Welcome to...

NSF Funding for Maker Education R&D

May 2019

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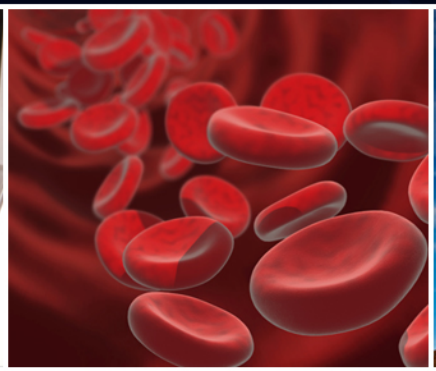
Education & Human Resources, NSF



Directorate of Education and Human Resources

- **Mission:** *Achieve excellence in STEM education at all levels and in all settings in order to support the development of a diverse and well-prepared workforce of scientists, technicians, engineers, mathematicians and educators and a well-informed citizenry that have access to the ideas and tools of science and engineering.*

NSF Support of Maker Projects

NSF Makes Several Types of Investments:

1. Research that supports the development of maker technologies
2. Maker education in informal and formal educational settings
3. Support of research on the educational impact of maker education
4. Support of marketing & entrepreneurial projects related to making

1. NSF Research Support for 3-D printing and custom manufacturing

- Early/continuing funding for additive manufacturing, totaling approximately $200 million from more than 600 grants awarded from 1986-2012

- Example: Engineering Directorate's (SBIR) grants to two key early firms in additive manufacturing field to develop the selective laser sintering process (high powered laser is used to fuse small particles into precise 3-D shapes)

- Example: Helisys to commercialize the sheet lamination process (sheets glued together and cut to shape with knife or laser cutter)

NSF Support of Maker Education

- Active tinkering can engage people of all ages in learning science, technology, engineering and mathematics (STEM). Tinkering Studio at the San Francisco Exploratorium http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=1317 61
- Makerspace at Massachusetts high school lets diverse students design new technologies http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=1356 09
- From Problem to Product (I2) takes high school students through the entire process of inventing a device, software or other technology http://www.nsf.gov/awardsearch/showAward?AWD_ID=13119 81

3. NSF-supported research on the Educational Impact of Making

- A Stanford University project is researching what learning happens after tinkerers leave the Exploratorium tinkering space.

- A Northwestern University project is investigating how reflective interactions between parents and children (ages 6-8) during making/ tinkering activities ultimately impact child engagement in STEM.

- A Georgia Tech project is research the incorporation of Maker activities into upper-level computer science courses to see how maker activities will improve knowledge transfer & interdisciplinary work.

4. NSF Support of Marketing & Entrepreneurial Projects: SBIR

- NSF's SBIR program provides funds for early-stage research and development (R&D) at small businesses.
- NSF encourages proposals from a diversity of entrepreneurs -- new and seasoned – to commercialize a transformative idea or innovation.
- How to apply: https://seedfund.nsf.gov/apply/

4. More NSF Support for Entrepreneurs: I-Corps

- The NSF Innovation Corps (I-Corps™) prepares scientists and engineers to extend their focus to the commercial world for research results that show immediate potential.
- I-Corps is a public-private partnership program that teaches grantees to identify valuable product opportunities that can emerge from academic research, and offers entrepreneurship training to student participants.
- The curriculum is administered via online instruction and on-site activities through one of several I-Corps nodes.
- https://www.nsf.gov/news/special_reports/i-corps/

Making and Tinkering Resources

- *Empirical Studies on the Maker Movement, a Promising Approach to Learning: A Literature Review* Papavlasopoulou, S. et al.
- *Math in the Making: Reflections for the Field* Pattison, S. et al.
- *The Makerspace Movement: Sites of Possibilities for Equitable Opportunities to Engage Underrepresented Youth in STEM* Calabrese Barton, A. et al.
- *The Promise and the Promises of Making in Science Education: A Literature Review* Bevan, B.
- *Envisioning the Future of the Maker Movement: https://www.asee.org/documents/papers-and-publications/papers/maker-summit-report.pdf*

Select Publications

Math in the Making

Selected Programs

ECR Program

EHR Core Research

Deadline: Oct. 3, 2019

https://www.nsf.gov/pubs/2019/nsf19508/nsf19508.pdf

ECR supports **basic research**; it invites researchers to conduct research on basic questions in order to advance STEM learning in general, or to address specific challenges of great importance in four general areas:

- STEM learning & learning environments
- Workforce development
- Broadening participation in STEM

ECR supports…

- ***Research Proposals :*** study of a foundational research question/issue designed to inform the transformation of STEM learning and education
  - Up to $3 million (see announcement for details)
- ***Conference/Synthesis***
  - typically $25K-$100K

DRK-12

Discovery Research PreK-12

Deadline: 2nd Wednesday in November

https://www.nsf.gov/pubs/2017/nsf17584/nsf17584.htm

Resource Center: http://cadrek12.org/

DRK-12's Three Strands

1. **The Assessment Strand:** projects that develop and study valid and reliable assessments of student and teacher knowledge, skills, and practices
2. **The Learning Strand:** projects that develop and study resources, models and tools to support all students' STEM learning, enhance their knowledge and abilities, and build their interest in STEM fields
3. **The Teaching Strand:** projects that develop and study resources, models and tools to help pre- and in-service teachers provide high quality STEM education for all students

DRK-12 Proposal Types

- **Exploratory Studies**
- **Design and Development Studies** (Early Stage or Late Stage)
- **Impact Studies**
- **Implementation and Improvement Studies**
- **Conferences and Syntheses**
- **3 funding levels, up to $5 million (check for details)**

ITEST Program

Innovative Technology Experiences for Students and Teachers

https://www.nsf.gov/publications/pub_summ.jsp?WT.z_pims_id=5467&ods_key=nsf19583

Deadline: August 14, 2019

Resource Center stelar.edc.org

Aim of the ITEST Program

Ensure a high-quality STEM workforce by supporting projects that:

- Increase student awareness of career opportunities in STEM and cognate fields.
- Motivate students to pursue appropriate educational pathways to STEM-related careers.
- Provide technology-rich experiences that develop disciplinary knowledge, practices, and non-cognitive skills needed in STEM fields.
- Applied Research
- **Broadening Participation**

ITEST Project Types

- **Exploring Theory and Design Principles (ETD):** Early stage or exploratory studies that result in a preliminary theoretical framework or a prototype (that may provide the foundation for a DTI project). (Up to $400K)

- **Developing and Testing Innovations (DTI): D**esigning the and pilot-testing or implementing an innovative approach to STEM-career focused education. (Up to $1.5 million)

- **Scaling, Expanding, and Iterating Innovations (SEI):** Uses an existing and proven innovation and investigates the mechanisms that expand its reach to broader audiences (Up to $3 million)

- **Synthesis Studies (up to $300K) and Conference Projects (up to $100K).**

STEM+C Program

STEM + Computing Partnerships

Target Date: No deadline.

Proposals received by July 2, 2018 were considered for possible funding in FY18. Proposals received after that date will be reviewed on a rolling basis.

https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505006

Resource Center hub.mspnet.org

Computing is Defined Broadly

Referring to the range of understandings, concepts, and competencies used in computational approaches to problem solving, such as:

Computational thinking

Computational science

Data science

Computer science (in K-12)

AISL Program

Advancing Informal STEM Learning

Deadline: Nov. 6, 2019

https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504793

Resource Center www.informalscience.org

AISL Program

- **Advancing** – Innovative projects that advance the field through building knowledge via innovative approaches and research.
- **Informal** – Out-of-School learning that makes learning lifelong, life wide, & life deep.
- **STEM** – Not just focused on science, but all of NSF-funded STEM Fields.
- **Learning** – Learning outcomes include: interest, engagement, motivation, behavior, identity, persistence, understanding, awareness, knowledge, and use of STEM content and practices, and 21st century skills.

Project types

- Pilot and Feasibility Studies: Exploratory development work or feasibility studies
- Research in Service to Practice: Advances knowledge & provides evidence base for practice
- Innovations in Development: Builds knowledge through the development of innovative products
- Broad Implementation: Expands models, programs, technologies, assessment or other advances that have documented record of success
- Conferences, Symposia & Workshops: Focus on development of communities of practice, field-advancing practice, assessments, & research agendas
- Funding ranges up to $3,000,000 (depends on project type; see solicitation for details)

More NSFSupport for Maker Projects: Undergraduate

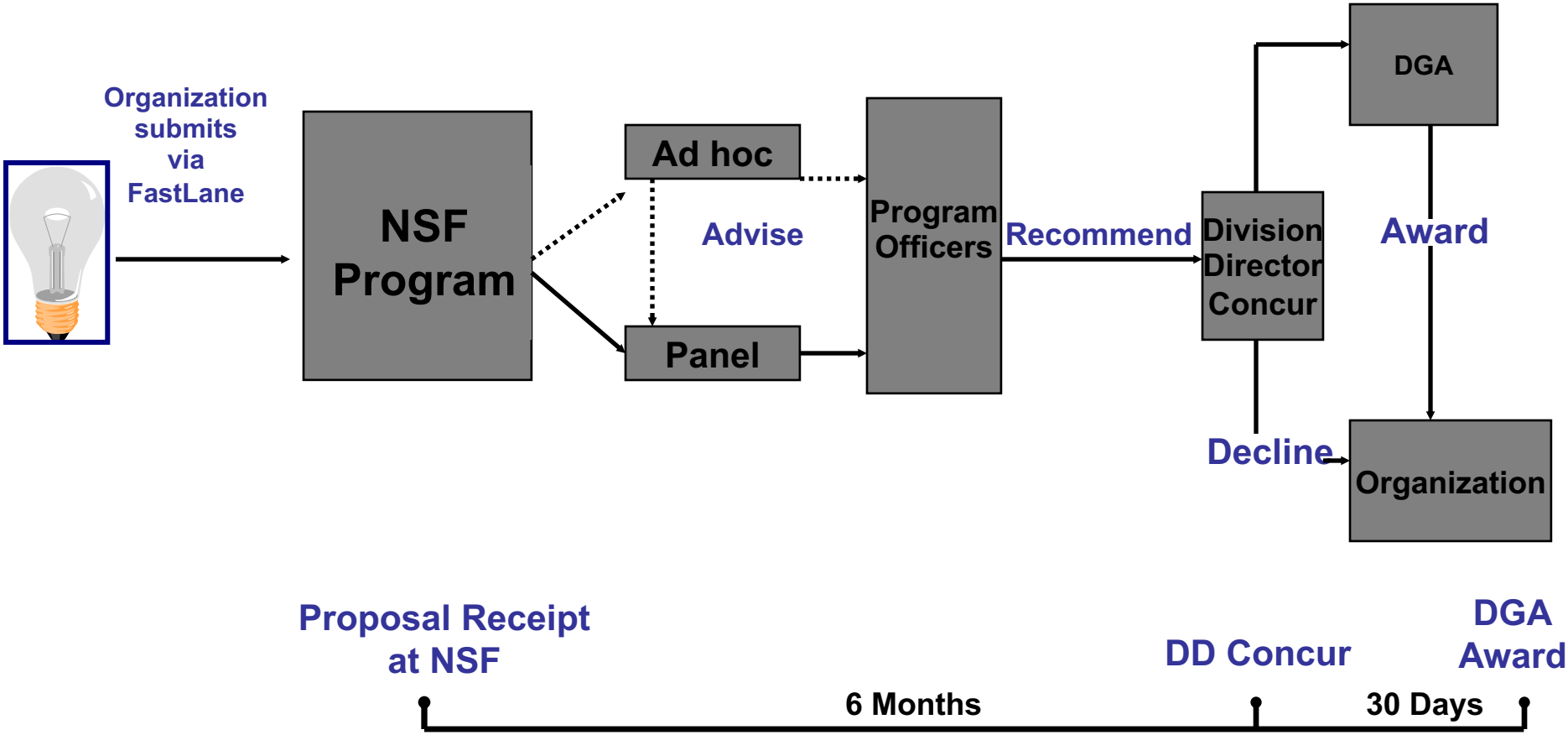
- Improving Undergraduate Stem Education: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505082

- Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf10544&org=DGA

Knowing Your Audience

- The Review Process
- Merit Review Criteria

Proposal Review Process and Timeline



NSB Report on Merit Review Criteria:

Two Review Criteria

When evaluating NSF proposals, reviewers 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 would 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 are 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.

Online Resources

- Advanced Award Search: Demo
  www.nsf.gov/awardsearch/advancedSearch.jsp
- Secret Information: Element Codes
  - ECR: 7980
  - DRK-12: 7645
  - ITEST: 7227
  - STEM+C: 005Y
  - AISL: 7259
- STEM Video Showcase:
  https://stemforall2019.videohall.com/

Resource Centers

- **DRK-12:** Community for Advancing Discovery Research in Education (CADRE) cadrek12.org
- **ITEST:** STEM Learning and Research Center (STELAR) stelar.edc.org
- **STEM+C**: Math and Science Partnership Network (MSPnet) hub.mspnet.org
- **AISL:** Center for Advancement of Informal Science Education (CAISE) informalscience.org/community

Goals and Purposes

- Why is this project important?
- What have you and others done?
- What are you going to do?
- How are you going to do it?
- Who will do the work? What expertise is needed?
- Who will provide independent (*external*) feedback on project progress and success?
- How will results be disseminated?

NSF EAGER Maker Summit

Charting the Future of Making in STEM Education

Held December 10-11, 2018 Alexandria, VA

What is a Maker Space?

"A gathering place for tools, projects, mentors, and expertise."

(Graves et. al., 2006)

Maker spaces typically include technology such as 3-D printers, laser cutters, computer design shop tools, and other electronics.

"Time, talk and tools" + creativity.

(John Dewey)

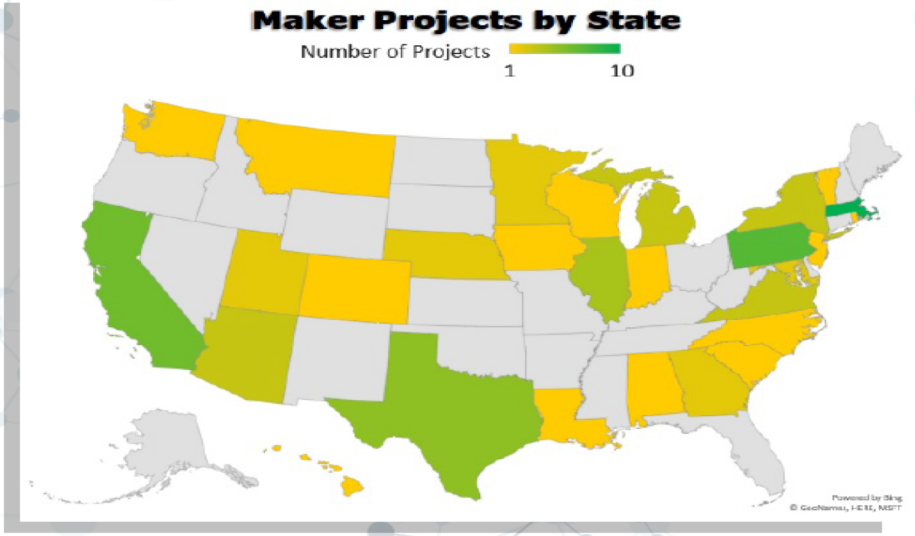
NSF Funding of Maker Projects

...many prompted by a Dear Colleague Letter using EAGER

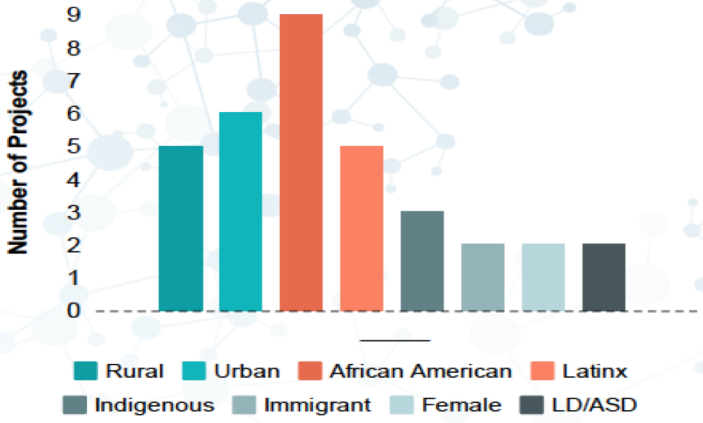
60 maker projects 2013-2018

31 from 2017

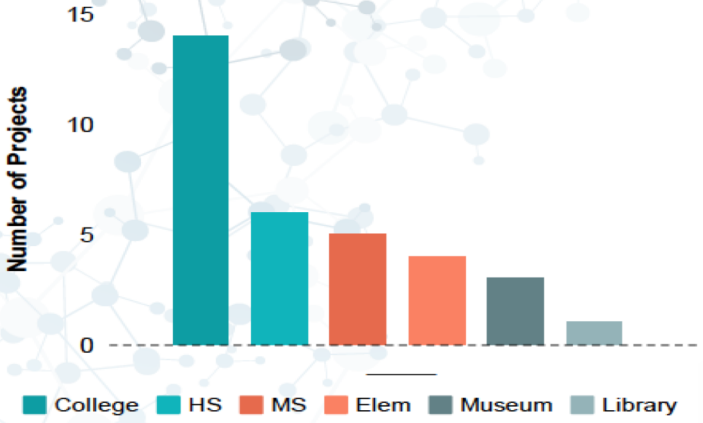
7 collaborative projects



Underrepresented Groups



Project Setting



Impacting Communities in 28 States

with innovative technologies & maker projects such as:

16 Workforce development & STEM pathways
Ex: Veteran Maker Workshop

1 Robotics
Ex: Rural library makerspace with robotic telepresence mentors.

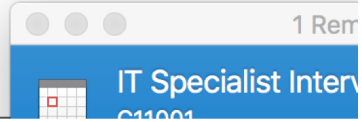
1 Nano-Makerspace
Ex: Microscale structures on butterfly wings.

8 PD/Teacher prep
EX: Immersive MakerSTEM Lab experience to teach content & pedagogy to pre-service educators.

4 VR/AR
Ex: See the flow of electrons in a project you are building.

3 Bio maker spaces
Ex: Build genetic circuits to modify microorganisms.

6 Mobile maker spaces
Ex: Support learning & well-being in a children's hospital.



Five Summit Themes

Co-created through collaboration between NSF, EDC/STELAR, and PI's who volunteered for the planning committee.

Broadening Participation

Partnerships

Process & Pedagogy

Research & Evaluation

Workforce Development

This event was supported by NSF grant # DRL-1614697. Any opinions, findings, and conclusions or recommendations expressed in this event are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Resources

http://stelar.edc.org/nsf-eager-maker-summit
https://www.asee.org/documents/papers-and-publications/papers/maker-summit-report.pdf
https://curiositycommons.wordpress.com/a-brief-history-of-makerspaces/
https://s3.amazonaws.com/littleBits_pdfs/littleBits-GettingSmart-Infographic.pdf
http://informalscience.org/
https://nationofmakers.us/resources.html
https://makered.org/resources/

EDC Education Development Center

stelar
STEM LEARNING AND RESEARCH CENTER

NSF

May 21, 2019

Bob Russell, NSF Program Officer
Brenda Carpenter, Einstein Fellow

Thanks for Participating!

We look forward to receiving your proposals.

Bob Russell, Program Officer
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