



NATIONAL SCIENCE FOUNDATION
4201 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22230

NSF 17-065

Dear Colleague Letter: Growing Convergence Research at NSF

April 3, 2017

Dear Colleague:

Growing Convergence Research at the National Science Foundation (NSF) is one of [10 Big Ideas for Future NSF Investments](#). NSF seeks to highlight the value of convergence as a process for catalyzing new research directions and advancing scientific discovery and innovation. This Dear Colleague Letter describes an initial set of opportunities to explore Convergence approaches within four of the research-focused NSF Big Ideas:

- Harnessing the Data Revolution for 21st Century Science and Engineering
- Navigating the New Arctic
- The Quantum Leap: Leading the Next Quantum Revolution
- Work at the Human-Technology Frontier: Shaping the Future

Another Big Idea, Understanding the Rules of Life: Predicting Phenotype, is actively promoting Convergence research through other mechanisms.

BACKGROUND

Convergence can be characterized as the deep integration of knowledge, techniques, and expertise from multiple fields to form new and expanded frameworks for addressing scientific and societal challenges and opportunities. It is related to other concepts used to identify research that spans disciplines: *transdisciplinary, interdisciplinary, and multidisciplinary*. Convergence research is an intentional process. It is most closely linked to transdisciplinary research in its merging of distinct and diverse approaches into a unified whole to foster new paradigms or domains. Similar characterizations of convergence are presented in recent reports by the National Research Council and MIT, and a series of volumes on convergence edited by NSF staff, Mihail C. Roco and William S. Bainbridge. These reports along with additional background on convergence can be found at <https://www.nsf.gov/od/oia/convergence/index.jsp>.

NSF identifies Convergence research as having two primary characteristics:

- **Deep integration across disciplines.** As experts from different disciplines pursue common research challenges, their knowledge, theories, methods, data, research communities and languages become increasingly intermingled or integrated. New frameworks, paradigms or disciplines can form from sustained interactions across multiple communities.
- **Research driven by a specific and compelling problem.** Convergence research is generally inspired by the need to address a specific challenge or opportunity, whether it arises from deep scientific questions or pressing societal needs.

A Convergence research project should bring together an intellectually diverse team of scientists and/or engineers to create novel framings and solutions for research problems. The Convergence paradigm augments a more traditional transdisciplinary approach to research by framing challenging research

questions at inception, and fostering the collaborations needed for successful inquiry. NSF's Big Ideas are ideal candidates for Convergence approaches. NSF is asking for workshop and Summer School proposals as well as Research Coordination Network (RCN) proposals to start the communities' thinking about convergence in these areas.

SUMMARY OF THE OPPORTUNITIES

1. Harnessing the Data Revolution for 21st Century Science and Engineering (HDR)

To generate a true data revolution, there is a need for education and training opportunities to create teams of data scientists and disciplinary researchers that can not only work together, but also *think* together. Past work has shown that data science lacks maximal impact without the knowledge, involvement, and collaboration of those who have a deep understanding of the problem. NSF is seeking to encourage workshops to address the transdisciplinary education and training agenda for HDR. Workshops could explore whether there is an emerging core shared framework of data science; whether aspects of data science are discipline independent and, thus, applicable to all situations; and which aspects are discipline-specific. For each case, what is the corresponding set of education/training topics? Next-generation data scientists must work in partnerships with scientists in other areas and be equipped with a language and framework that makes these partnerships fruitful. A properly educated/trained data scientist must be aware of the general as well as the specific nature of issues in data analysis, and also be attentive to the socio-technical concerns that may arise.

***HDR Workshop** proposals submitted in response to this DCL must be submitted to the Critical Techniques, Technologies, and Methodologies for Advancing Foundations and Applications of Big Data Sciences and Engineering (BIGDATA) program and include the prefix "Convergence HDR:" in front of the proposal title. **HDR Workshop** awards will provide up to one year of support for projects that do not exceed \$100,000 in total. For full consideration, **HDR Workshop** proposals should be received under the BIGDATA program by May 15, 2017.*

2. Navigating the New Arctic (NNA)

NSF challenges the research community to join together the diverse perspectives of physical, biological, and social and behavioral sciences with computer science, engineering, and education to define the key challenges and research imperatives facing humans and the environment in the Arctic region. NSF is seeking to encourage proposals for Research Coordination Networks (RCNs) and workshops to identify Convergence research topics relevant to social, environmental, economic, or security issues of the Arctic while advancing understanding of our planet. In addition, NSF seeks activities to advance observational capabilities directly linked to broad research questions, including improved capabilities in robust sensing and data collection technology, data analysis, and computational science. Observational platforms that involve partnerships between private and public research infrastructure based in the United States and internationally are of particular interest. Proposals that link the relevant research disciplines with the needs of northern communities (indigenous and non-indigenous), which may benefit from their explicit engagement in, and co-leadership of, the research enterprise, are particularly encouraged. RCNs and workshops are also expected, as a collateral benefit, to prepare the research community to respond more rapidly and with a Convergence focus to potential future Navigating the New Arctic funding opportunities.

***NNA** proposals submitted in response to this DCL must be submitted to the Arctic System Science Program and include the prefix "Convergence NNA:" in front of the title. **NNA Workshop** awards will provide up to one year of support for projects that do not exceed \$100,000 in total. For full consideration, **NNA Workshop** proposals should be received by May 15, 2017. **NNA RCN** awards will provide four to five years of support for projects with total budgets that do not exceed \$500,000. For full consideration, **NNA RCN** proposals should be received by June 1, 2017.*

3. The Quantum Leap: Leading the Next Quantum Revolution (QL)

Quantum Leap focuses on advancing quantum communications, quantum computing, quantum sensors, and quantum simulators. Progress will be achieved by an inherent cross-disciplinary approach and a strong coupling of experiment, computation, and theory. The convergence of diverse ideas, approaches, and technologies will enable researchers to address the challenges of de-coherence, increased operational temperature, and scalability of future quantum devices. To this end, NSF encourages proposals for Summer Schools that seek to identify, train, and develop a new transdisciplinary workforce for QL. Multi-year efforts that develop the intellectual, technical, and collaborative skills of graduate students in science and engineering would align with the goals of QL. Public dissemination and assessment of outcomes should be part of the proposed activities. NSF also seeks proposals for QL Cross-Sector activities to encourage the convergence of science and engineering across different sectors, including but not limited to academia, industry, national laboratories, and private foundations by fostering collaboration between mentors, students, and non-academic partners. Proposals of this type could, for example, include a series of annual meetings organized for graduate students working with their research supervisors and an industry representative over a period of three years, nurturing and facilitating the transfer of intellectual capital between sectors. Proposals for workshops focused on advancing Convergence research within the QL are also welcomed.

*QL proposals submitted in response to this DCL must be submitted to the Condensed Matter Physics Program in the Division of Materials Science and include the prefix "Convergence QL:" in front of the title. For full consideration, all types of QL proposals should be received by June 1, 2017. **QL Summer School** awards will provide four or five years of support for projects with total budgets that do not exceed \$700,000. **QL Cross-Sector** awards will provide up to three years of support. **QL Workshop** awards will provide up to one year of support for projects that do not exceed \$100,000 in total.*

4. Work at the Human-Technology Frontier: Shaping the Future (HTF)

Intelligent, interactive, and highly networked machines — with which people increasingly share their autonomy and agency — are a growing part of the landscape, particularly in regards to work. As automation today moves from the factory floor to knowledge and service occupations, insight and action are needed to reap the benefits in increased productivity and increased job opportunities, and to mitigate social costs. Moreover, there is currently high demand for STEM-Tech workers, those with STEM and technology training beyond a high school diploma but less than a four-year college degree; simultaneously, there are many unemployed workers with this level of education, but in need of the STEM and technology training to prepare them to fill these jobs. HTF prioritizes: (1) research to understand the social and economic consequences of today's emerging technologies, and the associated educational needs; and (2) research to develop tools that shape human-technology partnerships, improve worker performance, increase career longevity and job satisfaction, and facilitate the life-long learning of new skills. NSF encourages proposals for workshops and Research Coordination Networks (RCNs) to facilitate the convergence of computer science, education, engineering, and the physical, biological, and social and behavioral sciences to define the key challenges and research imperatives of the nexus of humans, technology, and work.

*HTF proposals submitted in response to this DCL must be submitted to the Cyber-Human Systems (CHS) program and include the prefix "Convergence HTF:" in front of the title. **HTF Workshop** awards will provide up to one year of support for projects that do not exceed \$100,000 in total. For full consideration, **HTF Workshop** proposals should be received by May 15, 2017. **HTF RCN** awards will provide four to five years of support for projects with total budgets that do not exceed \$500,000. For full consideration, **HTF RCN** proposals should be received by June 1, 2017.*

PREPARATION INSTRUCTIONS

This Dear Colleague Letter complements other NSF efforts to support interdisciplinary and transdisciplinary research. It is also intended to be part of a broader set of opportunities that advance the research agendas in the NSF Big Ideas. *Potential proposers are encouraged to contact the relevant points of contact listed below before preparing a proposal.*

Convergence projects submitted in response to this Dear Colleague Letter should be grounded in a compelling research challenge. This challenge should be aligned with one of the Big Ideas described above, and require a novel and deep integration of expertise. The proposal should address the current state of the research challenge and describe a Convergence strategy for addressing the challenge. Proposals submitted in response to this DCL should be prepared and submitted in accordance with the general guidelines contained in the [NSF Proposal & Award Policies & Procedures Guide \(PAPPG\)](#).

POINTS OF CONTACT

General inquiries about convergence at NSF should be directed to convergence@nsf.gov.

Specific questions pertaining to convergence opportunities related to the Big Ideas participating in this Dear Colleague Letter can be directed to the following persons:

Harnessing the Data Revolution for 21st Century Science and Engineering

- Chaitanya Baru, Senior Advisor for Data Science, CISE/OAD, cbaru@nsf.gov
- John Cherniavsky, Senior Advisor for Research, EHR/DRL, jchernia@nsf.gov

Navigating the New Arctic

- Diane McKnight, Arctic System Sciences Program Director, GEO/PLR, dmcknigh@nsf.gov

The Quantum Leap: Leading the Next Quantum Revolution

- Saul Gonzalez, Senior Advisor, MPS/OAD, sgonzale@nsf.gov
- Sohi Rastegar, Senior Advisor, ENG/OAD, srastega@nsf.gov

Work at the Human-Technology Frontier: Shaping the Future

- Meghan Houghton, Staff Associate, CISE/OAD, mehought@nsf.gov
- Steven Breckler, Social Psychology Program Director, SBE/BC, sbreckle@nsf.gov

Sincerely,

Scott Borg, Assistant Director (Acting), GEO

Suzanne Iacono, Head, OIA

Barry Johnson, Assistant Director (Acting), ENG

Jim Kurose, Assistant Director, CISE

Jim Lewis, Assistant Director (Acting), EHR

Fay Lomax Cook, Assistant Director, SBE

James Ulvestad, Assistant Director (Acting), MPS