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Future of Work at the Human - Technology Frontier: Advancing Cognitive and Physical Capabilities (FW-HTF)

PROGRAM SOLICITATION NSF 18-548



National Science Foundation

Directorate for Social, Behavioral & Economic Sciences

Directorate for Computer & Information Science & Engineering

Directorate for Education & Human Resources

Directorate for Engineering

Office of Integrative Activities

Letter of Intent Due Date(s) (required) (due by 5 p.m. submitter's local time):

April 16, 2018

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

June 04, 2018

IMPORTANT INFORMATION AND REVISION NOTES

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) ([NSF 18-1](#)), which is effective for proposals submitted, or due, on or after January 29, 2018.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Future of Work at the Human-Technology Frontier: Advancing Cognitive and Physical Capabilities (FW-HTF)

Synopsis of Program:

The landscape of jobs and work is changing at unprecedented speed, driven by the development of new technologies that have moved from the factory floor to an expanding array of knowledge and service occupations. These changes promise benefits to the Nation in the creation of new industries and occupations, increased productivity, opportunity for innovation, and sustained global leadership. But there are risks as well. Technological advances scale back the need for some workers, and in some cases, eliminate job sectors, with consequences to displaced workers who must adapt to emerging new technologies and the changing economy through retraining and reskilling.

The Future of Work at the Human-Technology Frontier (FW-HTF) is one of 10 new and far-sighted [Big Ideas](#) for Future Investments announced by NSF in 2016. NSF aims to respond to the challenges and opportunities of the changing landscape of jobs and work by supporting convergent research to: understand and develop the human-technology partnership; design new technologies to augment human performance; illuminate the emerging socio-technological landscape and understand the risks and benefits of new technologies; and foster lifelong and pervasive learning with technology. In order to be nimble and responsive to new opportunities and challenges as they are recognized, focus areas for the FW-HTF solicitation, the centerpiece of the FW-HTF Big Idea, may change from year to year.

This solicitation focuses on advancing cognitive and physical capabilities in the context of human-technology interactions. The solicitation will support two themes: Theme 1 will focus on **Foundations for Augmenting Human Cognition** and Theme 2 will focus on **Embodied Intelligent Cognitive Assistants**. In shaping projects responsive to these two themes, PIs consider the importance of understanding, anticipating, and shaping the larger implications at the individual, institutional, corporate, and national levels, including issues arising from the needs or consequences for training and education. In addition, projects should be framed in terms of their focus on the potential contribution toward (a) transforming the frontiers of science and technology for human performance augmentation and workplace skill acquisition; (b) improving both worker quality of life and employer financial metrics; (c) enhancing the economic

and social well-being of the country; and (d) addressing societal needs through research on learning and instruction in the context of augmentation. Projects must include a Collaboration Plan which outlines the way in which the project will leverage and integrate multiple disciplinary perspectives.

Two classes of proposals — differing in scope, duration, and team size — will be considered through this solicitation:

- Small projects may be requested for a total budget ranging from \$750,000-1,500,000 for a period of 3 to 5 years; and
- Large projects may be requested for a total budget ranging from \$1,500,001-3,000,000 for a period of 3 to 5 years.

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.

- Jie Yang - CISE, telephone: (703) 292-4768, email: jyang@nsf.gov
- David Corman - CISE, telephone: (703) 292-8754, email: dcorman@nsf.gov
- Alexandra Medina-Borja - EHR, telephone: (703) 292-7557, email: amedinab@nsf.gov
- Amy L. Baylor - EHR, telephone: (703) 292-5126, email: abaylor@nsf.gov
- Jordan M. Berg - ENG/CMMI, telephone: (703) 292-5365, email: jberg@nsf.gov
- Betty K. Tuller - SBE, telephone: (703) 292-7238, email: btuller@nsf.gov
- Nancy A. Lutz - SBE, telephone: (703) 292-7280, email: nlutz@nsf.gov
- Robert Scheidt - ENG/CMMI, telephone: (703) 292-2477, email: rscheidt@nsf.gov
- Anthony Kuh - ENG/ECCS, telephone: (703) 292-2210, email: akuh@nsf.gov

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

- 47.041 --- Engineering
- 47.070 --- Computer and Information Science and Engineering
- 47.075 --- Social Behavioral and Economic Sciences
- 47.076 --- Education and Human Resources
- 47.083 --- Office of Integrative Activities (OIA)

Award Information

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 24

Up to 16 Small Awards and up to 8 Large Awards

Anticipated Funding Amount: \$27,000,000

Anticipated Funding Amount: \$27,000,000 pending availability of funds

Two classes of proposals will be considered through this solicitation:

- Small projects may be requested for a total budget ranging from \$750,000 - 1,500,000 for a period of 3 to 5 years; and
- Large projects may be requested for a total budget ranging from \$1,500,001 - 3,000,000 for a period of 3 to 5 years.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

Who May Serve as PI:

PIs, Co-PIs, or other senior project personnel must hold primary, full-time, paid appointments in research or teaching positions at US-based campuses/offices of eligible organizations.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 1

An individual may participate as PI, Co-PI, or Senior Personnel on only one proposal in response to this solicitation. This eligibility constraint will be strictly enforced. In the event that an individual exceeds this limit, proposals will be accepted based on earliest date and time of proposal submission (i.e., the first compliant proposal received will be accepted and the remainder will be returned without review). No exceptions will be made.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Submission of Letters of Intent is required. Please see the full text of this solicitation for further information.
- **Preliminary Proposal Submission:** Not required
- **Full Proposals:**
 - Full Proposals submitted via FastLane: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
 - 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: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

Inclusion of voluntary committed cost sharing is prohibited.
- **Indirect Cost (F&A) Limitations:**

Not Applicable
- **Other Budgetary Limitations:**

Not Applicable

C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):

April 16, 2018
- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

June 04, 2018

Proposal Review Information Criteria

Merit Review Criteria:

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

Award Administration Information

Award Conditions:

Standard NSF award conditions apply.

Reporting Requirements:

Standard NSF reporting requirements apply.

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I. INTRODUCTION

The landscape of jobs and work is changing at unprecedented speed, driven by the development of new technologies that have moved from the factory floor to an expanding array of knowledge and service occupations. These changes promise benefits to the Nation in the creation of new industries and occupations, increased productivity, opportunity for innovation, and sustained global leadership. But there are risks as well. Technological advances scale back the need for some workers, and in some cases, eliminate job sectors, with consequences to displaced workers who must adapt, to the changing economy and social structure through retraining and reskilling.

The Future of Work at the Human-Technology Frontier (FW-HTF) is one of 10 new [Big Ideas](#) for Future Investments announced by NSF in 2016. NSF's FW-HTF solicitation aims to respond to the challenges and opportunities associated with the changing landscape of jobs and work as no other funding agency can — by supporting new convergent research to understand and develop the human-technology partnership, to design new technologies to augment human performance, to illuminate the emerging socio-technological landscape, and to foster lifelong and pervasive learning with technology.

FW-HTF is a cross-directorate initiative, supported by NSF's Directorates for Computer and Information Science and Engineering (CISE), Education and Human Resources (EHR), Engineering (ENG), Social, Behavioral, and Economic Sciences (SBE), and the Office of Integrative Activities (OIA). In order to be nimble and responsive to new opportunities and challenges as they are recognized, focus areas for the FW-HTF program solicitation, the centerpiece of the FW-HTF Big Idea, may change from year to year, with this first solicitation centered on advancing cognitive and physical capabilities in the context of human-technology interactions.

II. PROGRAM DESCRIPTION

This FW-HTF solicitation is a call for far-reaching, creative proposals for fundamental research with the potential for transformative breakthroughs in advancing cognitive and physical capabilities, and includes two themes: Theme 1 focuses on Foundations for Augmenting Human Cognition; and Theme 2 focuses on Embodied Intelligent Cognitive Assistants. While the themes are clearly related, principal investigators must identify the primary theme their project addresses.

In shaping projects responsive to these two themes, PIs consider the importance of understanding, anticipating, and shaping the larger implications of human-technology interactions in various worlds of work at the individual, institutional, corporate, and national levels, including issues arising from the needs or consequences for training and education. In addition, projects should be framed in terms of the potential contribution toward (a) transforming the frontiers of science and technology for human performance augmentation and workplace skill acquisition; (b) improving both worker quality of life and employer financial metrics; (c) enhancing the economic and social well-being of the country; and (d) addressing societal needs through research on learning and instruction in the context of augmentation. Projects should include fundamental research and be attentive to impacts that are equitable socially and economically.

Advancing cognitive and physical capabilities research applied to the future of work is frequently focused on providing support for knowledge-workers in professions ranging from law to medicine to design to education. However, research is also encouraged that addresses the potential for advancing cognition and physical capabilities that benefit skilled workers and laborers in, for example, care-giving, manufacturing, construction, service industries, and natural resource industries. Indeed, a framing vision for the future of work that meets the future and varied needs of the Nation is encouraged.

Theme 1 - Foundations for Augmenting Human Cognition:

Projects submitted for Theme 1, Foundations for Augmenting Human Cognition, will address fundamental questions regarding human cognitive systems in the context of the future of work, leading to new knowledge in relevant science, engineering, and education fields. Projects may also incorporate meaningful research collaborations in which hardware or software testbeds co-evolve with, and synergistically inform, augmentation of human cognition.

Theme 1 projects are invited to address the fundamental ways in which human cognition can be bolstered with technology, augmenting perception, learning, language understanding, interdisciplinary communication, decision making, planning, and collaboration, in the context of how work and society can benefit from these improvements. Models of human cognition, social understanding, and interaction, including an understanding of biases in judgment, and models of attention, learning, memory, perception, emotion, and comprehension are foundational to advancing cognitive capabilities. Research on augmentation of human physical abilities that interact with perceptual, cognitive, affective, and social abilities are also encouraged, as well as research examining how the mind may shape and be shaped by cognitive technology, including the reciprocal effects of technology and human skills and abilities. In addition, the increasing imperative for retraining over the lifespan heightens the importance of understanding and enhancing how people and systems learn in educational settings including classrooms and online, and how instruction can change to incorporate technologies.

Theme 2 - Embodied Intelligent Cognitive Assistants:

Theme 2 on Embodied Intelligent Cognitive Assistants invites proposals for fundamental research into embodied Intelligent Cognitive Assistants (ICAs), including suitable devices and systems. Theme 2 proposals must establish their potential to impact the future of work in a way that improves both employee quality of life and employer economic metrics.

ICAs are defined here as electronic devices, external to the body, that are informed by and responsive to the architecture of the human brain for the purpose of enhancing human capabilities. ICAs utilize innovative machine learning and artificial intelligence algorithms, advanced multimodal sensing and high bandwidth communications capabilities. ICAs may exclusively augment cognition, or they may be embodied. Embodiment refers to the integration of perception and action in response to environmental and/or user stimuli. Theme 2 proposals must focus on (e-ICA) devices and systems that combine both perception and response.

The e-ICA devices studied in Theme 2 projects may be embodied in diverse platforms and systems such as self-driving cars, communication systems, power grids, chemical processes and manufacturing plants, medical devices, transportation networks, smart homes, buildings and infrastructure, classrooms or other educational environments, aircraft and ships, and industrial or personal robots. Research on e-ICA testbed devices and systems may address integration of contextual knowledge and artificial intelligence, learning across multiple timescales including real-time learning, operating with human partners through natural interactions involving intuitive interfaces, developing trust within human-machine interactions, and being both secure and reliable. Theme 2 projects may lay the fundamental groundwork for production of an embodied device or system, including, for example, their requirements for computation, communication, power, packaging, reliability, and scalability. Convergent topics of interest include understanding which human capabilities can be delegated to the e-ICA platform or system, how new capabilities of e-ICAs can best enhance specific jobs, and how the introduction of e-ICAs can enhance job satisfaction, corporate profitability and the national economic health. Projects may also explore the impact of e-ICA-enabled systems on the education and training required to enhance worker viability in the future workplace.

Important Project Characteristics

Because research proposals must establish their potential to shape and improve the future of work, principal investigators are urged to assemble cross-disciplinary teams capable of evaluating the nature of, and the potential for, social impact. In addition, proposals must make a convincing case that the research proposed is clearly distinct from development research supported by industry and by other funding agencies.

Two classes of proposals — differing in scope, duration, and team size — will be considered through this solicitation:

- Small projects may be requested for a total budget ranging from \$750,000-1,500,000 for a period of 3 to 5 years; and
- Large projects may be requested for a total budget ranging from \$1,500,001-3,000,000 for a period of 3 to 5 years.

Funds will be used to support transformative research with high-impact potential. In this way, NSF will catalyze exciting new research activities with the potential to make significant advances in the state of the art.

International and/or academic-industry collaborations that promise to result in major science, engineering, or education advances are welcome. The program hopes to attract proposals from researchers and faculty across a broad range of academic institutions, including faculty at minority-serving and predominantly undergraduate institutions. Refer to the [Foreign organizations section](#) of the NSF PAPPG concerning the eligibility requirements for foreign organizations.

While the overall goals of the solicitation are described in broad terms, important scientific progress may be gained by focusing on special cases. If the proposed research falls into this category, PIs should include an explanation of how the proposed activities connect to the overall goals of the solicitation.

Principal Investigator Meetings

In order to accelerate the rate of dissemination of ideas among researchers, to build an intellectual research core to address FW-HTF challenges, and to enable enhanced research collaborations, the FW-HTF program plans to host principal investigator (PI/Co-PI) meetings every year with participation from all funded projects and other representatives from academia, industry, government, and community organizations. PIs **must** participate in these PI/Co-PI meetings throughout the duration of the award. For multi-institution projects, investigators from each collaborating institution are expected to participate. A substitute project representative may be designated to attend a PI/Co-PI meeting, but only with prior approval from an NSF Program Officer. As noted in "Budget Preparation Instructions," budgets for all projects must include funding for one or more designated FW-HTF project representatives (PI/Co-PI senior personnel or NSF-approved replacement) to attend each FW-HTF PI/Co-PI meeting during the proposed lifetime of the award.

III. AWARD INFORMATION

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 24

Up to 16 Small Awards and up to 8 Large Awards

Anticipated Funding Amount: \$27,000,000 pending availability of funds

Two classes of proposals will be considered through this solicitation:

- Small projects may be requested for a total budget ranging from \$750,000 - 1,500,000 for a period of 3 to 5 years; and
- Large projects may be requested for a total budget ranging from \$1,500,001 - 3,000,000 for a period of 3 to 5 years.

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

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

Who May Serve as PI:

PIs, Co-PIs, or other senior project personnel must hold primary, full-time, paid appointments in research or teaching positions at US-based campuses/offices of eligible organizations.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 1

An individual may participate as PI, Co-PI, or Senior Personnel on only one proposal in response to this solicitation. This eligibility constraint will be strictly enforced. In the event that an individual exceeds this limit, proposals will be accepted based on earliest date and time of proposal submission (i.e., the first compliant proposal received will be accepted and the remainder will be returned without review). No exceptions will be made.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Letters of Intent (*required*):

A FastLane Letter of Intent (LOI) is required to submit a FW-HTF Theme 1 or Theme 2 proposal. The LOI must be compliant with the instructions below and submitted by the LOI deadline. Submitting a Letter of Intent does not oblige potential proposers to submit a full proposal. If a collaborative proposal is planned, a single LOI should be submitted by the lead institution only. LOIs are not subject to merit review but are used for internal planning purposes. Investigators should not expect to receive any feedback on their LOIs. Although there are no restrictions on the submission of multiple LOIs from the same institution, an individual may participate as PI, Co-PI, or Senior Personnel in only one LOI in response to this solicitation. It is the responsibility of the PI to ascertain that no member of the proposed team is listed as PI, Co-PI, or Senior Personnel on any other LOI.

Each Letter of Intent must include the following information:

- In the "Synopsis" data field, summarize the work in sufficient detail to convey the high-risk, high-payoff, integrative nature of the project and to permit an appropriate selection of potential reviewers. (limit: 2500 characters)
- In the Project PI and Other Senior Project Personnel sections, list the names and institutional affiliations for all PIs, Co-PIs, and senior personnel on the project, including those of any collaborative proposals or subawardees. If the project will have an advisory board or consultants, list those names and affiliations at the end of the LOI Synopsis data field. The project PI must serve as point of contact for NSF inquiries; the project PI's e-mail should be used as the point of contact e-mail address.
- In the Participating Organizations section, list all of the institutions involved in the project, and any associated projects if applicable.
- List the FW-HTF Theme and focus area(s) that the project will advance, with the most relevant focus area listed first, and the participating NSF directorates to which the proposal is relevant. (limit: 255 characters; use the focus areas named in this solicitation, and NSF directorate acronyms)
- Describe why this project would not be suitable scientifically as a submission to an NSF core program. (limit: 255 characters)

- What are the distinct areas of expertise, research approaches, or disciplines represented by the research team, and how do they complement each other in a synergistic fashion? (limit: 255 characters).

Upon successful submission of the Letter of Intent by the Authorized Organizational Representative, please save a PDF copy of the submitted LOI for use in the Full Proposal submission.

While multiple LOIs are allowed per institution, an individual may participate as PI, Co-PI, or Senior Personnel in only one LOI in response to this solicitation.

Letter of Intent Preparation Instructions:

When submitting a Letter of Intent through FastLane in response to this Program Solicitation please note the conditions outlined below:

- Submission by an Authorized Organizational Representative (AOR) is required when submitting Letters of Intent.
- A Minimum of 1 and Maximum of 4
Other Senior Project Personnel are permitted
- A Minimum of 0 and Maximum of 10
Other Participating Organizations are permitted
- FW-HTF Theme 1 or Theme 2, Focus Area(s) and NSF Directorates
is required when submitting Letters of Intent
- Why is this project not suitable scientifically for an NSF core program?
is required when submitting Letters of Intent
- What are the distinct areas of expertise, research approaches, or disciplines?
is required when submitting Letters of Intent
- Submission of multiple Letters of Intent is permitted

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 Proposal & Award Policies & Procedures Guide (PAPPG)*. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG 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: (https://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. PAPPG Chapter II.D.3 provides additional information on collaborative proposals.

See PAPPG Chapter II.C.2 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 PAPPG instructions.

Cover Sheet

Proposal Title: The title of the proposal **must** begin with **FW-HTF Theme [1 or 2]**. While projects may have relevance to both solicitation themes, principal investigators must select in the title the primary theme their project addresses.

The rest of the title of the proposal should describe the project in concise, informative language so that a technically-literate reader can understand what the project is about. The title should emphasize the science and engineering work to be undertaken, and be suitable for use in public press.

Personnel Listed on the Cover Sheet: Provide complete information requested on the cover sheet for the PI and up to four Co-PIs.

Project Description:

Project Descriptions are limited to 15 pages in length.

In addition to the requirements of the PAPPG, the Project Description must:

- Fully describe the relevance of the project to the goals of NSF's FW-HTF Big Idea. In this regard, PIs must frame the proposed research in terms of the potential contribution toward (a) transforming the frontiers of science and technology for human performance augmentation and workplace skill acquisition; (b) improving both worker quality of life and employer financial metrics; (c) enhancing the economic and social well-being of the country; and (d) addressing societal needs through research on learning and instruction in the context of augmentation.
- Outline specific research questions, hypotheses, and gaps in science, engineering, and/or education knowledge responsive to FW-HTF Theme 1 or 2.
- Describe the vision of success for the proposal — specifically defining the project goals and the definition of a successful outcome.

Supplementary Documents: Supplementary documents are limited to the specific types of documents listed in the PAPPG, with the following exception:

1. **Collaboration Plan.** A Collaboration Plan is required for all projects. The Plan must be submitted as a Supplementary Document and may not exceed two pages. **Proposals that fail to submit a Collaboration Plan will be returned without review.** The Collaboration Plan must be labeled "Collaboration Plan" and must provide a detailed approach for the creation of new knowledge through the rigorous integration of disciplinary knowledge spanning disparate engineering and scientific disciplines. The plan should list the key disciplines needed to achieve the objectives of the proposed research, explain the role of each and why it is necessary, identify the PI or Co-PIs who represent one or more disciplines as experts, outline the approach to the integration and management of these disciplines/experts, and suggest the advances in knowledge that their integration will yield. If a Project Manager is proposed, her or his activities in the project must be described in the Collaboration Plan.
2. **Letters of Collaboration:** The Project Description must fully detail any substantial collaborations and engagements (included or not included in the budget) with partner institutions. Letters of Collaboration should be provided in the Supplementary Documents section of the proposal and follow the format instructions specified in the NSF PAPPG. **Letters of Collaboration should not contain endorsements or evaluation of the proposed project.** One format for a letter of collaboration is as follows:

"If the proposal submitted by Dr. [insert the full name of the Principal Investigator] entitled [insert the proposal title] is selected for funding by NSF, it is my intent to collaborate and/or commit resources as detailed in the Project Description or the Facilities, Equipment or Other Resources section of the proposal."

Collaborative activities that are identified in the budget should follow the instructions in the NSF PAPPG. Any substantial collaboration with individuals not included in the budget should also be described in the Facilities, Equipment and Other Resources section of the proposal and documented in a Letter of Collaboration from each collaborator.

Single Copy Documents

Collaborators and Other Affiliations Information: Proposers should follow the guidance specified in Chapter II.C.1.e of the NSF PAPPG.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

Budgets for all projects must include funding for one or more designated FW-HTF project representatives (PI/Co-PI/senior personnel or NSF-approved replacement) to attend each FW-HTF PI/Co-PI meeting during the proposed lifetime of the award (see section II of this program solicitation). For budget preparation purposes, PIs should assume these meetings will be held in the spring of each year in the Washington, DC area.

C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):

April 16, 2018

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

June 04, 2018

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 PAPPG Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: https://www.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 *Investing in Science, Engineering, and Education for the Nation's Future: NSF Strategic Plan for 2014-2018*. 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 strategic objectives 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 must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of 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. (PAPPG 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 PAPPG 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
 - a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
 - b. 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

Reviewers will be asked to:

- Comment on the extent to which the project scope identifies compelling and innovative research problem(s) responsive to FW-HTF, including the potential for contribution toward (a) transforming the frontiers of science and technology for human performance augmentation and workplace skill acquisition; (b) improving both worker quality of life and employer financial metrics; (c) enhancing the economic and social well-being of the country; and (d) addressing societal needs through research on learning and instruction in the context of augmentation.
- Comment on the collaborative and interdisciplinary nature of the proposed research and the Collaboration Plan proposed.

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

B. Award Conditions

An NSF award consists of: (1) the award 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 https://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 *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer 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 Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=papppg.

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:

- Jie Yang - CISE, telephone: (703) 292-4768, email: jyang@nsf.gov
- David Corman - CISE, telephone: (703) 292-8754, email: dcorman@nsf.gov
- Alexandra Medina-Borja - EHR, telephone: (703) 292-7557, email: amedinab@nsf.gov
- Amy L. Baylor - EHR, telephone: (703) 292-5126, email: abaylor@nsf.gov
- Jordan M. Berg - ENG/CMMI, telephone: (703) 292-5365, email: jberg@nsf.gov
- Betty K. Tuller - SBE, telephone: (703) 292-7238, email: btuller@nsf.gov
- Nancy A. Lutz - SBE, telephone: (703) 292-7280, email: nlutz@nsf.gov
- Robert Scheidt - ENG/CMMI, telephone: (703) 292-2477, email: rscheidt@nsf.gov
- Anthony Kuh - ENG/ECCS, telephone: (703) 292-2210, email: akuh@nsf.gov

For questions related to the use of FastLane, contact:

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

For questions relating to Grants.gov contact:

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

IX. OTHER INFORMATION

The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "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>.

ABOUT THE NATIONAL SCIENCE FOUNDATION

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

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

NSF receives approximately 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 (FASSED) provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.E.6 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 <https://www.nsf.gov>

- **Location:** 2415 Eisenhower Avenue, Alexandria, VA 22314
- **For General Information** (NSF Information Center): (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**
 - Send an e-mail to: nsfpubs@nsf.gov
 - or telephone: (703) 292-7827
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

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

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

Suzanne H. Plimpton
Reports Clearance Officer
Office of the General Counsel
National Science Foundation
Alexandria, VA 22314

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