Improving Undergraduate STEM Education: Computing in Undergraduate Education (IUSE: CUE)

PROGRAM SOLICITATION
NSF 19-546

National Science Foundation

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

Directorate for Education & Human Resources
    Division of Undergraduate Education

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

    May 09, 2019

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 19-1)

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

    Improving Undergraduate STEM Education: Computing in Undergraduate Education (IUSE: CUE)

Synopsis of Program:

    Increasingly, undergraduate computer science (CS) programs are being called upon to prepare larger and more diverse student populations for careers in both CS and non-CS fields, including careers in scientific and non-scientific disciplines. Many of these students aim to acquire the understandings and competencies needed to learn how to use computation collaboratively across different contexts and challenging problems. However, standard CS course sequences do not always serve these students well. With this solicitation, NSF will support teams of Institutions of Higher Education (IHEs) in re-envisioning the role of computing in interdisciplinary collaboration within their institutions. In addition, NSF will encourage partnering IHEs to use this opportunity to integrate the study of ethics into their curricula, both within core CS courses and across the relevant interdisciplinary application areas.

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.

- Janice Cuny, Program Director, CISE, telephone: (703) 292-8900, email: jcuny@nsf.gov
- Fay Cobb Payton, Program Director, CISE/CNS, telephone: (703) 292-7939, email: fpayton@nsf.gov
- Stephanie August, Program Director, EHR/DUE, telephone: (703) 292-5128, email: saugust@nsf.gov

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

- 47.070 --- Computer and Information Science and Engineering
- 47.076 --- Education and Human Resources

Award Information

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 12 to 15

Anticipated Funding Amount: $4,500,000

We expect to fund 12 to 15 awards. Proposals that do not include an ethics component may request a maximum budget of $300,000 over 18 months; and proposals that do include an ethics component may request a maximum budget of $350,000 over 18 months.

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

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.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

Proposals must comprise a multi-institutional partnership, with a lead IHE and 2-4 additional IHE partners. Proposals that do not meet this requirement will be returned without review.

A single IHE may partner on at most two submitted proposals.

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

There are no restrictions or limits.

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* (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:**

  Other budgetary limitations apply. Please see the full text of this solicitation for further information.

C. Due Dates

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

  May 09, 2019

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:

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

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I. INTRODUCTION

As noted in a recent report by the National Academies of Sciences, Engineering, and Medicine, *Assessing and Responding to the Growth of Computer Science Undergraduate Enrollments* [Washington, DC: The National Academies Press, 2018 (https://doi.org/10.17226/24926)]:

It is a time for institutions to consider their missions and the constituencies they serve, and to determine what role computing should play in the experience, knowledge, and skills of its graduates of 2025 and beyond.

Computing is increasingly central to innovation across a wide range of disciplinary and interdisciplinary problem domains. As a result, undergraduate CS programs are being called upon to prepare larger and more diverse student populations for careers involving computer science. Many of these students are not traditional CS students who want to major in CS and pursue careers as software engineers, database architects, or user interface specialists. Rather, they are interested in integrating advanced computational skills and methods with domain-specific knowledge from their non-CS majors. Indeed, many departments are already experiencing rapid increases in the enrollment of non-CS majors in higher-level computing courses. At the same time, new interdisciplinary programs are arising in areas such as data science and artificial intelligence. Standard CS course sequences do not always serve these new, larger, and more diverse student populations well. In response, some departments have created novel, more flexible degree pathways, often called "CS+X" or "X+CS"—where X is a discipline or set of disciplines that may include both STEM (Science, Technology, Engineering, and Mathematics) and non-STEM subjects; X might also be a significant societal problem requiring contributions from many such disciplines. The study of X is combined with relevant computing courses tailored to X.

With this solicitation, NSF aims to support partnerships of Institutions of Higher Education (IHEs) as they begin to rethink the role and

positioning of CS education, looking perhaps at CS+*X* or *X*+CS programs but also at a more holistic restructuring of interdisciplinary degree pathways, with the goal of better preparing a wider, more diverse range of students to collaboratively use computation across a range of contexts and challenging problems.

In addition, as computing becomes more central to so many aspects of our public and private lives, it is incumbent upon the academic community to better prepare students to assume their ethical responsibilities in the use of technology and in guarding against its misuse. Increasingly, the decisions that we make as citizens, consumers, workers, and community members are shaped by digital technologies. Although these technologies can generate large benefits, they can also pose risks, such as erosion of privacy, lack of fairness or accountability in algorithmic decision-making, and the spread of misinformation. It is therefore imperative that computer scientists, data scientists, and engineers have the education and training needed to think critically about the responsible development of these technologies. NSF encourages proposers to use their efforts to re-envision the role of computing to also better integrate the study of ethics into their curricula, both within core CS courses and across the relevant interdisciplinary application areas.

Given its focus on undergraduate education, the IUSE: CUE program is aligned with NSF's Improving Undergraduate STEM Education (IUSE) framework, which is a comprehensive effort to accelerate improvements in the quality and effectiveness of undergraduate education in STEM fields. IUSE: CUE builds on past investments by NSF's Directorate for Computer and Information Science and Engineering (CISE), including in the previous IUSE/Professional Formation of Engineers: REvolutionizing engineering and computer science Departments (IUSE/PFE: RED) program.

II. PROGRAM DESCRIPTION

This IUSE: CUE solicitation supports the initial formation of teams from multiple IHEs to work together to re-envision how CS education can better support the ubiquitous role of computation across disciplines and within interdisciplinary teams and projects. The efforts should include disciplinary faculty across a broad range of STEM disciplines, including education researchers. It is anticipated that future IUSE: CUE solicitations will support more extensive implementations by successful teams and projects.

Two requirements further define this program:

i. Curricular reforms undertaken by a single IHE often have limited impact on the larger academic community. This solicitation intends to build community around efforts that are robust and operate across a range of IHEs. With that in mind, *IUSE: CUE will fund collaborations of 3 to 5 IHEs working together, structured and functioning (formally or informally) as a Networked Improvement Community (NIC).*[1]

NICs are design communities in which partners share a common goal, develop a common understanding of what it will take to reach that goal, employ common metrics, and meet often to share activities and progress. Individual implementations may vary across partners but the researchers and practitioners together engage in rapid cycles of Plan, Do, Study, Act (PDSA) in order to "learn fast, fail fast, and improve quickly."[2] In this way, they develop, test, and refine interventions that can be effectively adapted across a variety of educational contexts. Proposers are encouraged to include faculty from different disciplines and departments, as well as administrators. In addition, they should include the researchers and evaluators who will be needed to provide the "Study" aspect of the PDSA cycles. The effort should be generally organized according to best practices for NICs.

ii. In many cases, the students who are now gravitating to CS courses to support their non-CS majors are more diverse than those in traditional CS programs. Thus, the IUSE: CUE effort comes with an opportunity to recruit, welcome, and retain a much broader group of students, thereby benefiting all CS students and, more widely, the computing disciplines as a whole. With this in mind, *IUSE: CUE requires that all proposals include specific efforts to broaden participation in computing (BPC).*

Successful proposals will provide demographic information about the student populations served at each department/IHE. In addition, they will identify relevant characteristics and needs of participants from the underrepresented or under-served groups that are to be served in this effort, and include specific plans or strategies for addressing or accommodating those needs. See Additional Solicitation Specific Review Criteria below.

Proposers are encouraged to leverage the resources of the NSF-funded Broadening Participation in Computing Alliances (BPC-A; https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503593), and to consult the resources available through BPCnet.org. In addition, proposers are encouraged to establish collaborations, as appropriate, with projects in the NSF INCLUDES (Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science) national network (https://www.nsf.gov/news/special_reports/nsfincludes/index.jsp).

Finally, proposers are encouraged (but not required) to use this opportunity to better integrate the study of ethics into their curricula, both within core CS courses and across the relevant interdisciplinary application areas. Proposals that include such work will be eligible for additional funding, as described below.

Proposal size classes:

The IUSE: CUE program welcomes two classes of proposals:

- Proposals that do not include an ethics component may request a maximum budget of $300,000 for up to 18 months; and
- Proposals that do include an ethics component may request a maximum budget of $350,000 for up to 18 months.

Proposers should budget for team members to attend two principal investigators' (PI) meetings over the 18-month award period.

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[1] Resources on NICs can be found at https://www.carnegiefoundation.org/resources/publications/.

[2] "Improvement Discipline in Practice," Alicia Grunow, July 21, 2015 at https://www.carnegiefoundation.org/blog/improvement-discipline-in-practice.

III. AWARD INFORMATION

We expect to fund 12 to 15 awards for a total program funding of $4,500,000. Proposals that do not include an ethics component may request a maximum budget of $300,000 over 18 months; and proposals that do include an ethics component may request a maximum budget of $350,000 over 18 months.

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.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

Proposals must comprise a multi-institutional partnership, with a lead IHE and 2-4 additional IHE partners. Proposals that do not meet this requirement will be returned without review.

A single IHE may partner on at most two submitted proposals.

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

There are no restrictions or limits.

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 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:

By their very nature, proposals responding to this solicitation may well be working with Human Subjects (looking at outcomes for faculty, students or both). If that is the case, on the cover sheet, mark the **Human Subjects** box as pending, approved, or exempted (with exemption subsection indicated). **This box should not be left blank.** The **Human Subjects** box should be marked as pending if an IRB is either (1) reviewing the project plan and has not yet determined a ruling of "approved" or "exempt," or (2) the project plan has not yet been submitted to an IRB for review. Additional guidance on the use of Human Subjects is available in the PAPPG, Chapter II.D.5.

PROPOSAL TITLES:

Proposal titles should begin with "CUE" (if the proposal does not include an ethics component) or "CUE Ethics" (if the proposal does include an ethics component), followed with a colon, then the title of your project. That is, **CUE: (Title)** or **CUE Ethics: (Title)**.

If you submit a proposal as part of a set of collaborative proposals, the title of the proposal should begin with "CUE" or "CUE Ethics" followed by a colon, then "Collaborative Research" followed by a colon, and the title. For example, **CUE Ethics: Collaborative Research: (Title).**

PROJECT DESCRIPTION:

This program solicitation is particularly interested in BPC for groups that have been traditionally underrepresented or underserved in CS. Underrepresented groups in computing include women, Hispanics, African Americans, Native Americans and Indigenous Peoples, and persons with disabilities. However, if proposers wish to target a group not listed, the case for the need and the benefit should be made in the proposal.

All proposals must explicitly address broadening participation with respect to the two Additional Solicitation Specific Review Criteria:

1. Does the proposal identify the characteristics and needs of the identified underrepresented or underserved groups to be served?
2. Does the proposal include specific plans or strategies for addressing or accommodating the particular needs of participants of the identified underrepresented or underserved groups?

Reviewers will be asked to specifically evaluate the proposal on these two criteria as well as the two standard NSF Merit Review Criteria (Intellectual Merit and Broader Impacts). Proposals that do not adequately address these additional criteria will be declined.

In addition, Project Descriptions should include

- a description of the partnership among IHEs and the relevant characteristics of its members;
- an initial statement of common goals and examples of possible common metrics;
- plans for communication and convenings of members;
- descriptions of any management and administrative structures that will be put in place initially; and
- methods that will be used in assessing/evaluating the success of the effort.

All projects must plan for external, critical reviews of their designs and activities (including their organizational structures, mechanisms for and evidence of institutional collaborations, data collection, analyses, and reporting plans). For a given project, these reviews might be done by an external review panel or advisory board proposed by the project, or by a third-party evaluator. The external critical review should be sufficiently independent and rigorous to influence the project's activities and improve the quality of its findings. A successful proposal will (1) describe the expertise of the external reviewer(s); (2) explain how that expertise relates to the goals and objectives of the proposal; and (3) specify how the PI will report and use results of the project's external, critical review process.

All proposals must be submitted to the CNS division, regardless of the scientific area within CISE.

SPECIAL INFORMATION AND SUPPLEMENTARY DOCUMENTS:

List of Project Personnel

In addition to guidance provided in the PAPPG on required Special Information and Supplementary Documents, provide current, accurate information for all personnel and institutions involved in the project. NSF staff will use this information in the merit review process to manage reviewer selection. The list should include all PIs, co-PIs, Senior Personnel, paid/unpaid Consultants or Collaborators, Subawardees, Postdocs, and project-level advisory committee members. This list should be numbered and include (in this order) Full name, Organization(s), and Role in the project, with each item separated by a semi-colon. Each person listed should start a new numbered line. For example:

- Mary Smith; XYZ University; PI
- John Jones; University of PQR; Senior Personnel
- Jane Brown; XYZ University; Postdoc
- Bob Adams; ABC Community College; Paid Consultant
- Susan White; DEF Corporation; Unpaid Collaborator
- Tim Green; ZZZ University; Subawardee

SINGLE COPY DOCUMENTS:

Collaborators and Other Affiliations Information:

Proposers should follow the guidance specified in Chapter II.C.1.e of the NSF PAPPG. Grants.gov Users: The COA information must

be provided through use of the COA template and uploaded as a PDF attachment.

Note that this information is distinct from the List of Project Personnel specified above under Supplementary Documents: the listing of all project participants is collected by the project lead and entered as a Supplementary Document, which is then automatically included with all proposals in a project. The Collaborators and Other Affiliations are entered for each participant within each proposal and, as Single Copy Documents, these are available only to NSF staff.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Other Budgetary Limitations:

Budgets cannot exceed $300,000 for proposals that do not have an ethics component or $350,000 for proposals that do have an ethics component.

C. Due Dates

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

    May 09, 2019

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 *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. 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

This program solicitation is particularly interested in BPC for groups traditionally underrepresented or underserved in CS. Underrepresented groups in computing include women, Hispanics, African Americans, Native Americans and Indigenous Peoples, and persons with disabilities. However, if proposers wish to target a group not listed, the case for the need and the benefit should be made in the proposal. In addition to considering the two general NSF Merit Review Criteria, reviewers will also be asked to evaluate the following:

1. Does the proposal identify the characteristics and needs of the identified underrepresented or underserved groups to be addressed?
2. Does the proposal include specific plans or strategies for addressing or accommodating the particular needs of participants of the identified underrepresented groups?

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=pappg.

Projects will be required to maintain a website, attend two meetings or workshops, and participate in a common evaluation where appropriate.

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:

- Janice Cuny, Program Director, CISE, telephone: (703) 292-8900, email: jcuny@nsf.gov
- Fay Cobb Payton, Program Director, CISE/CNS, telephone: (703) 292-7939, email: fpayton@nsf.gov
- Stephanie August, Program Director, EHR/DUE, telephone: (703) 292-5128, email: saugust@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 (FASED) 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**   (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
Alexandria, VA 22314

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