Mapping the U.S. Innovation System Today

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UC Davis
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BASID Technology Conference

The Mythology: the garage or the giant corporate laboratory

Outline

1. How the innovation system has been transformed.

2. Strengths and weaknesses.

3. Dilemmas for managing a complex and decentralized innovation system.

Part 1: A Transformation over 30 Years

- The dramatic decline of the big corporate laboratories.

- The movement of industry scientists to small firms.

- Innovation now occurs overwhelmingly in public-private collaborations.

Ph.D. scientists at small firms

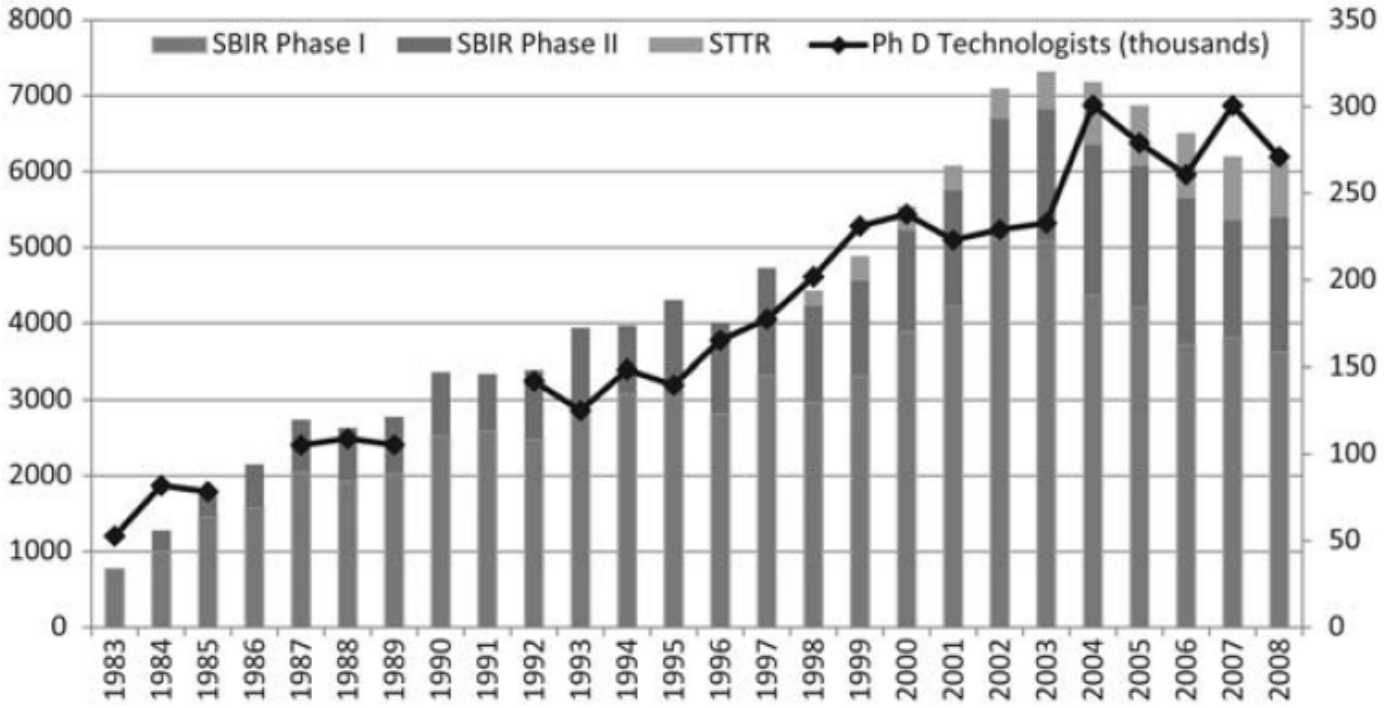


Figure 2 Trends in SBIR awards and PhD technologists employed by firms with fewer than 500 employees. *Note*: Data for 1983–1984 are for firms with fewer than 1000 employees; see note 7.

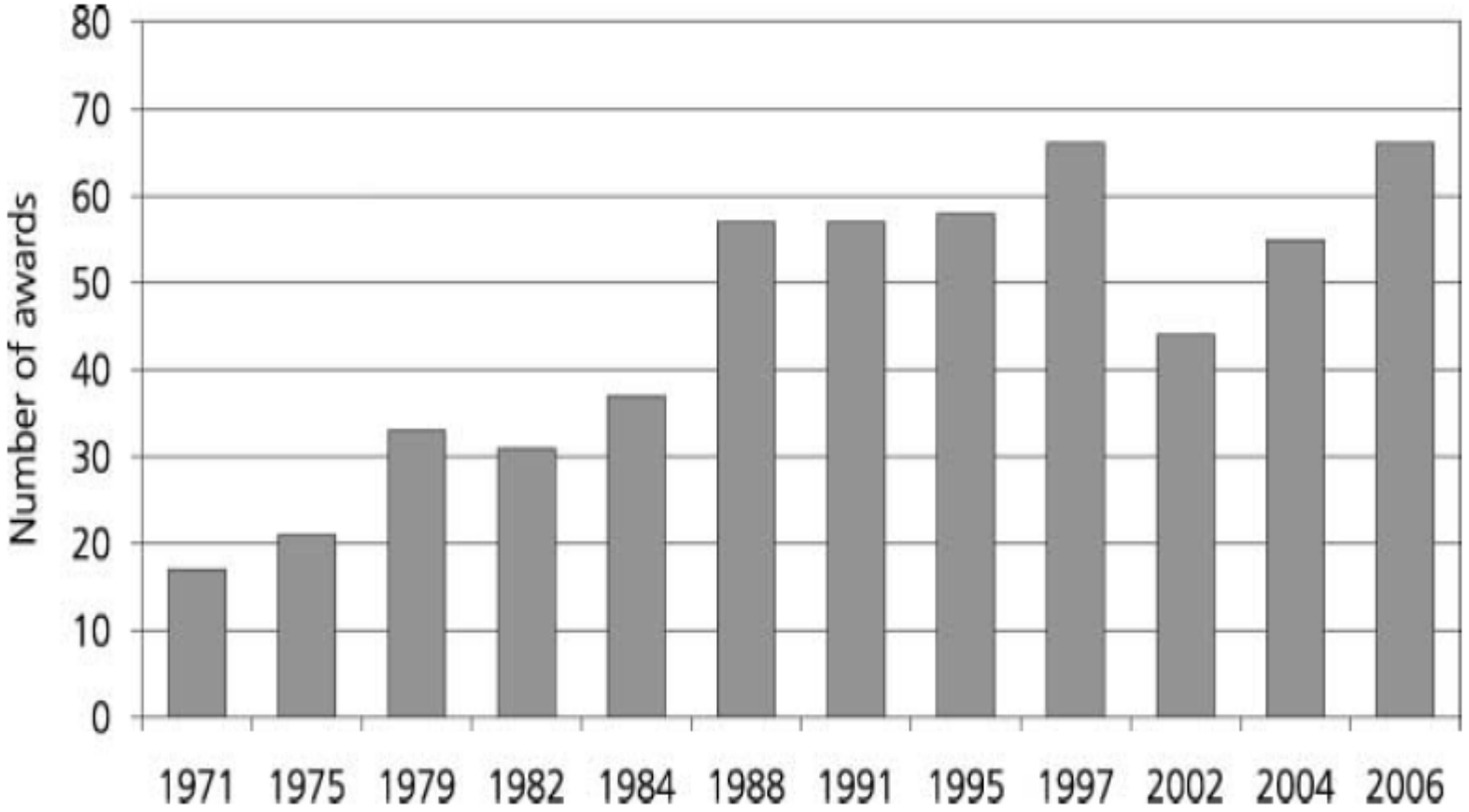


Figure 1 R&D 100 awards to inter-organizational collaborations.

Transformation began in the 1980's

- New era started from the example of computers and biotech—central role of new firms.
- Has now diffused to virtually every sector of the economy.
- The new model is built on government-university-industry cooperation.

Government-University-Industry = GUI

Pronounced as Gooey and difficult to manage.

Why the change ?

- Greater technological and scientific complexity
- Even the most successful firms cannot do it on their own
- Creativity and innovation flourish when technologists are not in hierarchical organizations

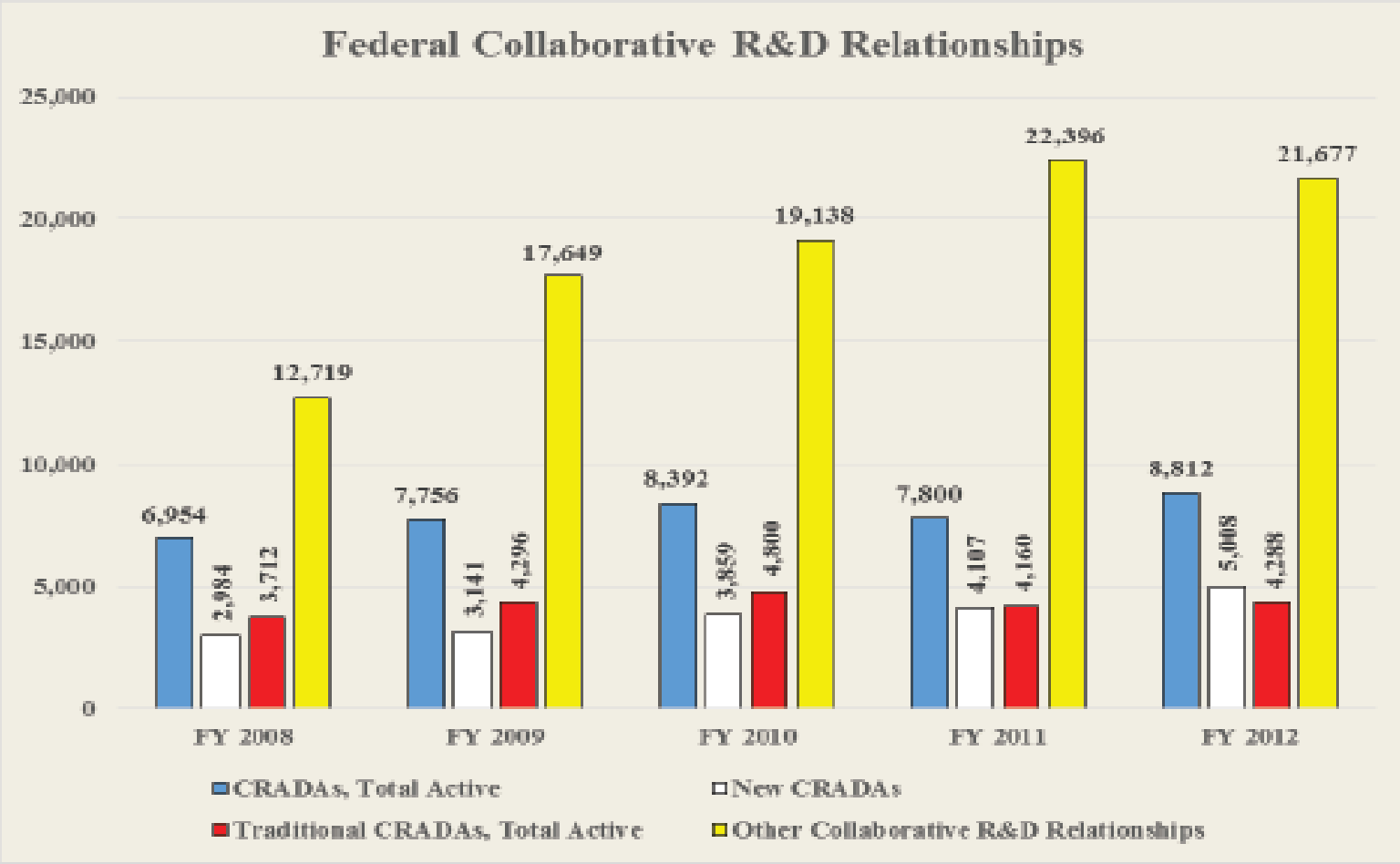
Key elements

- Tens of thousands of daily collaborations between industry technologists and publicly funded scientists

- Occurring in federal laboratories and on university campuses

Many different programs:

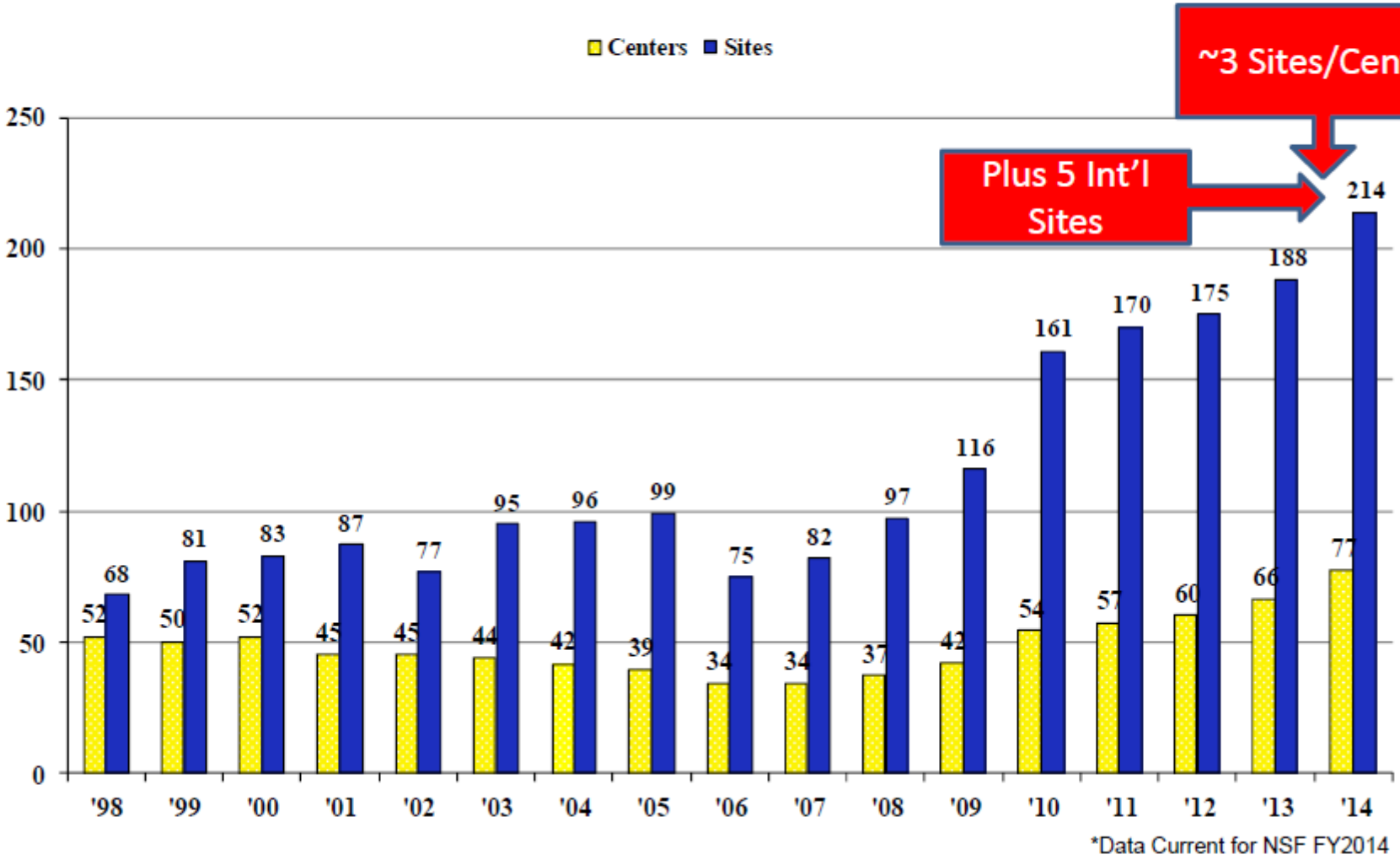
- Cooperative research and development agreements, work for others, facilities agreements at federal labs
- Cooperative Research Centers on campuses—such as ERC's, IUCRC's



	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012
CRADAs, Total Active	6,954	7,756	8,392	7,800	8,812
New CRADAs	2,984	3,141	3,859	4,107	5,008
Traditional CRADAs, Total Active	3,712	4,296	4,800	4,160	4,288
Other Collaborative R&D Relationships	12,719	17,649	19,138	22,396	21,677

ACTIVE CENTERS AND SITES BY YEAR*

Industry/University Cooperative Research Centers



*Data Current for NSF FY2014

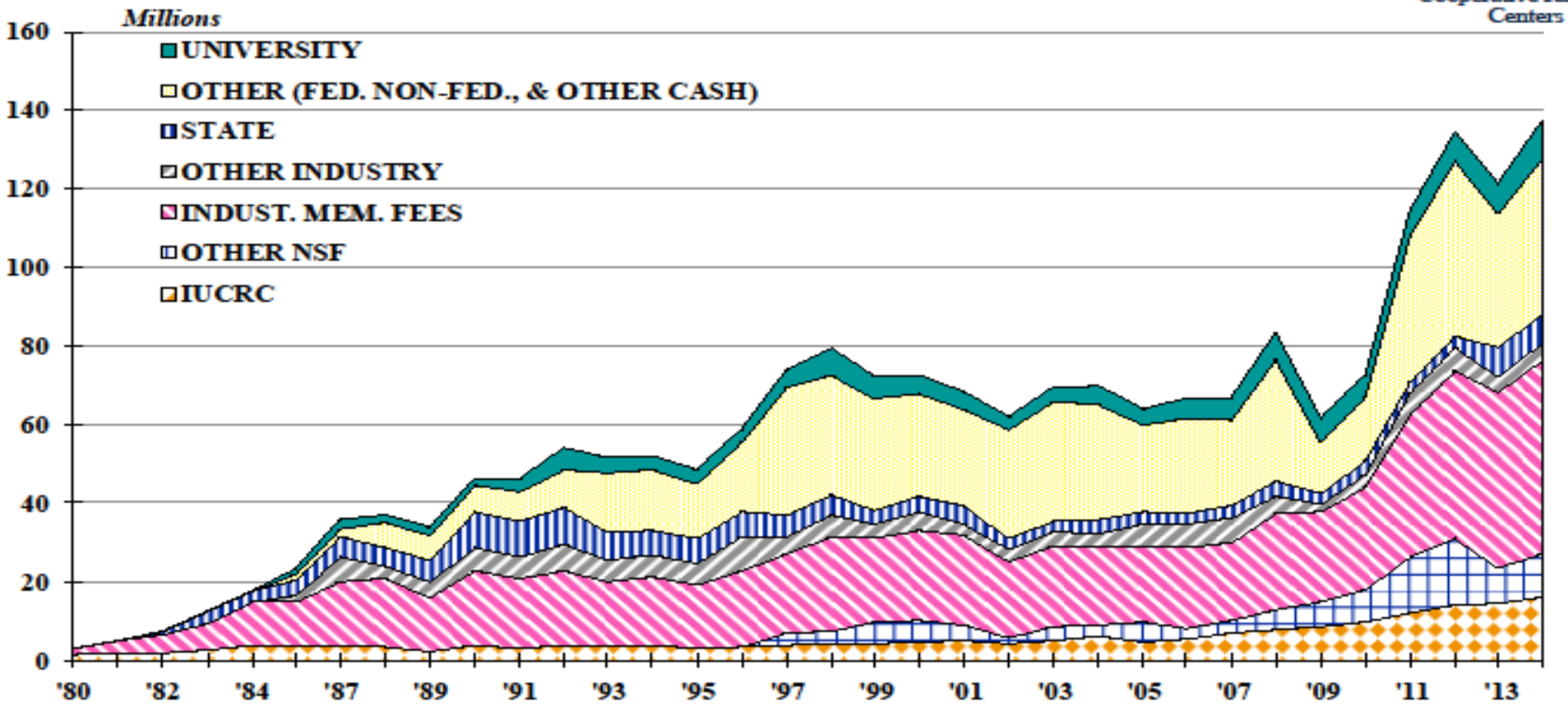
NSF-I/UCRC Center Structure Database

2014

Industry-Nominated Technology Breakthroughs of NSF Industry/University Cooperative Research Centers

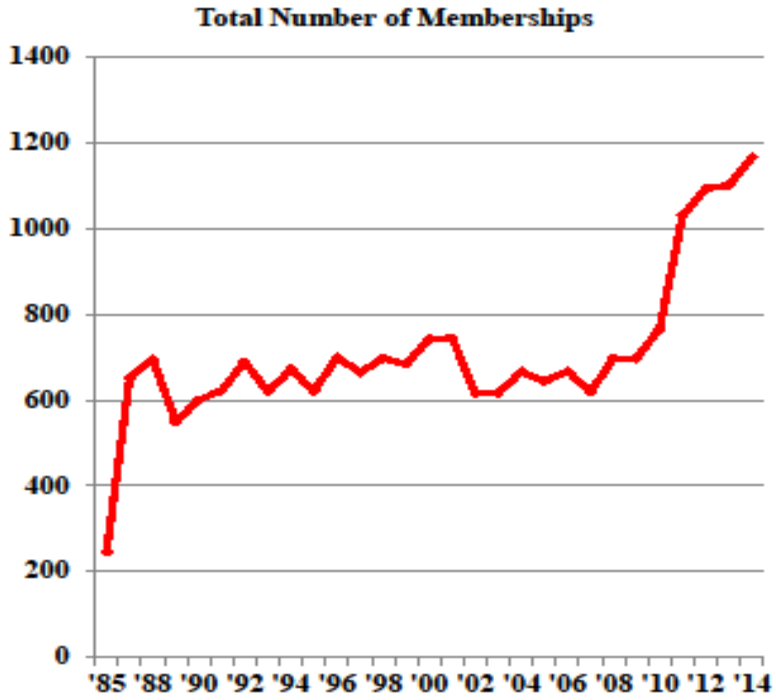
Total Funding by Source in Dollars

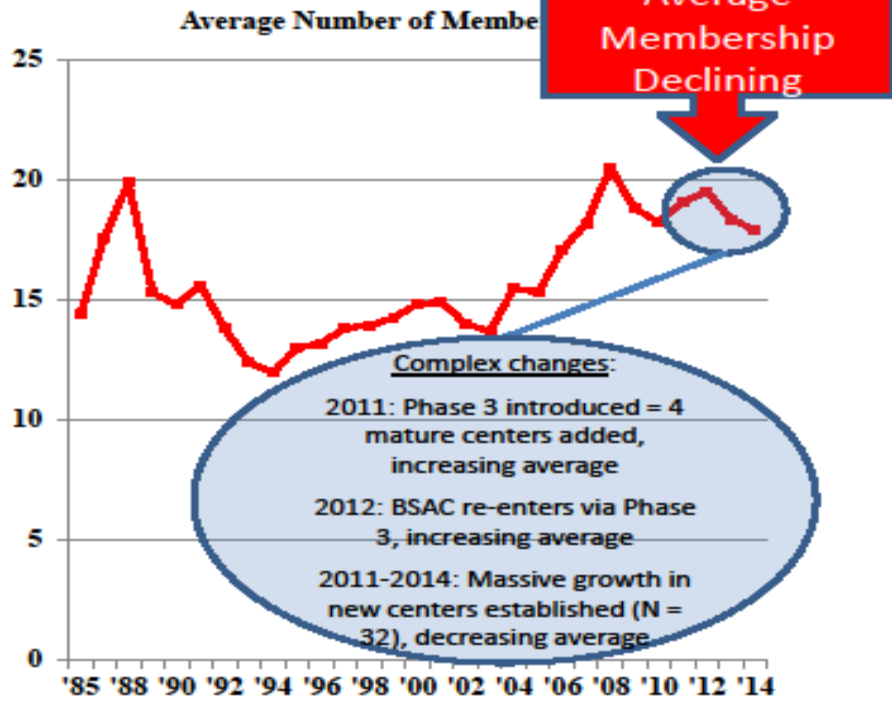
Industry/University Cooperative Research Centers



Industrial Memberships

Industry/University Cooperative Research Centers

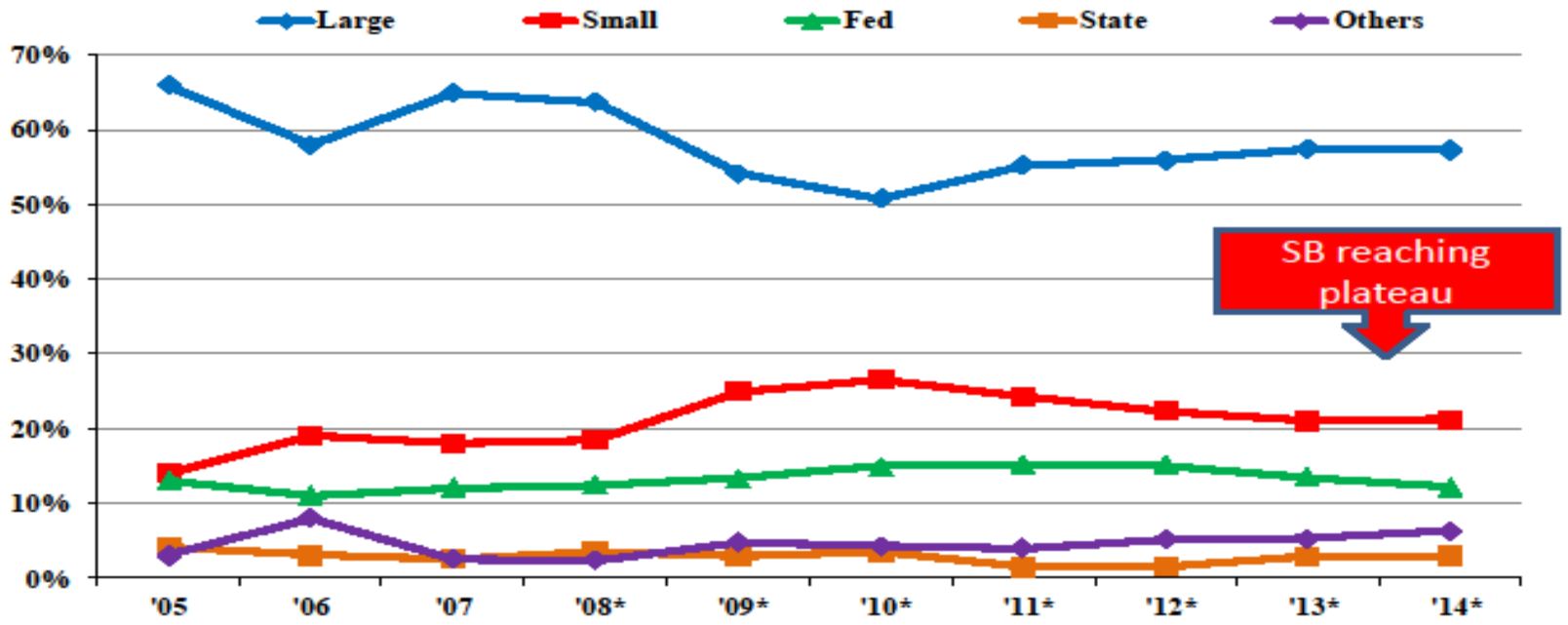




FY 2013-2014 NSF-I/UCRC Center Structure Database

Member Composition 2005-2014

Industry/University Cooperative Research Centers



*Years Advanced Forestry excluded as a small business outlier: '08 Small = 36, '09 Small = 49, '10 Small = 57, '11 Small = 66, '12 = 71, '13 = 77, '14 = 86.
^ Categories comprising Others include: non-profit, non-US gov't, and other org.

The Model has spread.

- **Department of Energy:**
  - **Bioenergy Research Centers (3)**
  - **Frontier Energy Research Centers (46)**
  - **Energy Innovation Hubs (4)**
- **Interagency Effort—Advanced Manufacturing Institutes—16 by the end of 2016.**
- **Cluster strategy pursued by Economic Development Administration.**

FHE MII Information Sheet

Flexible Hybrid Electronics Manufacturing Innovation Institute

September 2015

Mission

The FHE MII will pioneer a new era of advanced Flexible Hybrid Electronics manufacturing in the U.S. by:

- Catalyzing a U.S. FHE ecosystem
- Providing new manufacturing capability to the Department of Defense and industry partners
- Developing multiple product demonstrators
- Educating and training professionals and technicians
- Exploiting the Silicon Valley's innovation culture

The FHE MII is the 7th of 9 manufacturing innovation institutes to be established as part of the National Network for Manufacturing Innovation (NNMI) an effort to create a competitive, effective, and sustainable manufacturing research-to-manufacturing infrastructure. The goal is to enable U.S. industry and academia to solve manufacturing challenges for advanced technologies.

Part II: Strengths and weaknesses

- Strengths—

  1. Broadening the innovation funnel (think smart phone apps)—ubiquitous innovation.

  2. Reduced barriers to entry for innovators (think Tesla).

Part II: Strengths and weaknesses

- Weaknesses—

  1. Massive coordination problems because innovation is no longer being carried by deep pocketed corporations.
  2. Innovators usually have to build complex political alliances to scale up new technologies.
  3. Small firms face “valley of death”.

Part III: Dilemmas of Managing this System

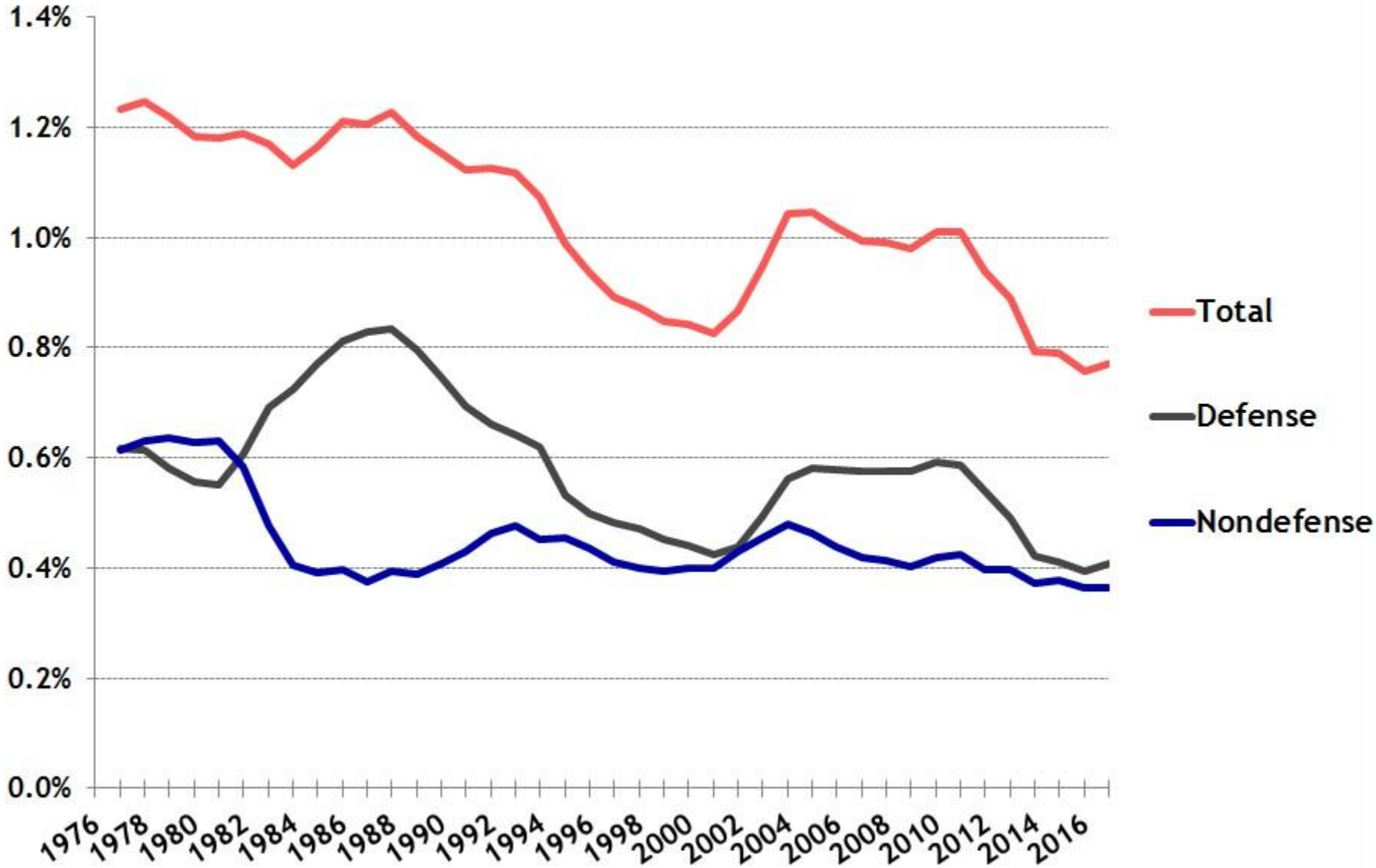
- Lack of public knowledge, understanding, visibility, legitimacy
- GUI coordination
- Funding
- A dysfunctional intellectual property regime
- Need for new financing arrangements for startups

GUI = high level of interdependence

- But we do not have a road map of how to organize these collaborations
- Worse—we are blinded by outdated ideas such as "the ivory tower university" or the faith that the free market will solve all problems

Trends in Federal R&D

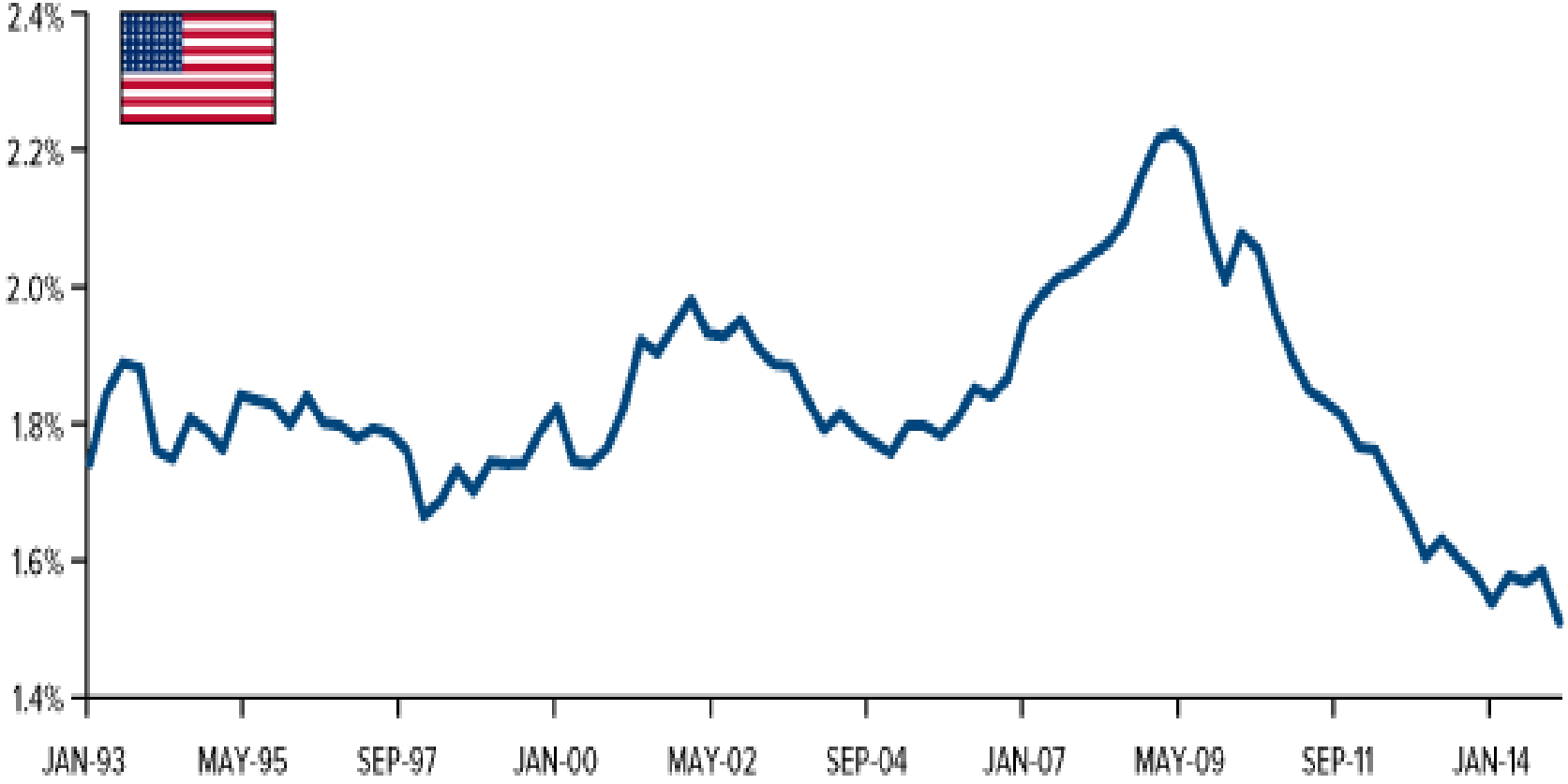
As a percent of GDP



Source: Up to 1994 - National Science Foundation, Survey of Federal Funds for Research and Development; 1995 to Present - AAAS data.
GDP figures are from *Budget of the U.S. Government FY 2016*. FY 2015 and FY 2016 figures are estimates. © 2015 AAAS

Total Public Construction Spending in the U.S. as a Percentage of GDP

January 1, 1993 – January 1, 2015



Source: Federal Reserve Bank of St. Louis, U.S. Global Investors

Intellectual property

- We have gone too far in treating knowledge as a commodity and subdividing it into tiny pieces
- The current system makes collaboration much more difficult than it should be

Startups continue to face the valley of death

- The venture capital system is broken; it only works for unicorns
- We need new mechanisms so that tens of thousands of small tech startups have a plausible chance to survive

Conclusion

- Importance of understanding how dramatically the innovation environment has shifted over a generation.

- Need to forge new rules, new institutions, new practices to make this new system work.