUNDATION
http://www.nsf.gov

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
http://www.nasa.gov/robotics

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY,
DEPARTMENT OF DEFENSE
http://www.darpa.mil/

NATIONAL INSTITUTES OF HEALTH
http://nih.gov/

NATIONAL INSTITUTE OF FOOD AND AGRICULTURE,
UNITED STATES DEPARTMENT OF AGRICULTURE
http://www.nifa.usda.gov

OFFICE OF ENVIRONMENTAL MANAGEMENT,
DEPARTMENT OF ENERGY
https://neup.inl.gov

PUBLIC BRIEFINGS

One or more collaborative webinar briefings with question and answer functionality may be held prior to the submission deadline date. Schedules will be posted on the sponsor announcement web sites.

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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 55,000 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**   (703) 292-5111
  (NSF Information Center)**:**

- **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
Office of the General Counsel
National Science Foundation
Arlington, VA 22230

X. APPENDIX

Legislative Authority:

The USDA authority for this solicitation is contained in Section 7406 of the Food, Conservation, and Energy Act of 2008 (FCEA) (Pub. L. 110-246) which amends section 2(b) of the Competitive, Special, and Facilities Research Grant Act (7 U.S.C. 450i(b)) to authorize the Secretary of Agriculture to establish the Agriculture and Food Research Initiative (AFRI); a new competitive grant program to provide funding for fundamental and applied research, extension, and education to address food and agricultural sciences. AFRI is subject to the provision found at 7 CFR Part 3430.

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