CISE Update and FY15 Budget Priorities

Farnam Jahanian, AD
Suzi Iacono, DAD

CISE AC Spring Meeting
May 15, 2014

NSF Director: France Córdova

Image credit: *Sandy Schaeffer*

ACI Division Director Search

External Search Committee

- **Co-chairs:**
  Jim Bottum, Clemson U
  Katherine Yelick, Lawrence Berkeley
- **Members:**
  Fran Berman, RPI
  Sharon Glotzer, U Michigan
  Bill Gropp, UIUC
  David Lifka, Cornell University
- **NSF liaison:**
  Keith Marzullo, DD/CNS

Congratulations Irene!

Irene Qualters

Two New DD Search Committees

IIS Division

- **Co-chairs:**
  - Jeffrey Naughton, U Wisconsin
  - Jennifer Preece, U Maryland,
- **Members:**
  - Vijay Kumar, UPenn
  - Elizabeth Mynatt, Georgia Tech
  - Daniela Rus, MIT
  - Dan Siewiorek, CMU
  - Jennifer Widom, Stanford
- **NSF liaison:**
  - Keith Marzullo, DD/CNS

CNS Division

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  - Rajesh Gupta, UCSD
  - Klara Nahrstedt, UIUC
- **Members:**
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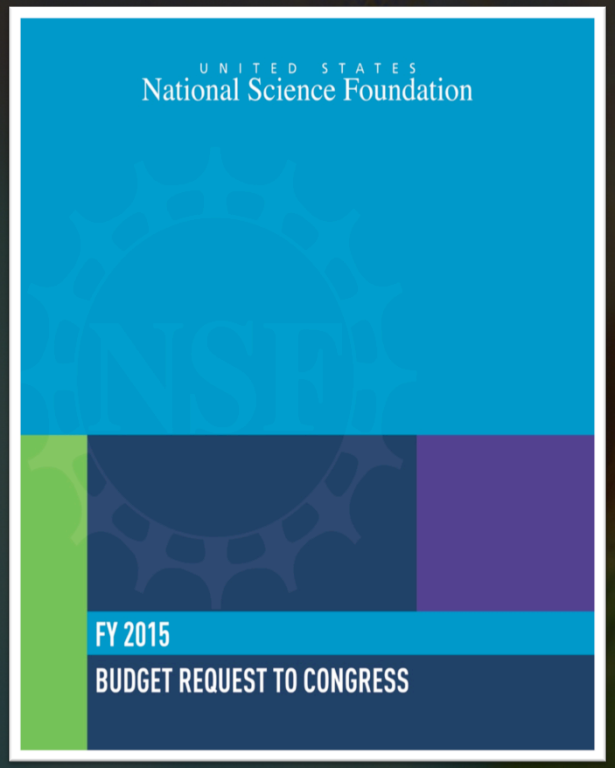
  - David Kotz, Dartmouth
  - Patrick McDaniel, Penn State University
  - George Pappas, U Penn
  - Craig Partridge, BBN Technologies
- **NSF liaison:**
  - Howard Wactlar, DD/IIS

Jim Donlon, CCF Deputy Division Director

FY 2015 Budget Request



- **NSF**
  - FY 2015 Budget Request: $7255.00 Million
- **CISE**
  - FY 2015 Budget Request: $893.35 Million
  - *CISE FY 2015 request is shaped by investments in core research, education, and infrastructure programs as well as critical investments in NSF cross-foundation priorities and programs.*

Budget from FY 2010 – 2015

	FY 2010 Actual ($M)	FY 2011 Actual ($M)	FY 2012 Actual ($M)	FY 2013 Actual ($M)	FY 2014 Estimate ($M)	FY 2015 Request ($M)
CISE Total	$618.71	$636.06	$653.32	$858.13	$894.00	$893.35
R&RA Total	$5,615.33	$5,608.38	$5,758.30	$5,558.88	$5,808.92	$5,807.46
NSF Total	$6,972.20	$6,912.55	$7,105.41	$6,901.91	$7,171.92	$7,255.00

- FY 2013 and FY 2014 Include ACI Division.
- FY 2013 also includes the impact of sequestration.

New Programs and Initiatives

- Big Data Program and Initiative (NSF 14-543)
- National Robotics Initiative, NRI (NSF 14-500)
- US Ignite Initiative
- Smart and Connected Health, SCH (NSF 13-543 jointly with NIH
- Campus Cyberinfrastructure – Infrastructure and Engineering Program, CCIIE (NSF 14-521
- CISE Research Infrastructure: Mid-Scale Inf NSFCloud (NSF 13-602)
- Cyberlearning and Future Learning Techn 14-526)
- Data Infrastructure Building Blocks, DIE
- Enhancing Access to the Radio Spectru 14-529)
- Exploiting Parallelism and Scalability
- Failure-Resistant Systems, jointly w
- Future Internet Architectures – Ne 13-538)
- Resilient Interdependent Infrast

Systems, RIPS (NSF 14-524)

and Trustworthy Cyberspace, SaTC (NSF 13-578)

orthy Cyberspace: Secure, Trustworthy,

nductors and Systems –

tion for the 21st

rogram in Quantum

n Computer Science,

WIFIUS

National Robotics Initiative (NRI)

The realization of co-robots acting in direct support of individuals and groups

PROGRAM SOLICITATION
NSF 14-500

REPLACES DOCUMENT(S):
NSF 12-607

National Science Foundation
Directorate for Computer & Information Science & Engineering
Division of Information & Intelligent Systems
Directorate for Engineering
Directorate for Education & Human Resources
Directorate for Social, Behavioral & Economic Sciences

National Aeronautics and Space Administration
Space Technology Mission Directorate, Game Changing Technology Program

National Institutes of Health
National Institute of Biomedical Imaging and Bioengineering
Eunice Kennedy Shriver National Institute of Child Health and Human Development
National Eye Institute
National Institute on Aging
National Institute on Deafness and Other Communication Disorders
National Institute of Neurological Disorders and Stroke
National Institute of Nursing Research

U.S. Dept. of Agriculture

National Institute of Food and Agriculture

Full Proposal Deadline(s) (due by 5 p.m. proposer's local time):
January 21, 2014
November 13, 2014
Second Thursday in November, Annually Thereafter

IMPORTANT INFORMATION AND REVISION NOTES

This is a revision of NSF 12-607, the solicitation for the National Robotics Initiative...

Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS)

Accelerating advances in 21st century smart engineered systems

- CISE focus includes:
  - Advanced Manufacturing,
  - Cyber-Physical Systems (CPS),
  - The National Robotics Initiative (NRI),
  - Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP),
  - and their interaction and synthesis.

$81.5M
CISE Request

CISE, BIO, EHR, ENG, and MPS

Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21)

Accelerating the progress of scientific discovery and innovation

$80.0 M
CISE Request

- CISE/ACI focus in CIF21 includes:
  - **BigData** – Developing core scientific and technological means of managing, analyzing, visualizing and extracting useful information from large, diverse, distributed and heterogeneous data sets;
  - **DIBBS** - Building data infrastructure building blocks through pilots and early implementations of robust and shared data-centric cyberinfrastructure for scientific communities;
  - **CDS&E** - Building and developing new computational and data-enabled science and engineering research communities;
  - **SI²** - Advancing new computational infrastructure, and catalyzing new paradigms and practices in the development and use of software that is robust, reliable, usable, and sustainable; and
  - **Community Building Partnerships** - EarthCube, Building Community and Capacity (BCC), and DataWay.

CISE, BIO, EHR, ENG, GEO, IIA, MPS, and SBE

Secure and Trustworthy Cyberspace (SaTC)

Securing our Nation's cyberspace

- Aligns with the national *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program* (released December 2011).
- SaTC cross-directorate program (NSF 13-578): Aims to support fundamental scientific advances and technologies to protect cyberspace.
- Scholarship for Service: Aims to increase the number of cybersecurity professionals in the U.S.
- Focus on Privacy: Dear Colleague Letter for new collaborations between Computer and Social Scientists, including a focus on privacy.

$67.0 M
CISE Request

CISE, EHR, ENG, MPS, and SBE

Cognitive Science and Neuroscience

Improve understanding of the brain

- White House BRAIN Initiative launched in April 2013 (NSF, NIH, DARPA).
- Addresses critical challenge of research integration across multiple scales ranging from molecular to behavioral levels with the ultimate goal of understanding the brain.
- Builds on NSF's unique ability to catalyze multi-disciplinary research and ongoing investments (e.g., Collaborative Research in Computational Neuroscience, CRCNS, in collaboration with NIH, Germany, France, and Israel; Robust Intelligence Core Research).

$5.54 M
CISE Request

CISE, BIO, ENG, MPS, and SBE

Cyberlearning and Future Learning Technologies

Improving learning by integrating emerging technologies with knowledge from research about how people learn

- **Solicitation NSF 14-526**
- **Research Thrusts:**
  - **Innovation**
    - Identifying new means of using technology for fostering and assessing learning;
  - **Advancing understanding of how people learn in technology-rich learning environments**
    - Enhancing understanding of how people learn and how to better foster and assess learning; and
  - **Promoting broad use and transferability of genres**
    - Extracting lessons from experiences with these technologies that can inform design and use.

$12.0M
CISE Request

Image Credit: *Georgia Computes! Georgia Tech*

CISE, EHR, ENG, and SBE

Other CISE Major Investments

Area of Investment	FY 2013 Actual ($M)	FY 2014 Estimate ($M)	FY 2015 Request ($M)
EARS	$9.00	$9.25	$9.00
I-Corps	$4.60	$8.00	$10.00
SEES -CyberSEES -HazardSEES	$13.85	$11.00	$11.00

President's Opportunity, Growth & Security Initiative

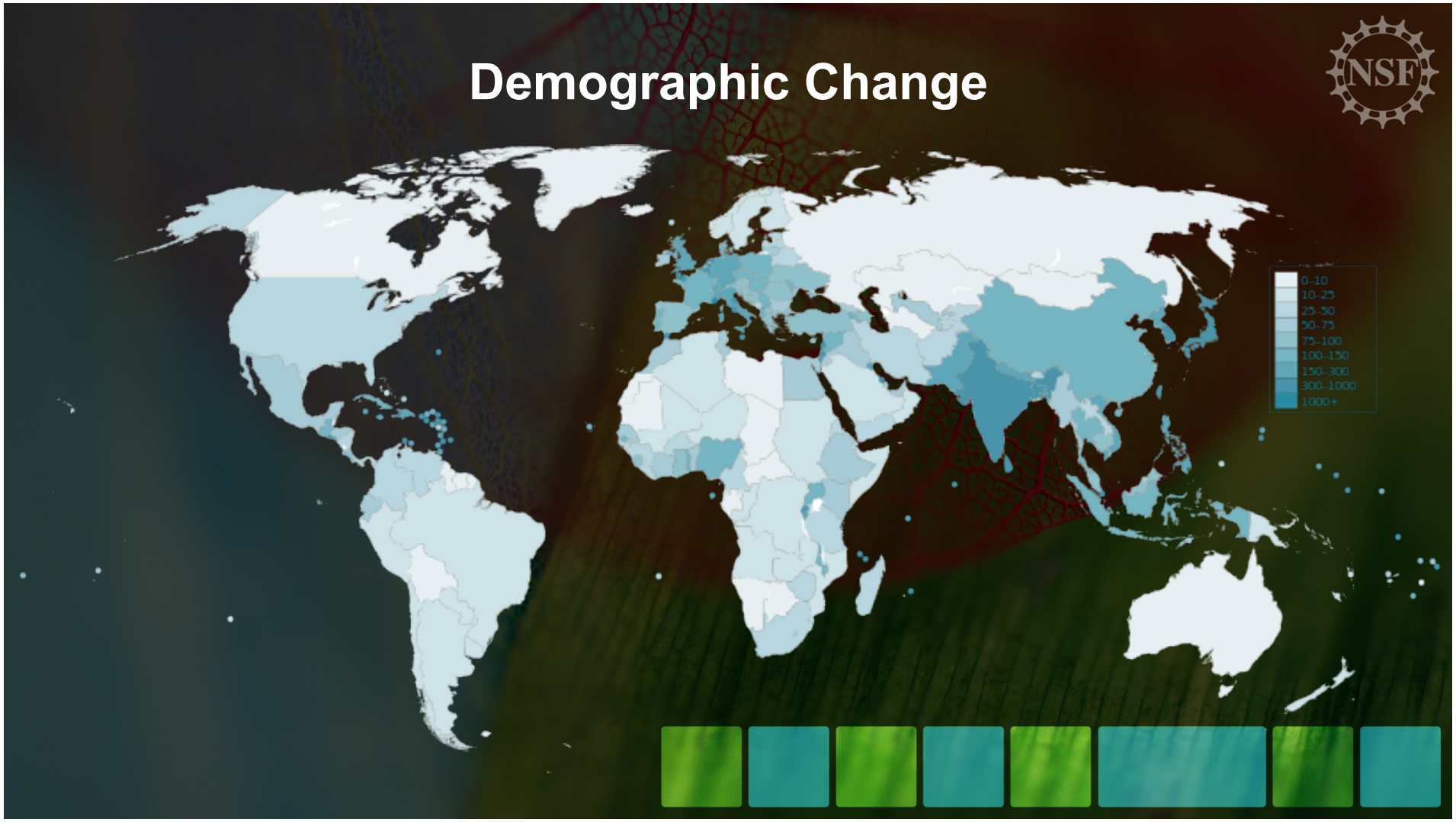
$552 million across NSF

Looking Forward

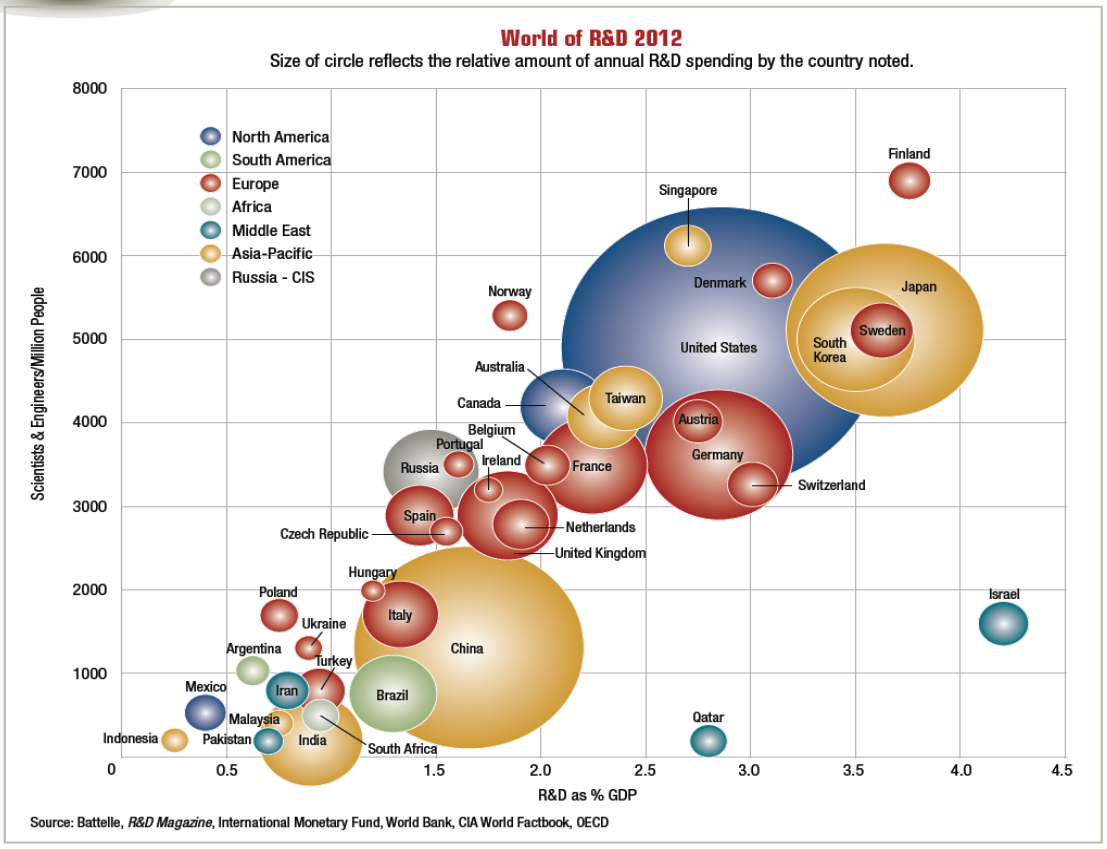
LSST

We are in a period of rapid and profound social, economic, and technological transformation accentuated by global competition.

- **Borderless knowledge enterprise:** Democratization of access and a fundamental change in the role of universities as originators and keepers of knowledge.
- **Shifting demographics domestically and internationally:** Rapidly increasing concentration of engineers and scientists in Asia, and increased competition for students and funding.
- **Shifting economics:** Research and education seen as ticket to economic prosperity in large and small developing countries.
- **Integration and deeper relationship with industry:** Reinforces the role of universities as drivers of innovation and growth.
- **Digital technologies and on-line education**: democratization of education and transformation of the way eduction is delivered and accessed

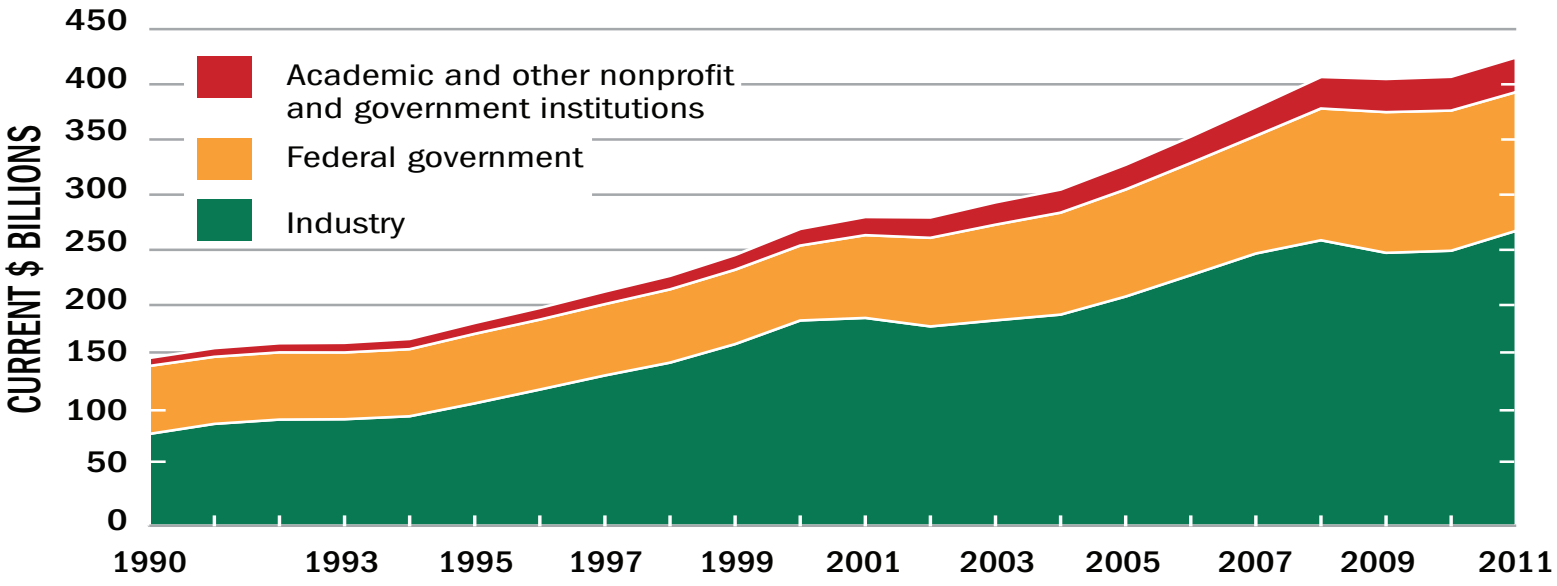

Demographic Change
NSF
0-10
10-25
25-50
50-75
75-100
100-150
150-300
300-1000
1000+

2013 Global *R&D Funding Forecast*



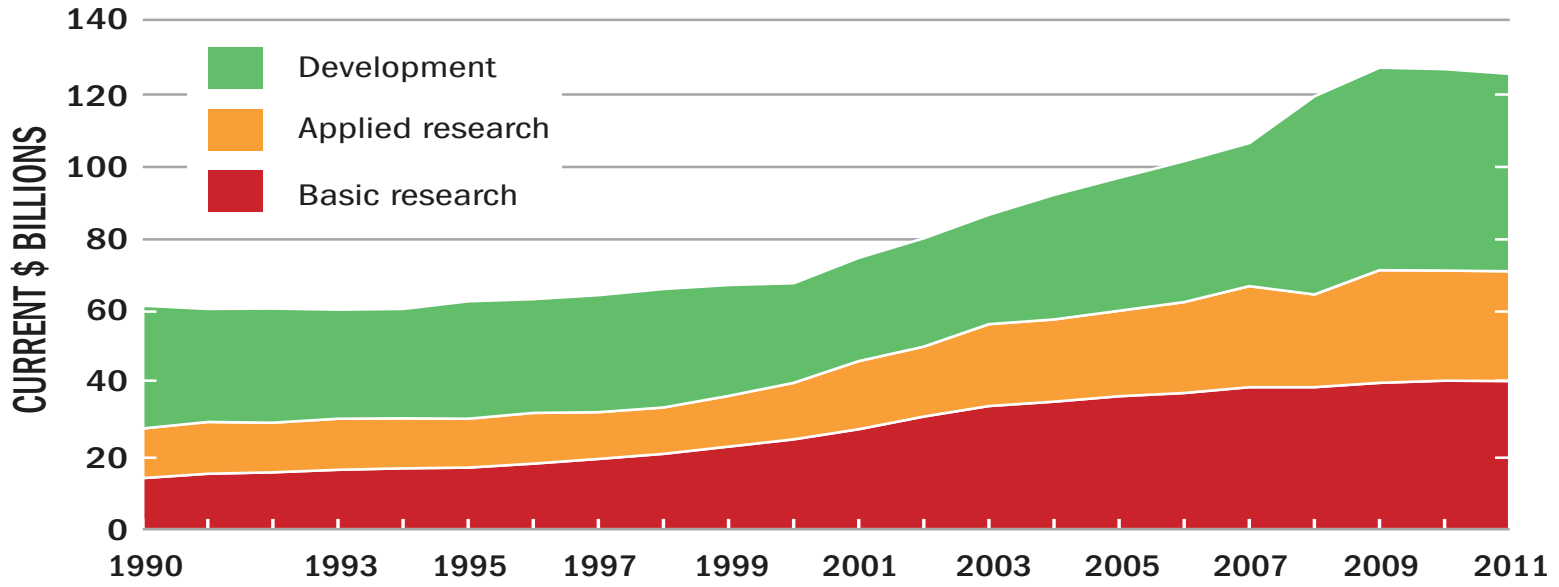
Source: Battelle, *R&D Magazine*, International Monetary Fund, World Bank, CIA World Factbook, OECD

U.S. R&D expenditures, by source of funds: 1990–2011



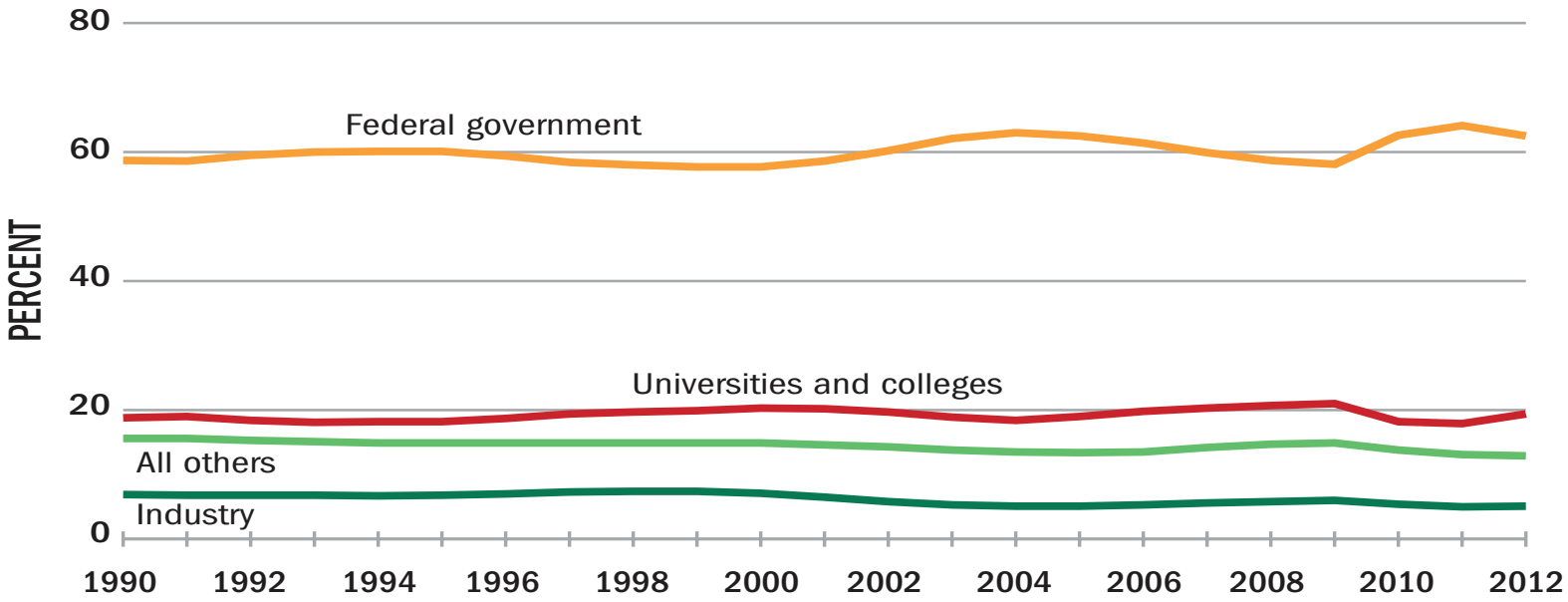
SEI 2014: **Sources of R&D Funding**, Chapter 4.

Federal R&D funds, by type of work: 1990–2011



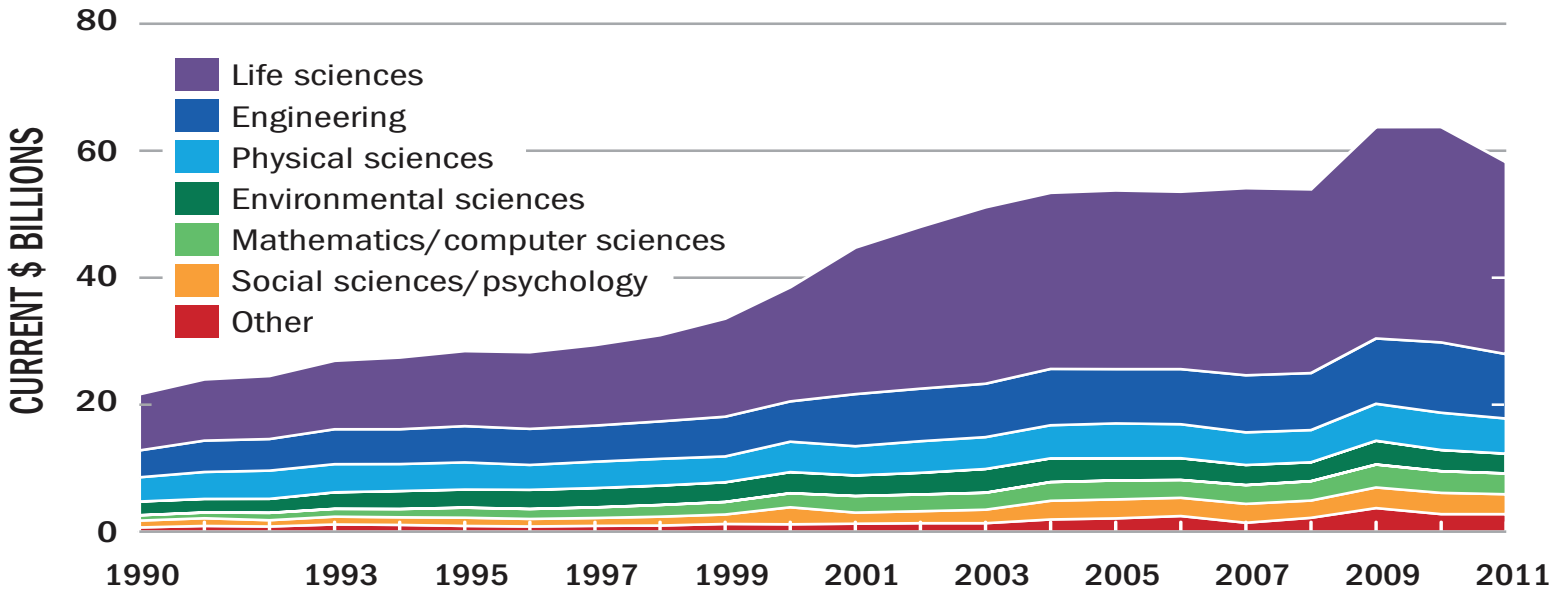
SEI 2014: **R&D, by Character of Work**, Chapter 4.

Funding sources for U.S. academic R&D: 1990–2012



SEI 2014: **Expenditures and Funding for Academic R&D**, Chapter 5.

Federal basic and applied research funds, by S&E field: 1990–2011



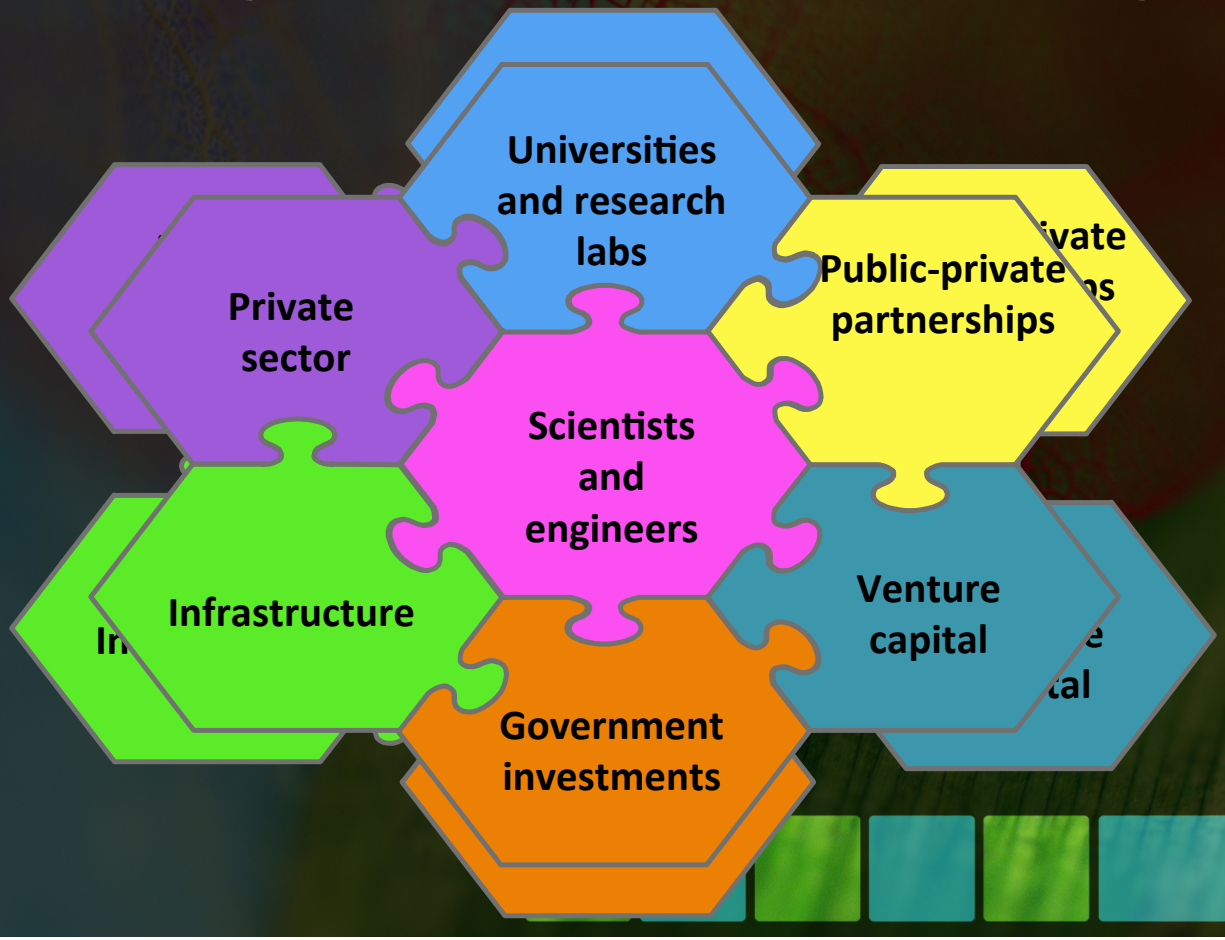
SEI 2014: **Federal Spending on Research, by Field**, Chapter 4.

POINT #1

A thriving basic research community is the foundation for long-term discovery and innovation, economic prosperity, and national security.

Paradox of Discovery and Innovation: no one knows how an idea or invention will impact the world until it is widely used, leading to unintended consequences.

Discovery and Innovation Ecosystem



Long-Term Investment in Basic Research is Imperative

- There is often a **long, unpredictable incubation period** – requiring sustained investment – between initial exploration and impact.
- Interactions of research ideas **multiply their impact** and **seed new ideas** with the potential to lead to unanticipated advances.
- **Unanticipated outcomes** are often as important as the anticipated ones.

The Future …

Top twelve economically disruptive technologies (by 2025)

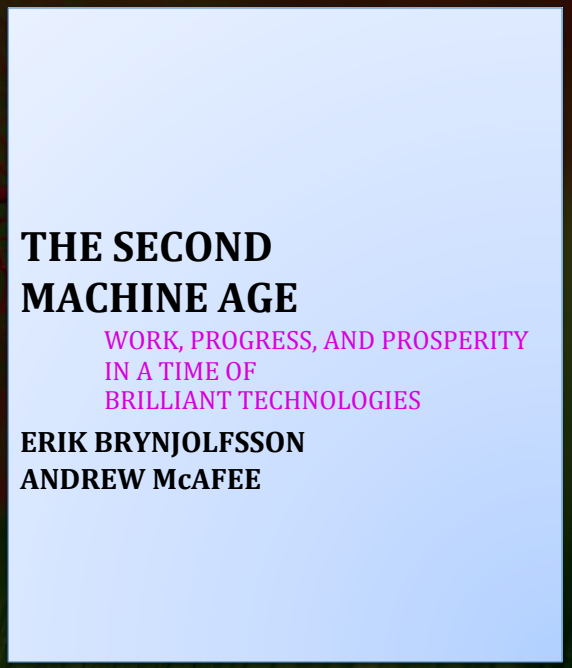
- Mobile Internet
- Automation of knowledge work
- The Internet of Things
- Cloud technology
- Advanced robotics
- Autonomous and near-autonomous vehicles
- Next-generation genomics
- Energy storage
- 3D printing
- Advanced materials
- Advanced oil and gas exploration and recovery
- Renewable energy

SOURCE: McKinsey Global Institute analysis

http://www.mckinsey.com/insights/business_technology/disruptive_technologies

An Inflection Point: The Second Machine Age

- Conventional wisdom: “Computers are good at following rules … but bad at pattern recognition.”
- Over the last ten years:
  - Self-serving cars
  - Complex communication, NLP
  - Face recognition
  - Language translation
  - Watson and Jeopardy
  - Robotics and deep inroads against Moravec’s Paradox
  - 3D printing and additive manufacturing



"Convergence"

- Advances in science and engineering – information technology, nanotechnology, materials, biotechnology, genetics, geoscience, cognitive and neuroscience, … – will continue to drive major innovations in addressing societal challenges.
- ***Convergence*** – the coming together of these scientific fields - will drive the greatest advances and innovations.
- Convergence will necessitate new levels and forms of collaboration and knowledge sharing.
- Computation- and data-intensive approaches and deep integration of cyber into the physical world will continue to accelerate the pace of discovery.

POINT #2

Prioritization of CISE research frontiers and programmatic initiatives – investments at the right scale – could have a transformative impact far beyond our discipline and the research community.

Remember … New Programs and Initiatives

- Big Data Program and Initiative (NSF 14-543)
- National Robotics Initiative, NRI (NSF 14-500)
- US Ignite Initiative
- Smart and Connected Health, SCH (NSF 13-543) – now jointly with NIH
- Campus Cyberinfrastructure – Infrastructure, Innovation and Engineering Program, CCIIE (NSF 14-521)
- CISE Research Infrastructure: Mid-Scale Infrastructure – NSFCloud (NSF 13-602)
- Cyberlearning and Future Learning Technologies (NSF 14-526)
- Data Infrastructure Building Blocks, DIBBS (NSF 14-530)
- Enhancing Access to the Radio Spectrum, EARS (NSF 14-529)
- Exploiting Parallelism and Scalability, XPS (NSF 14-516)
- Failure-Resistant Systems, jointly with SRC (NSF 12-566)
- Future Internet Architectures – Next Phase, FIA-NP (NSF 13-538)
- Resilient Interdependent Infrastructure Processes and Systems, RIPS (NSF 14-524)
- Secure and Trustworthy Cyberspace, SaTC (NSF 13-578)
- Secure and Trustworthy Cyberspace: Secure, Trustworthy, Assured and Resilient Semiconductors and Systems – SaTC: STARSS (NSF 14-528)
- STEM-C Partnerships: Computing Education for the 21st Century, CE21 (NSF 14-523)
- CyberSEES (NSF 14-531)
- Hazards SEES (NSF 12-610)
- CISE-MPS Interdisciplinary Faculty Program in Quantum Information Science (NSF 12-540)
- United States-Israel Collaboration in Computer Science, USICCS (NSF 12-603)
- US-Finland Wireless Innovation, WIFIUS

Many Dimensions …

- Future funding outlook for basic and applied research
- Core vs. inter-disciplinary research debate
  - Success rate challenges for core and cross-cuts
- Foundational vs. translational research debate
- Funding research areas and project at the right scale
  - Notable trends in CISE over the last few years
- Imperative to invest in early career researchers
- Community's engagement and input: YOU, CCC, CRA, CSTB, ACM, IEEE, workshops
- External factors:
  - Administration priorities, congressional oversight, PCAST, NSB
- Leveraging investment by the private sector and foundations
- Shaping national policy vs. formulating new programs
- We continue to underestimate extraordinary flexibility in shaping …

POINT #3

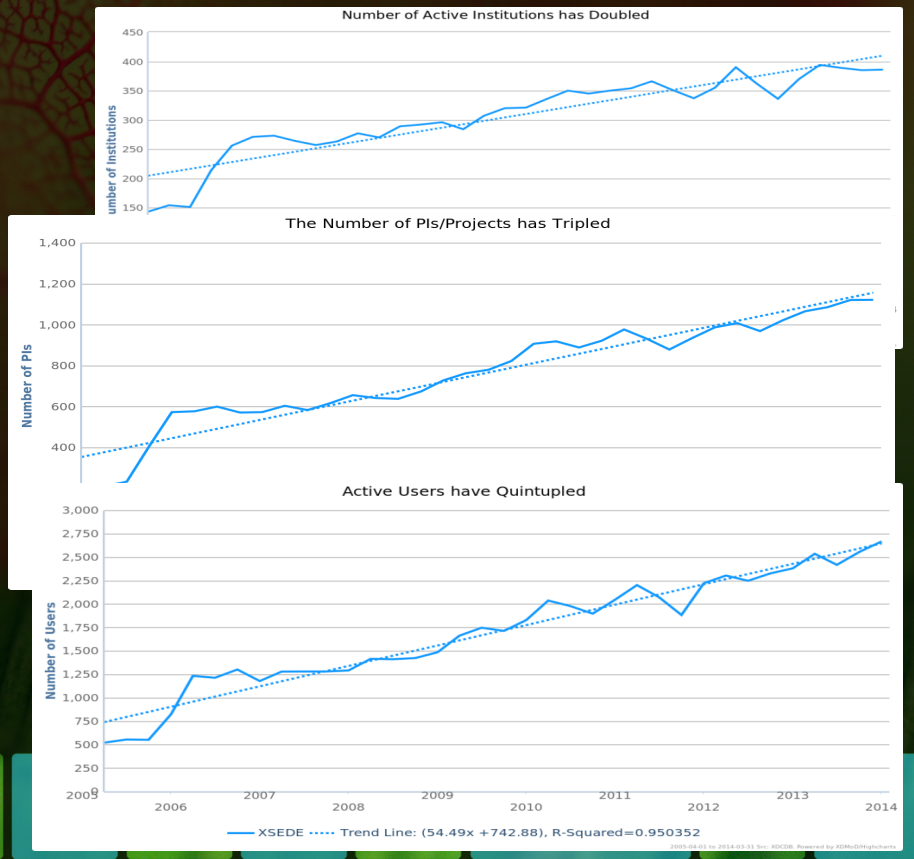
Discovery and innovation across disciplines demands advanced cyber infrastructure, and the demand has far exceeded our investments and available resources over the last decade.

Increased use of NSF advanced computing infrastructure

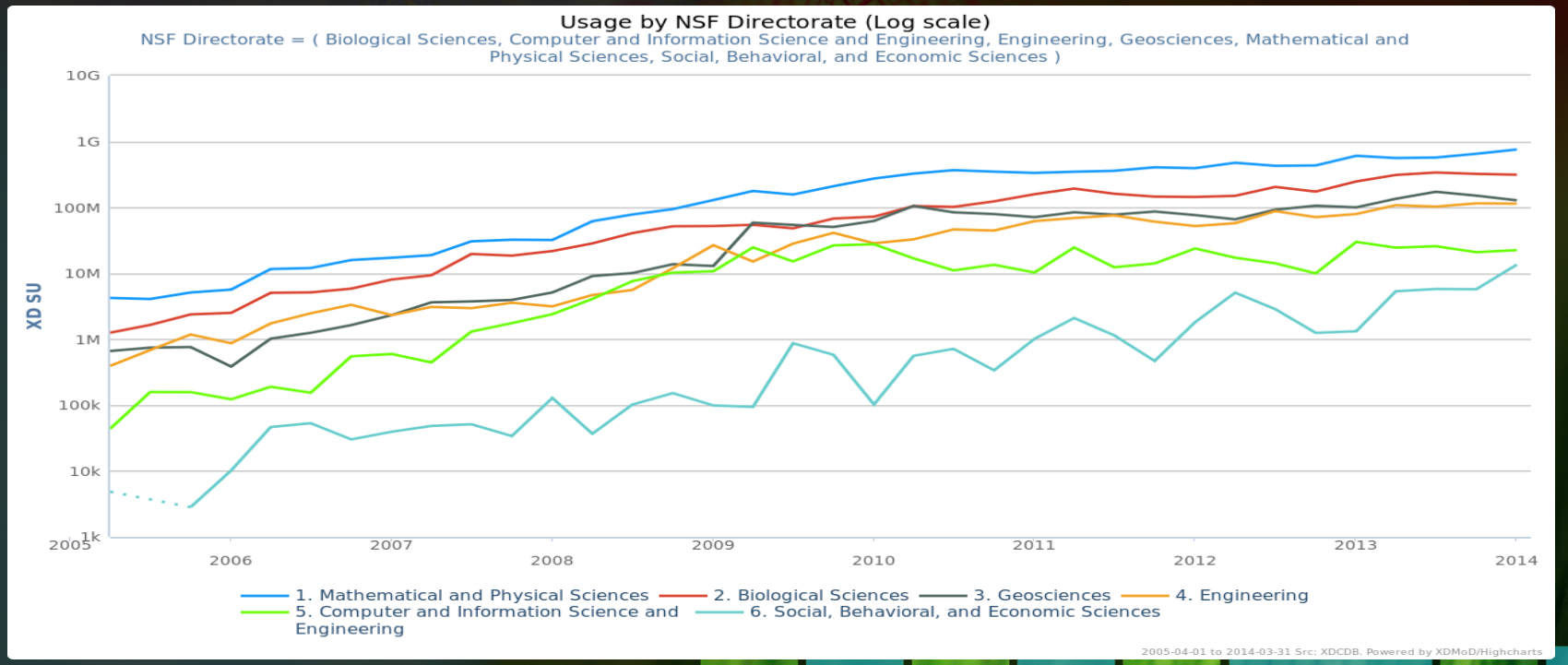
2x The number of active institutions has **DOUBLED**

3x The number of PIs per project has **TRIPLED**

5x The number of active users has **QUINTUPLED**



All scientific disciplines have increased use of resources



Advanced Cyberinfrastructure

Supports the research, development, acquisition, and provision of state-of-the-art CI resources, tools, and services

HIGH PERFORMANCE COMPUTING

- Enable petascale computing; provide open-science community with state-of-the-art HPC assets

DATA

- Support scientific communities in the use, sharing and archiving of data by creating building blocks to

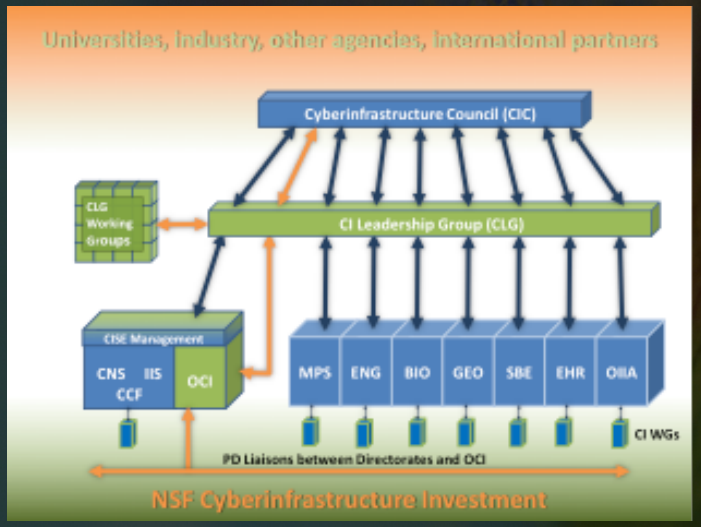
PEOPLE

- Invest in campus network improvements and re-engineering to support a range of activities in modern computational science. Support transition of cybersecurity research to practice.

- Transform innovations in research and education into sustained software resources that are an integral part of cyberinfrastructure.

Update on Realignment of ACI within CISE

Building on the strengths and expertise of ACI to enable secure, advanced, and global cyberinfrastructure for multi-disciplinary collaboration networks to effectively address science and engineering grand challenges in an increasingly computational- and data-intensive world



- **ACCI** has continued to provide advice on CI across the Foundation, reporting to all NSF ADs
- **Council for Cyberinfrastructure** provides overarching advice on strategic directions and oversight on current activities and budget implementation
- **Cyberinfrastructure Coordination and Leadership Group (CLG)** coordinates and manages a variety of CI programs across NSF, including developing solicitation guidance for cross-cutting programs, coordinating joint activities, and developing and maintaining an investment roadmap

In the era of digital science, CI needs are skyrocketing

Sustainability

Cyber Security

Education

Academic research infrastructures face challenges and opportunities

POINT #4

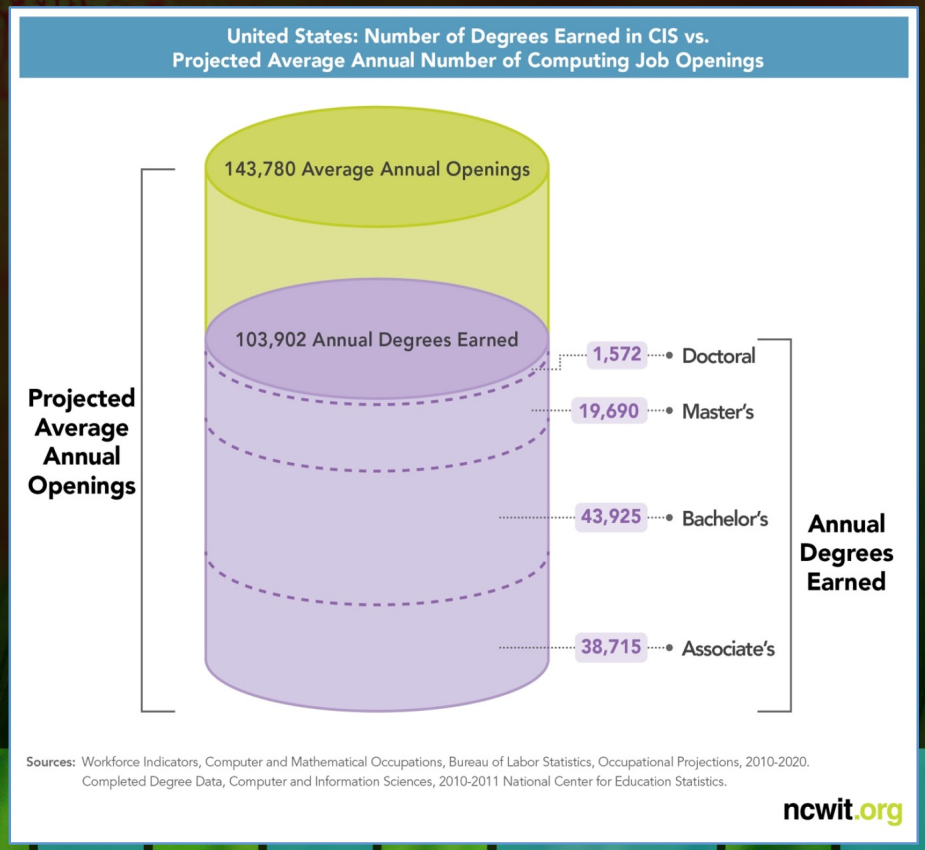
The lack of diversity in computing professionals is a loss of opportunity for individuals and a loss of talent and creativity to the discipline. This directly impacts our economic prosperity.

The computing community faces three significant and interrelated challenges in workforce development

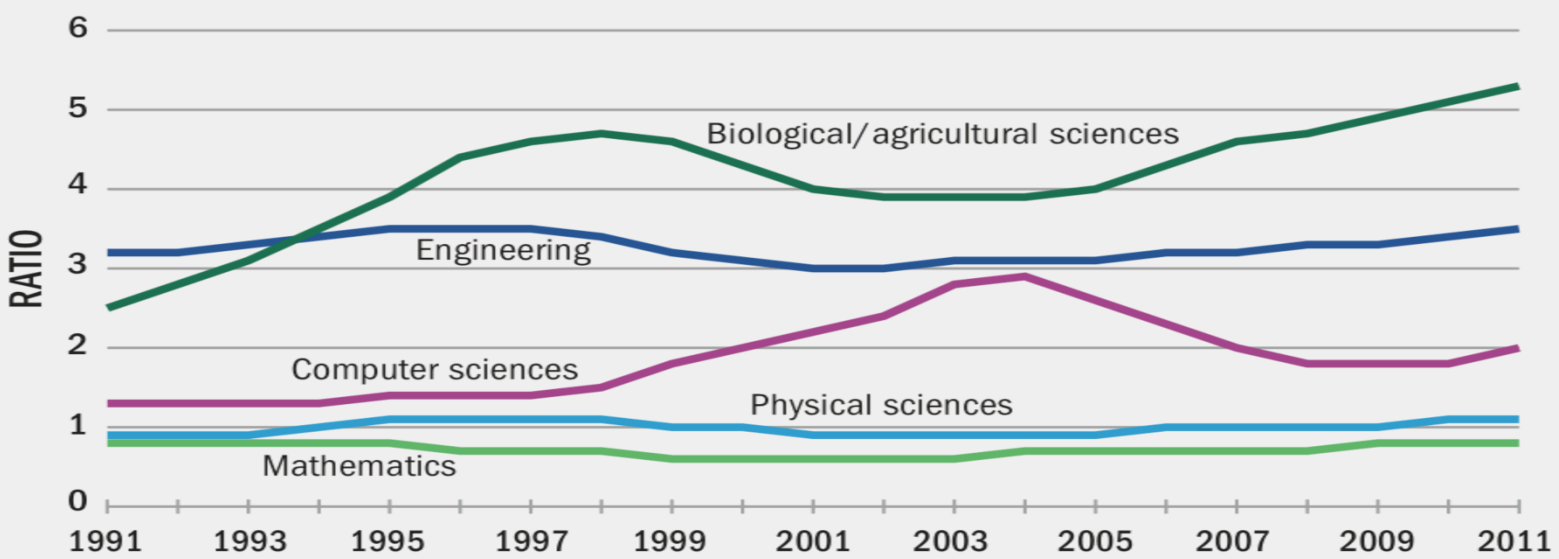
Underproduction of degrees

Under-representation

Lack of a presence in K-12



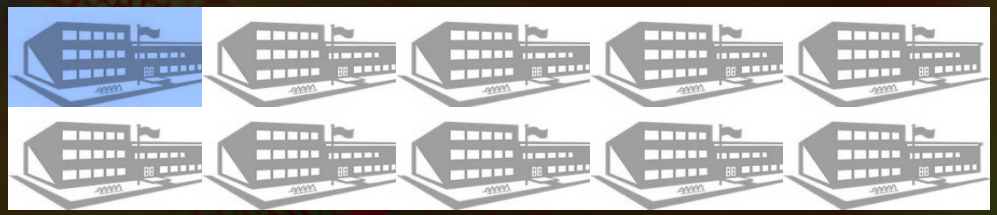
U.S. bachelor's degrees in selected S&E fields per 1,000 20–24-year olds: 1991–2011



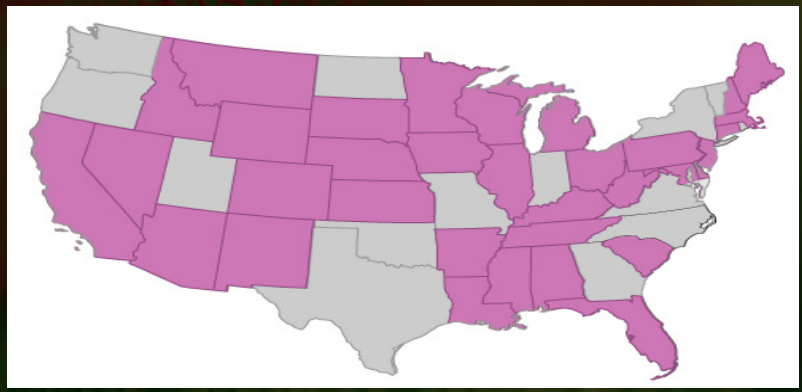
SEI 2014: **Undergraduate Degree Awards**, Chapter 2.

Presence in K-12

Computer science is offered in only **1 out of 10** high schools nationwide.

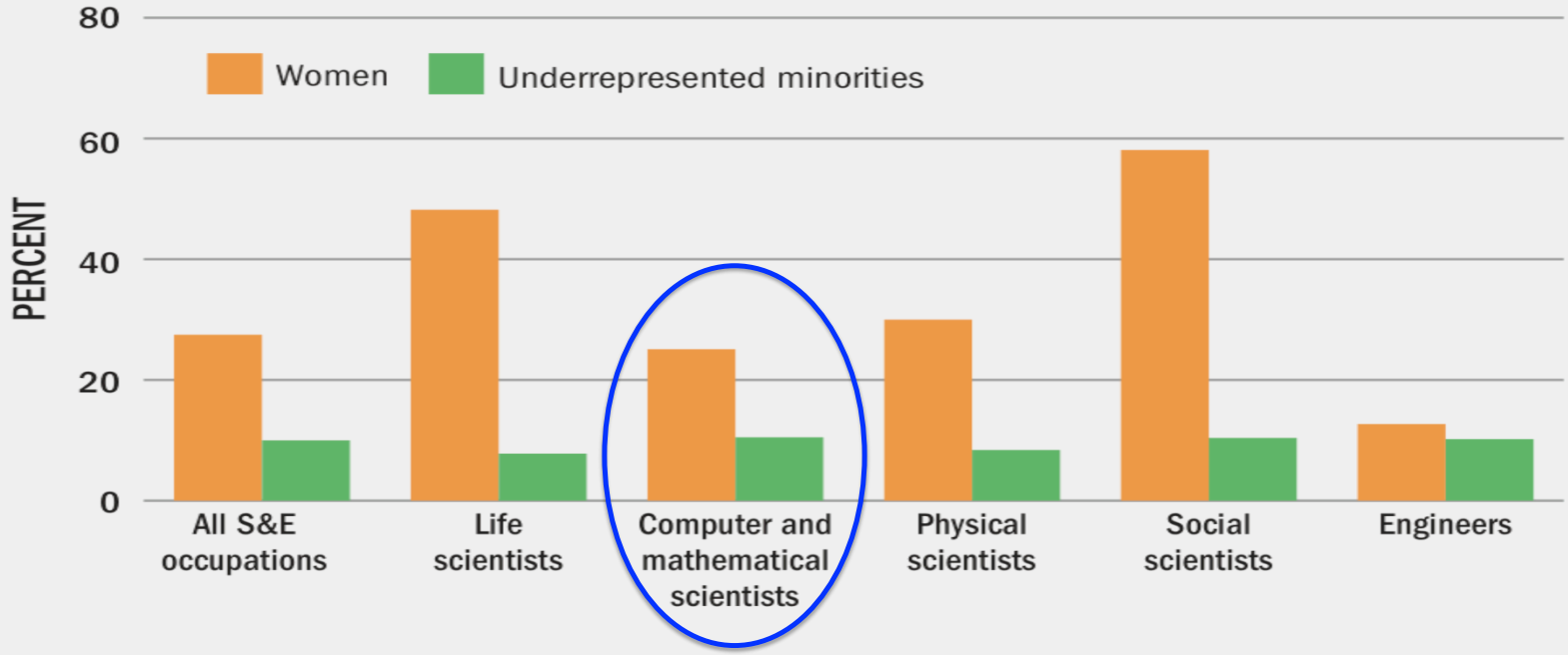


In **36 of the 50** states, computer science does not count towards the math or science graduation requirement



Yet computer science is a key capability for just about every 21st century endeavor

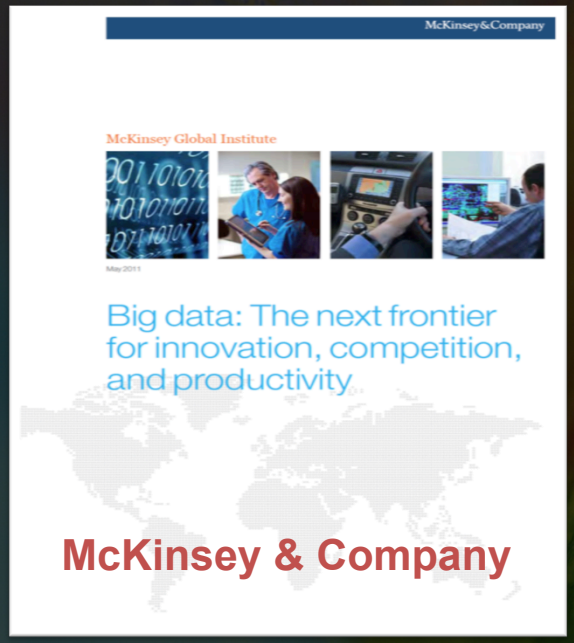
Women and underrepresented minorities in S&E occupations: 2010



SEI 2014: **Women and Minorities in the S&E Workforce**, Chapter 3.

Changing Face of the U.S.

Education, Learning, Workforce Development, Computational and Data-enabled Science



"By 2018 the United States alone faces a shortage of 140,000 to 190,000 people with analytical expertise and 1.5 million managers and analysts with the skills to understand and make decisions based on the analysis of big data."[1]

[1] McKinsey&Company (May 2011), "Big data: The next frontier for innovation, competition, and productivity." Available at: http://www.mckinsey.com/Insights/MGI/Research/Technology_and_Innovation/Big_data_The_next_frontier_for_innovation

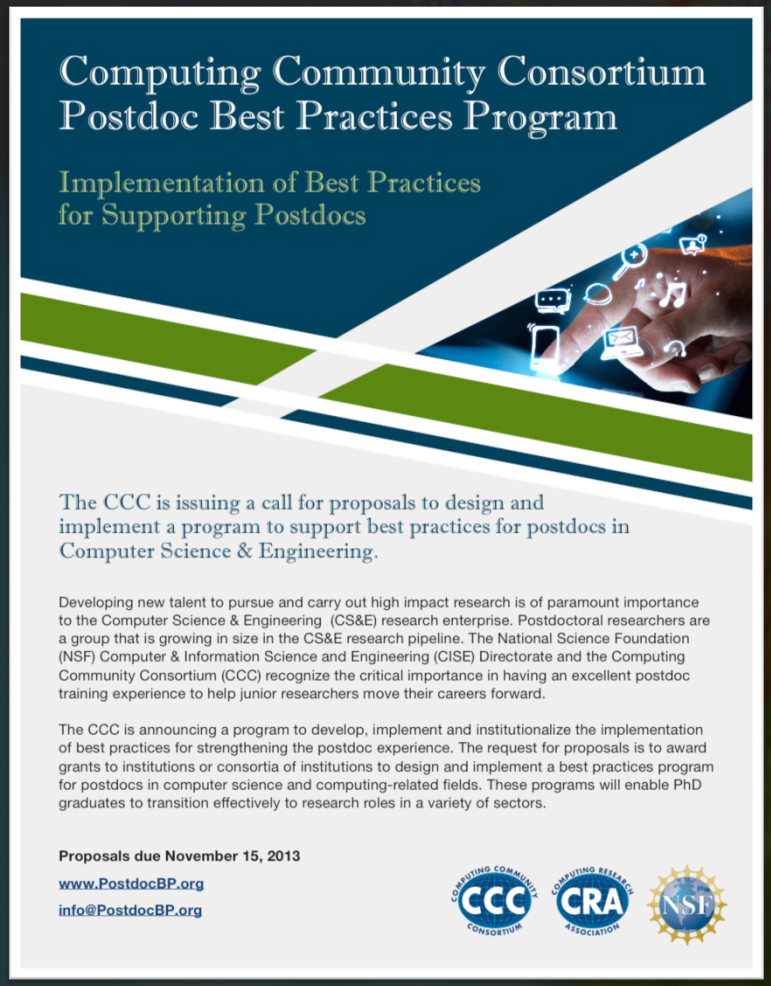
NSF Research Traineeship (NRT)

Preparing professionals in emerging STEM fields vital to the nation

Priority research theme: Data-enabled science and engineering

- **Solicitation NSF 14-548**
- **Purpose:** create and promote new, innovative, effective, and scalable models for STEM graduate student training and prepare scientists and engineers of the future, particularly in emerging STEM fields vital to the nation.
- Encourages strategic collaborations with the private sector, NGOs, government agencies, museums, and academic partners.

NSF-wide Initiative



Award Recipients:

1. **A Foundational Model for Postdoctoral Programs in Computer Science & Engineering at Large Universities,** Arizona State University; Chitta Baral, Lead PI

2. **Taking Collective Responsibility for the Postdoc Experience,** University of Washington; Gaetano Borriello, Lead PI

3. **ASCENT: Advancing computer Science Careers through Enhanced Networking and Training,** Columbia University, City University of New York, Cornell University, New York University, Shih-Fu Cheng, Lead PI

Faculty Early-Career Development (CAREER) Program

- The most prestigious award in support of a junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the development of activities that can effectively integrate research and education.
- Since its inception in 1996:
  - More than **200 programs** have reviewed CAREER proposals
  - More than **7,000 awards**

Computing Research Initiation Initiative

- A new program launched by CISE
- Goal: Encourage research independence within first two years of embarking on an academic career.
- How is it different from CAREER?
  - It has limited submissions and this is a limited time frame, i.e., first two years after PhD.
  - Shorter project description (10 pages).
  - It allows for a full budget; this is for grad student salary only (and some travel, equipment, but no PI salary).
- Deadline: September 2014

POINT #5

Technology *alone* will not solve all of society's challenges.

Thanks!

fjahania@nsf.gov

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