Advancing the Frontiers of Science and Engineering: NSF's 10 Big Ideas

Dawn Tilbury, Ph.D.

Assistant Director, Engineering
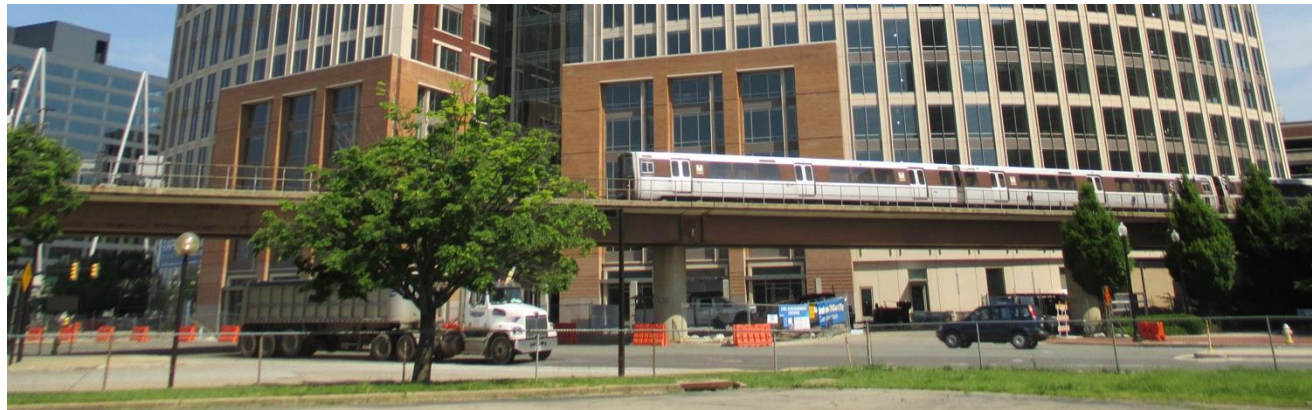
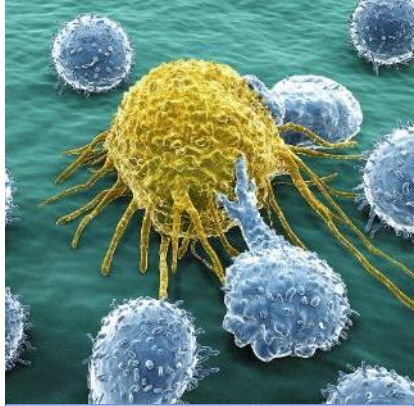**National Science Foundation**

June 18, 2018
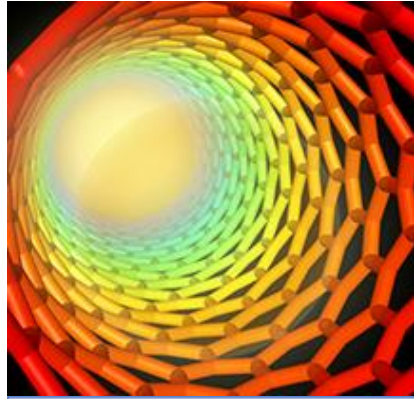
National Science Foundation

Mission: "To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…"
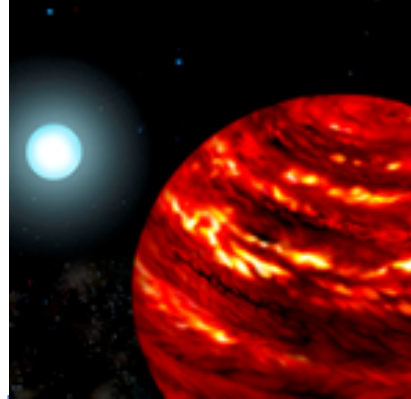
NSF Champions Research and Education in all Fields of Science and Engineering
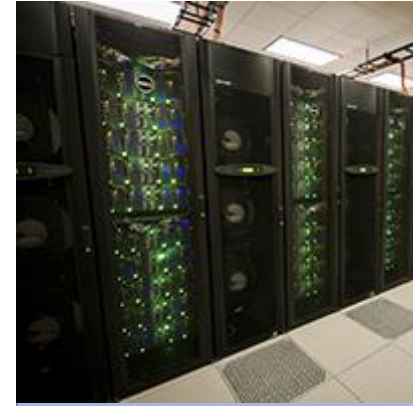

Biological Sciences

Engineering

Mathematical & Physical Sciences

Computer & Information Science & Engineering

Geosciences (including Polar Programs)

Integrative Activities

Education & Human Resources

Social, Behavioral & Economic Sciences

International Science & Engineering
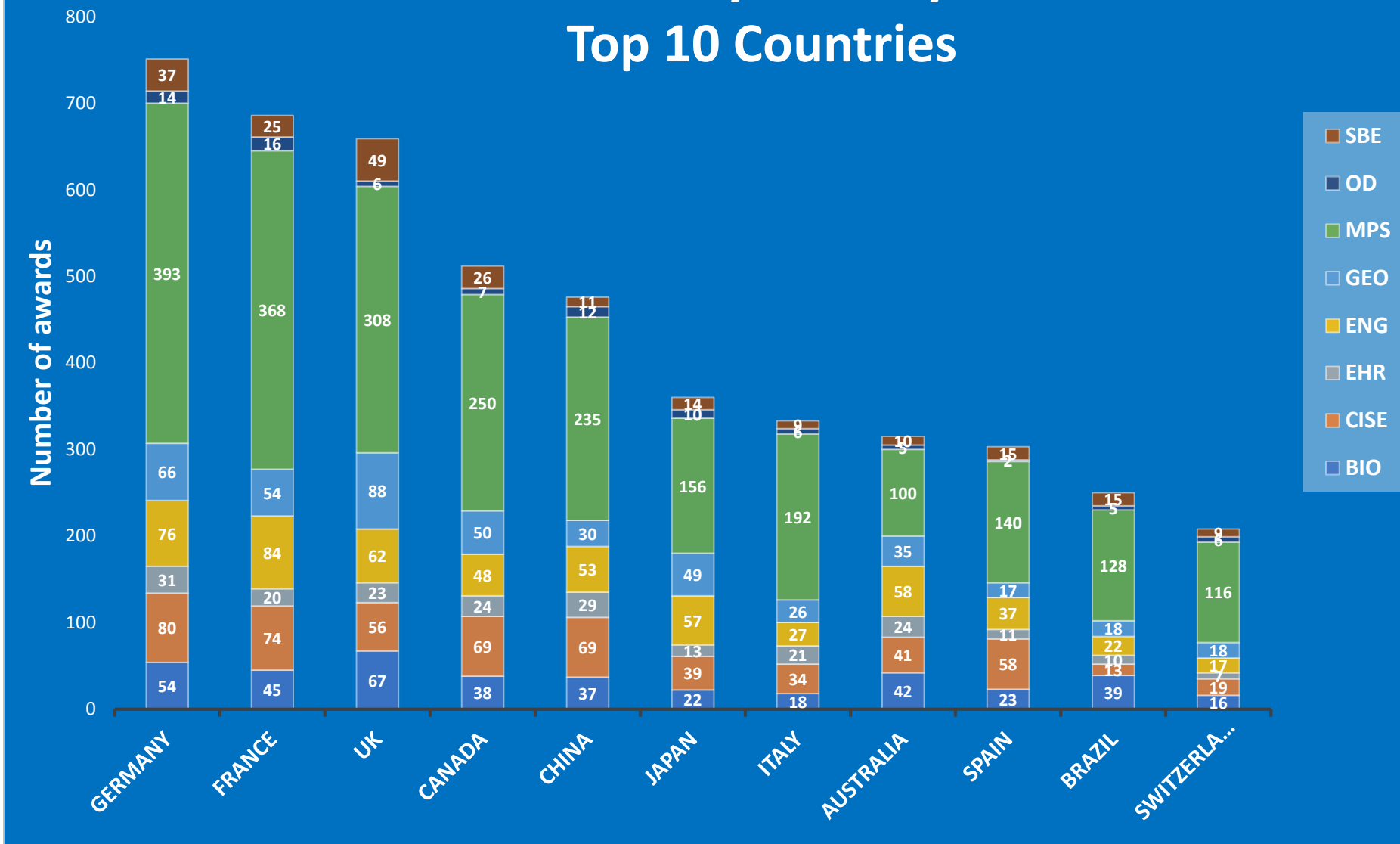
Source: Enterprise Reporting System data, accessed June 12, 2018.

NSF's International Programs Employ Two Approaches

Providing international research opportunities for U.S. students and early-career researchers

ACCELNET

IRES

PIRE

MULTIPLIERS

Advancing U.S. research through international partnerships and networks

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MULTIPLIER – <u>MULTIP</u>lying Impact <u>L</u>everaging <u>I</u>nternational <u>E</u>xpertise in <u>R</u>esearch Missions

Strategic fact-finding missions to visit international sites

Project approach with clear goals and follow-up toolkit

Teams of subject matter experts explore content-specific collaborations

Evidence-based outcomes inform next steps

10 Big Ideas for Future NSF Investments

RESEARCH IDEAS

MATHEMATICAL, STATISTICAL, COMPUTATIONAL FOUNDATIONS — OPEN — DISCOVERY — EDUCATION — WORKFORCE — ANALYTICS — DATA SCIENCE

HARNESSING THE DATA REVOLUTION

FUNDAMENTAL RESEARCH — MACHINE LEARNING — DOMAIN SCIENCE CHALLENGES — RESEARCH DATA CYBERINFRASTRUCTURE — MODELING — DATA MINING — INTERNET OF THINGS — HUMAN DATA INTERFACE

Work at the Human-Technology Frontier: Shaping the Future

Windows on the Universe: The Era of Multi-messenger Astrophysics

The Quantum Leap: Leading the Next Quantum Revolution

Harnessing Data for 21st Century Science and Engineering

Navigating the New Arctic

Understanding the Rules of Life: Predicting Phenotype

PROCESS IDEAS

**Mid-scale Research Infrastructure**

NSF 2026

Growing Convergent Research at NSF

NSF INCLUDES: Enhancing STEM through Diversity and Inclusion

*"engage NSF's research community in the pursuit of **fundamental research in data science and engineering**, the development of a cohesive, federated, national-scale approach to **research data infrastructure**, and the development of **a 21st-century data-capable workforce**."*

The Data Revolution
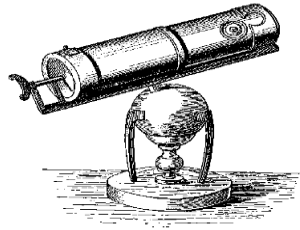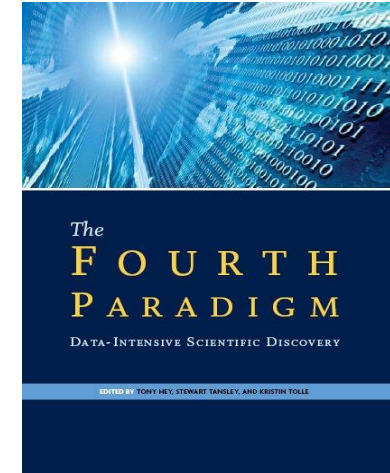
Experimental   Theoretical   Computational   Data

Harnessing the Data Revolution

Basic Research

Theoretical foundations

Systems foundations

Data-intensive research
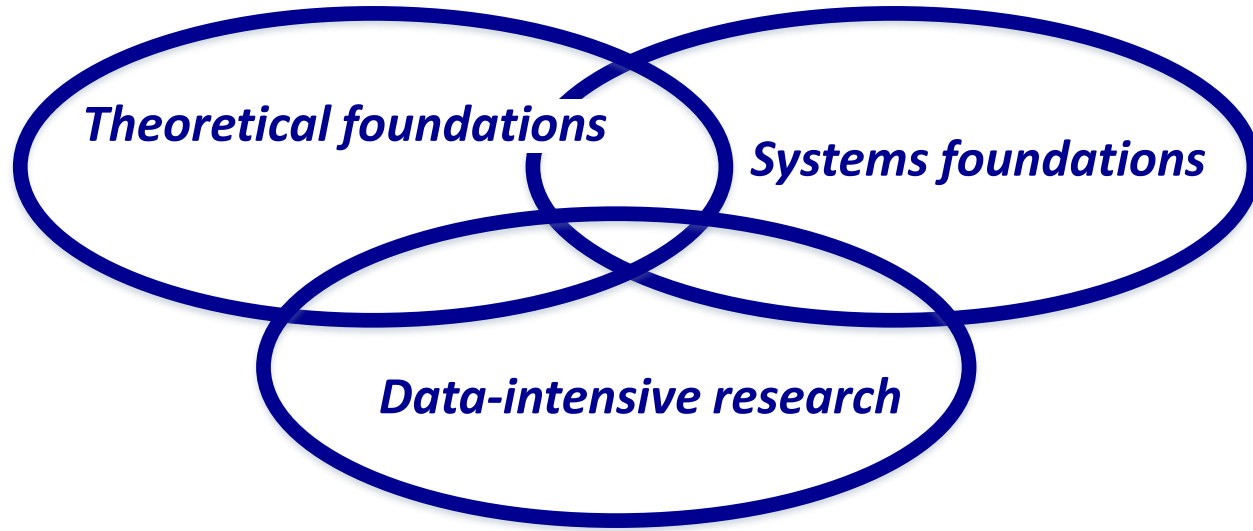
Educational pathways

Advanced cyberinfrastructure

The World of Work is Changing

- **On the cusp of a major transformation in work and the workplace**

- **Driven by combinations of**
  - **Artificial intelligence**
  - **Machine learning**
  - **The Internet of Things**
  - **Robotics**
  - **And more...**

- **Toward an evolving human-technology ecosystem**
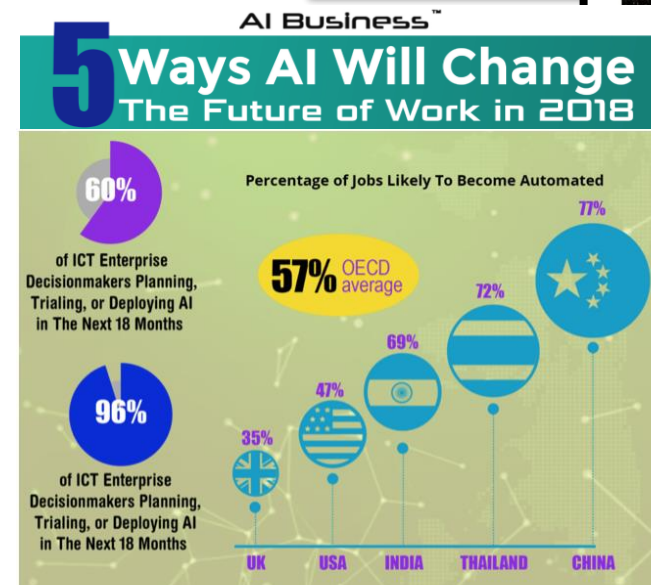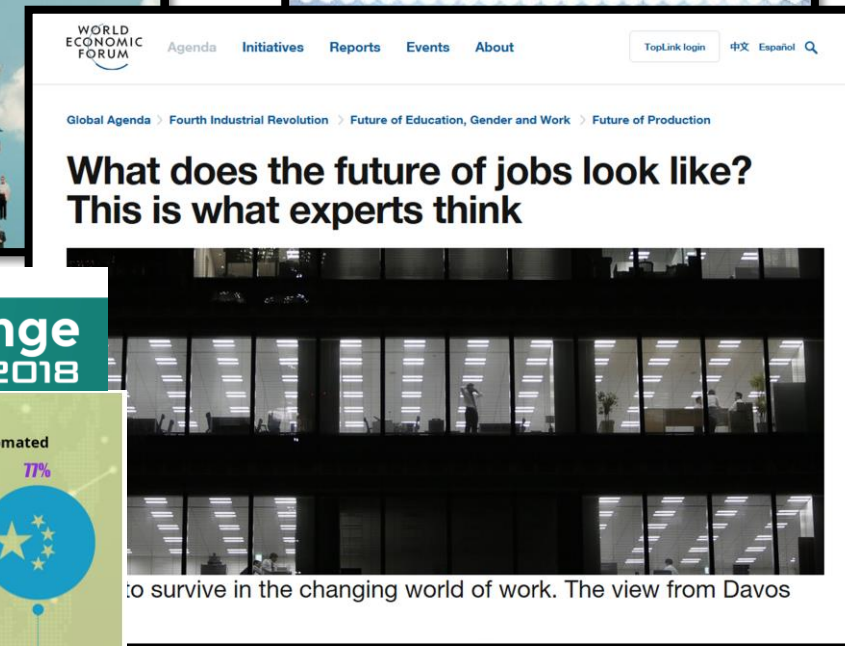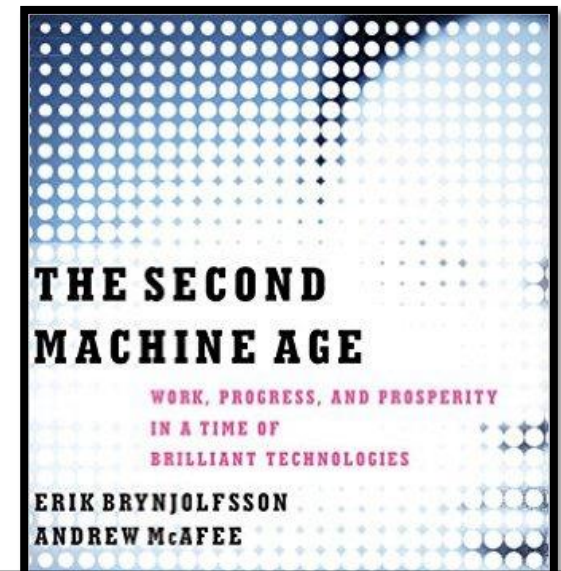
The Pace of Technological Development is Accelerating

- **Cost of computing dropping, computer power increasing**

- **Computers ubiquitous & networked (Internet of Things)**

- **Artificial Intelligence (AI) accelerates the impact of big data**

Self-driving car

Bridge sensors

Cars maintaining distances

A Changing World of Work: Why it Matters

How Technology is Destroying Jobs
Rotman (2013) *MIT Technology Review*

Journal of Economic Perspectives—Volume 29, Number 3—Summer 2015—Pages 3–30

Why Are There Still So Many Jobs?
The History and Future of Workplace Automation†

David H. Autor

The Atlantic
How to Protect Workers From Job-Stealing Robots
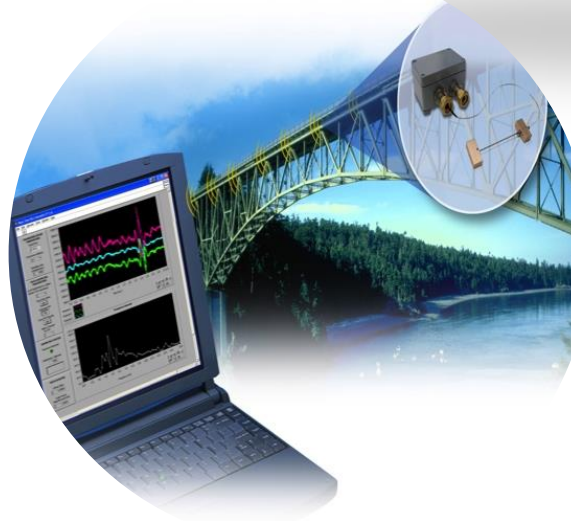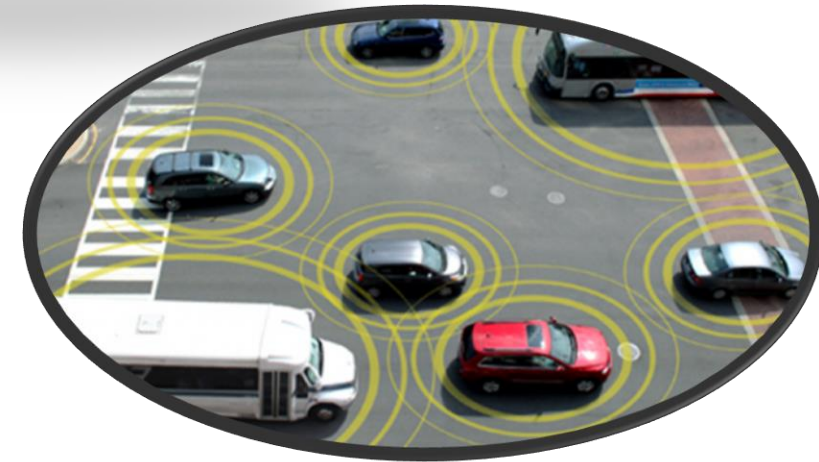President Obama's chief economist argues that, with the right policies, artificial intelligence can be boon to the labor market, not a threat.

theguardian
Economics
Technology has created more jobs than it has destroyed, says 140 years of data
Study of census results in England and Wales since 1871 finds rise of machines has been a job creator rather than making working humans obsolete

Katie Allen
Tuesday 18 August 2015 02.00 EDT

- **Employment**
- **Opportunity**
- **Productivity**
- **Economic Growth**
- **Competitiveness**
- **National Security**
- **U.S. Global Leadership**

Future of Work at the Human-Technology Frontier

- **A bold initiative to catalyze interdisciplinary science and engineering research to...**
  - **understand and build the human-technology partnership;**
  - **design new technologies to augment human performance;**
  - **illuminate the emerging socio-technological landscape; and**
  - **foster lifelong and pervasive learning with technology**

"a unique opportunity to actively shape the development and use of technologies to improve the quality of work while also increasing productivity and economic growth"

Convergence
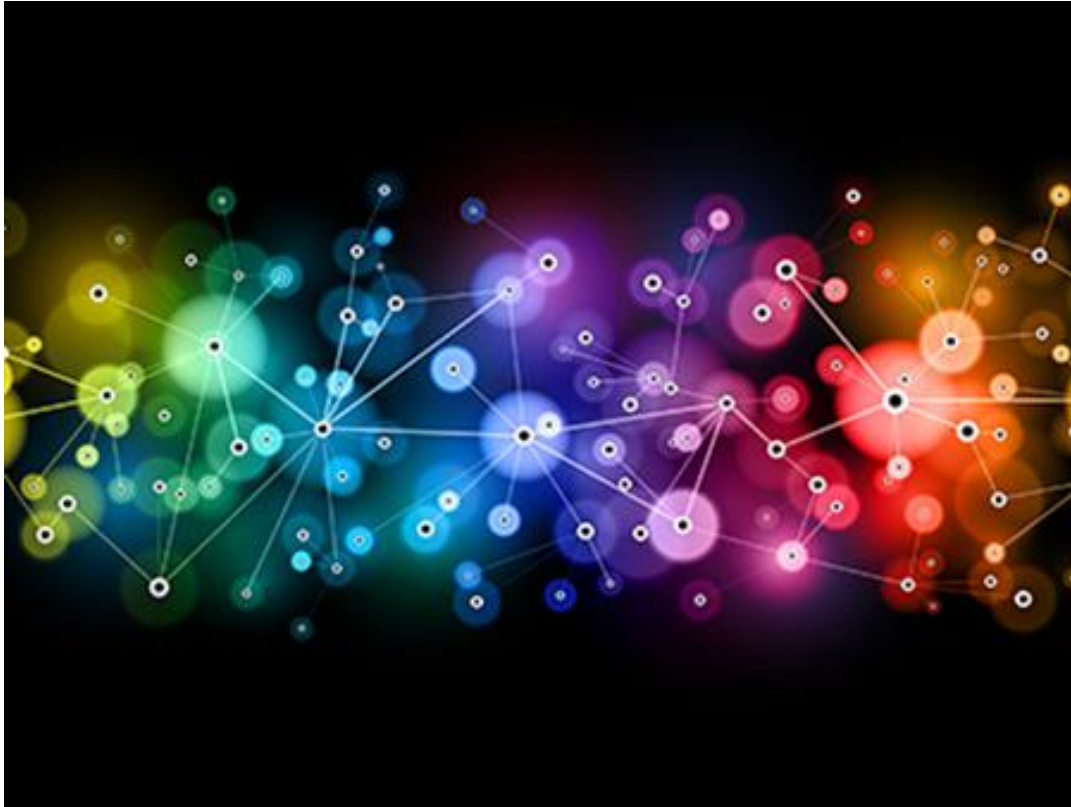
The grand challenges of today will not be solved by one discipline working alone. They require <u>convergence</u>: the merging of ideas, approaches and technologies from widely diverse fields of knowledge to stimulate innovation and discovery.

NSF INCLUDES

What is a Convergence Accelerator?

- A new organizational structure intended to leverage external partnerships to accelerate convergent and translational activities in an area of national importance

- A home for application-driven basic research

- Advances ideas from concept to deliverables

Key Characteristics

- **Fed by basic research & discovery**
- **Adopts convergent approach**
- **Cohorts, integrated teams**
- **Proactively and intentionally managed**
- **Seed investment, competition**
- **Intensive education and mentorship**
- **Attracts partnerships**
- **Fixed term**

How do CAs differ from Foundational Research?

- **CAs are intentional in outcomes, more goal-oriented**
- **CAs foster a range of approaches, solutions**
- **CAs feed on the tension between top-down strategic direction and bottom-up creative approaches**

Convergence Accelerator Phases

Prize(s)

NSF PIs, partners, basic research results

0: Team Seeding

- Organic and/or through structured workshops
- Multi-disciplinary
- Diverse membership

1: Team Formation

- Cohorts of ~20 teams in 3-5 tracks
- ~6 months
- **Ideation**
- **Convergence**
- **Team dynamics**

2: Accelerated Research

- Large grants to selected teams
- Semi-annual or annual reviews
- Maintain cohort structure

Review

Pitch

Compete

Unique NSF Expertise, combined in new ways, designed to decrease time to discovery

- **Convergence Accelerators build on NSF innovations and best practices**
  - **Network model: I-Corps (Teams and Cohorts)**
  - **Collective Impact: NSF INCLUDES**
  - **Team Development: Ideas Labs**
  - **Industry-inspired Workshop on Quantum (Mar. 2018): Industry wants more similar workshops on HDR and FW-HTF topics (and URoL)**
- **Convergence Accelerators add new dimensions**
  - **Selection by pitch, instead of 15-page research proposal**
  - **Competition for monetary prizes**

NSF's 10 Big Ideas

RESEARCH IDEAS

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" … bold questions that will drive NSF's long-term research agenda -- questions that will ensure future generations continue to reap the benefits of fundamental S&E research. "

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