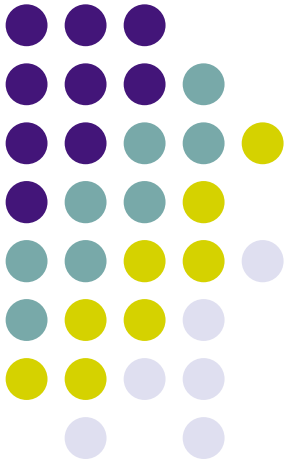
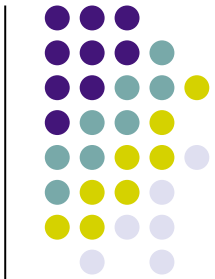
Rebalancing the Federal R&D Enterprise



Sounding the Alarm…



- Nuclear Energy Research Advisory Committee (DOE-2001)
- COSEPUP FS&T Committee (NAS/NAE/IOM-2003)
- Task Force on the Future of DOE Science Programs (DOE SEAB-2003)
- Committee to Assess Capacity of U.S. Engineering Research Enterprise (NAE-NSF-2004)

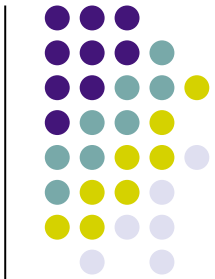
Nuclear Energy Research Advisory Committee
(NERAC)
Subcommittee on
Long-Term Planning for Nuclear Energy Research

Long-Term Nuclear Technology Research and Development Plan

SUMMARY

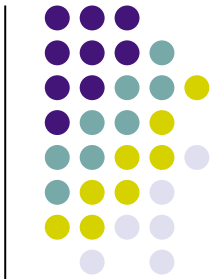
June 2000

Long-Range R&D Plan



- Basic Science and Engineering Research
- Nuclear Power
  - Advanced Fuels
  - Instrumentation and Controls
  - Technology and Economics
- Isotopes and Radiation Sources
- Space Nuclear Systems

The importance of investments in …



- New Knowledge (research)

  "Nation must restore an adequate investment in basic and applied research in nuclear energy if it is to sustain a viable U.S. nuclear power option."

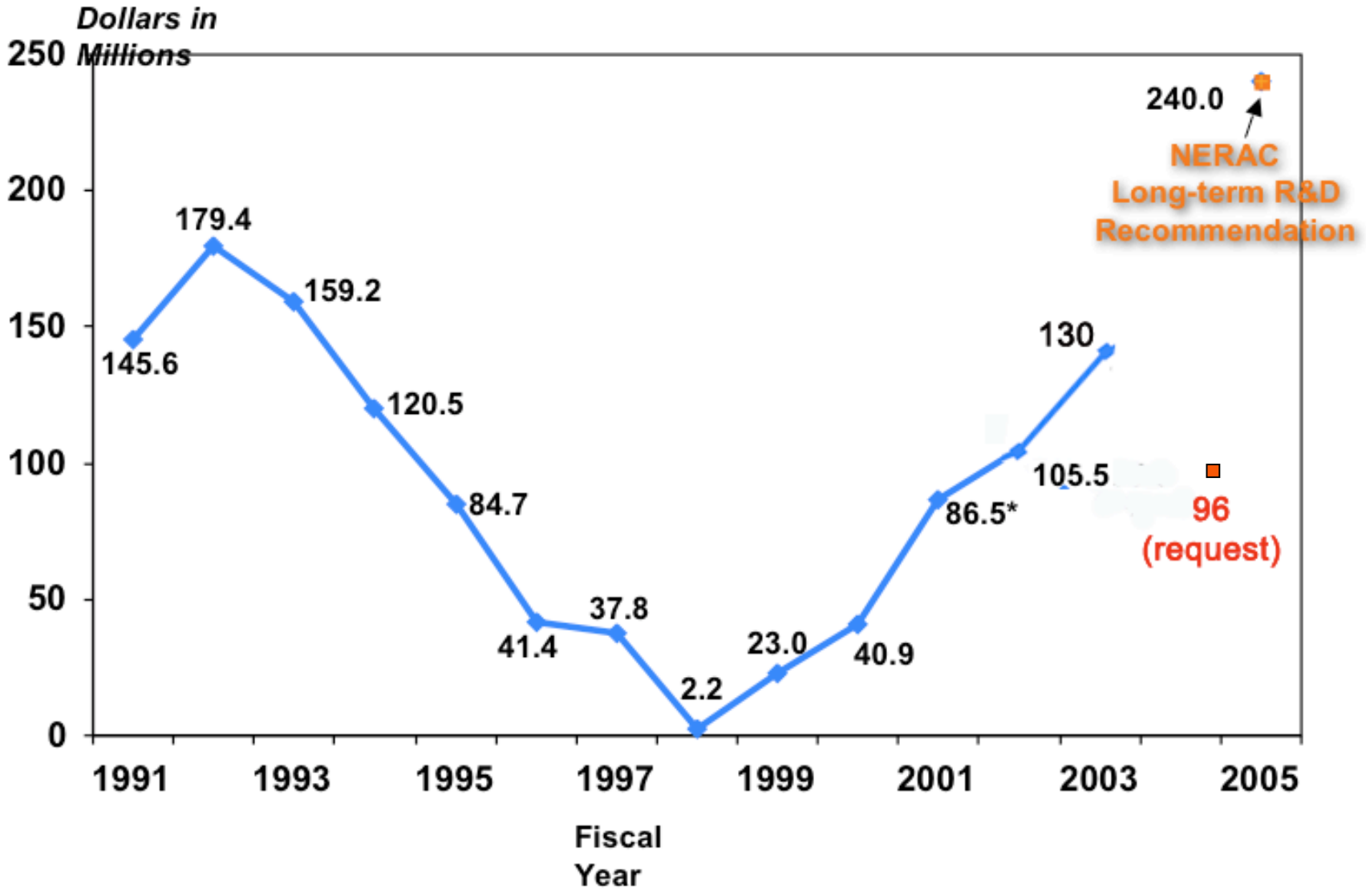
- Human Capital (education)

  "Perhaps the most important role for DOE/NE at the present time is to insure that the education system and its facility infrastructure are in good shape."

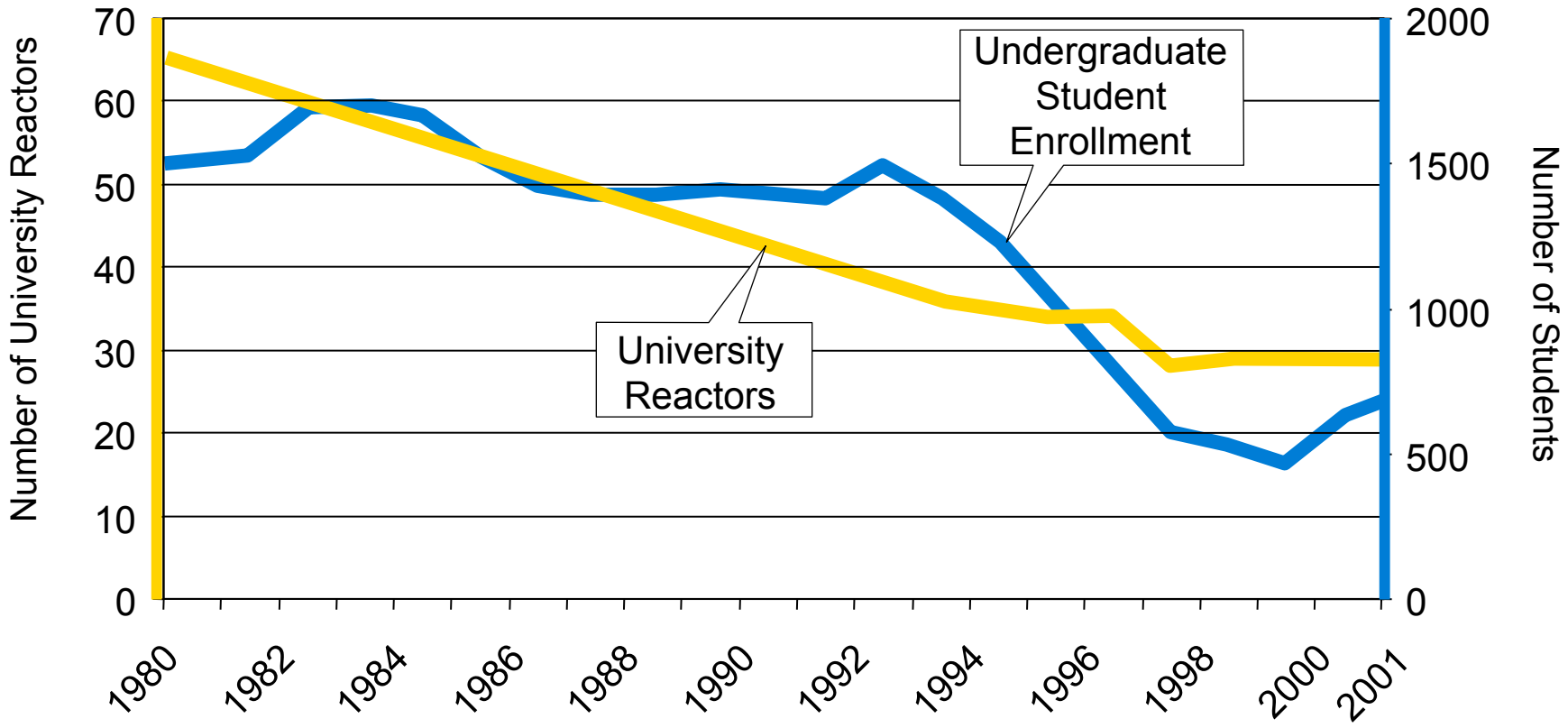
- Infrastructure (facilities)

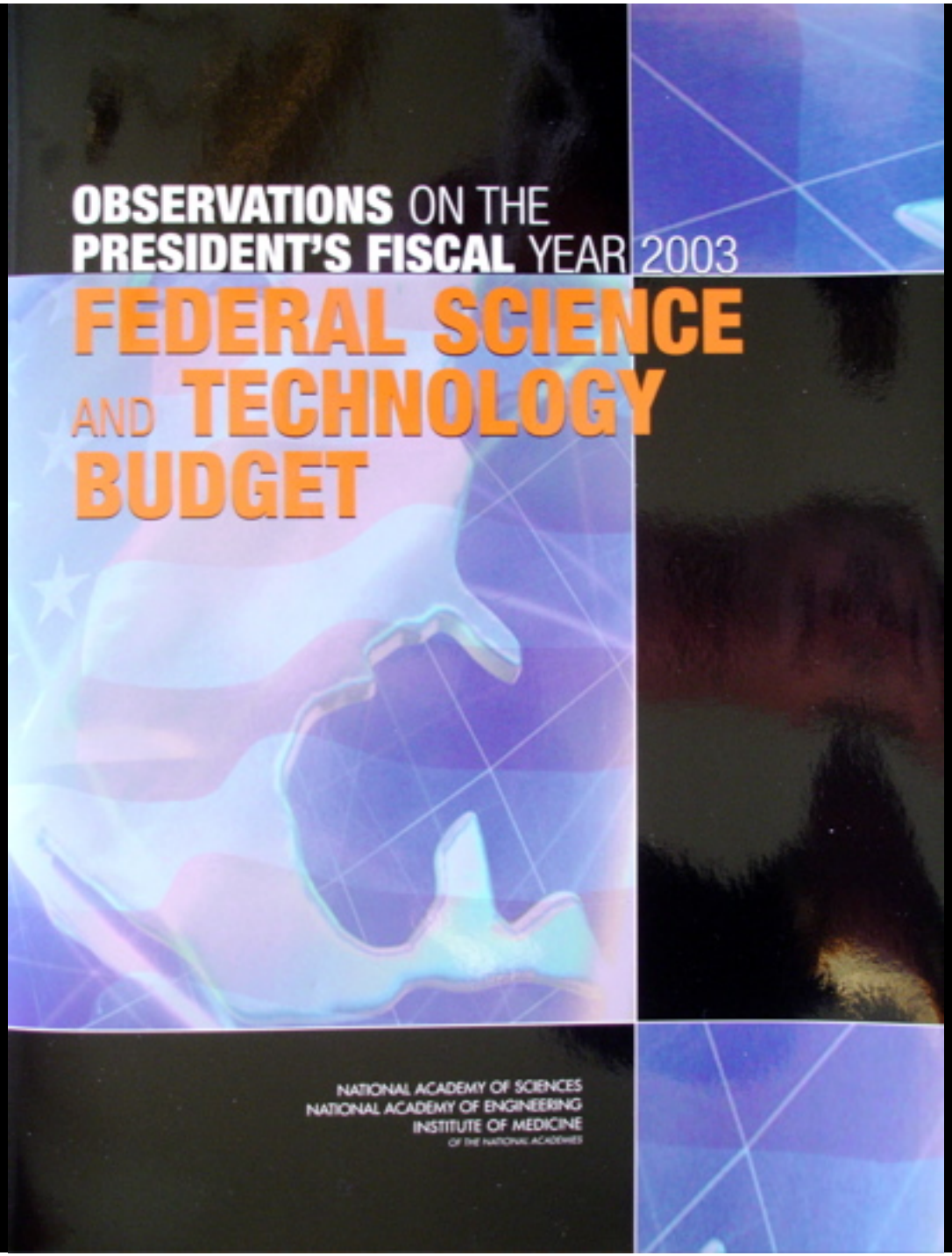
  "Need for adequate DOE facilities to sustain the nuclear energy research mission (particularly reactor facilities and isotope sources)."

Research & Development Budget History



Trends In University Nuclear Engineering

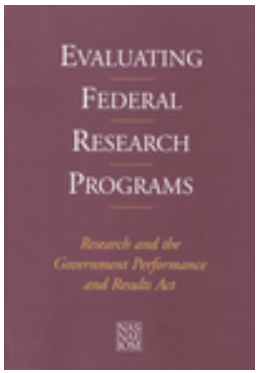



OBSERVATIONS ON THE PRESIDENT'S FISCAL YEAR 2003
FEDERAL SCIENCE AND TECHNOLOGY BUDGET
NATIONAL ACADEMY OF SCIENCES
NATIONAL ACADEMY OF ENGINEERING
INSTITUTE OF MEDICINE
OF THE NATIONAL ACADEMIES

Role of the National Academies

Annual FS&T Analysis

Developing methodology to do international benchmarking in various disciplines (e.g., materials science, mathematics, immunology)



Working with federal government to include benchmarking in application of Government Performance Results Act (GPRA) to research programs of federal agencies

FS&T Reports to date

1999

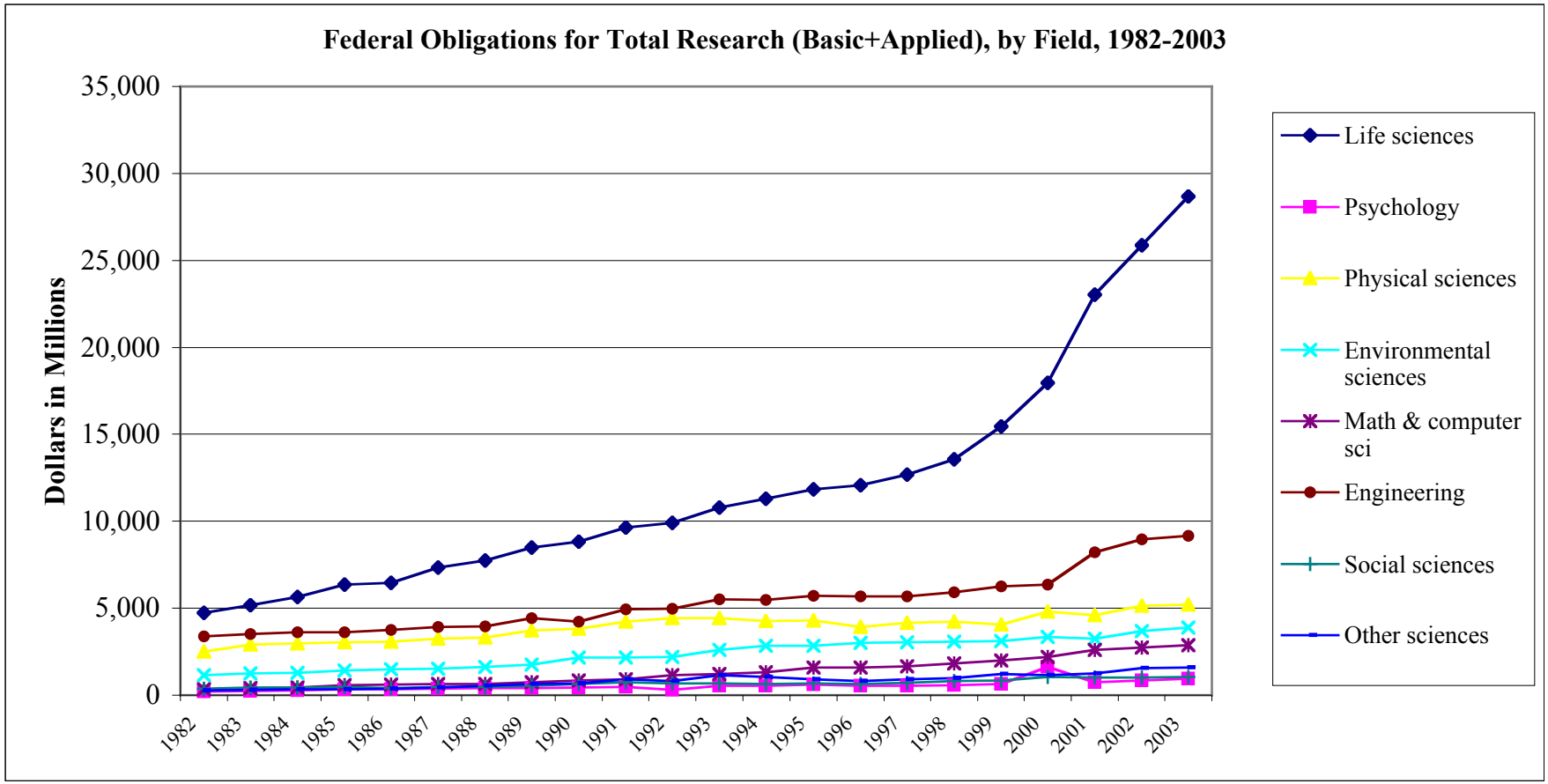
2000

2001

2002

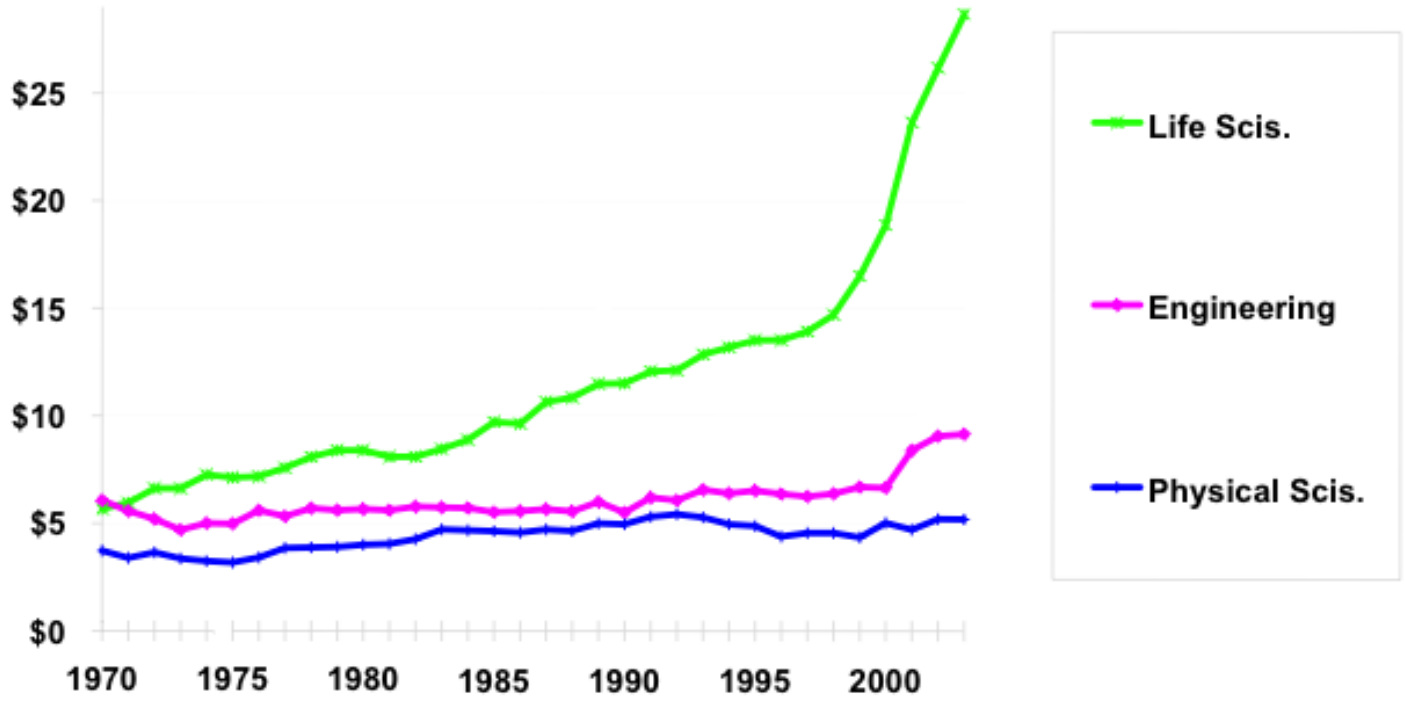
2003

Federal Research Obligations



Trends in Federal Research by Discipline, FY 1970-2003

obligations in billions of constant FY 2002 dollars

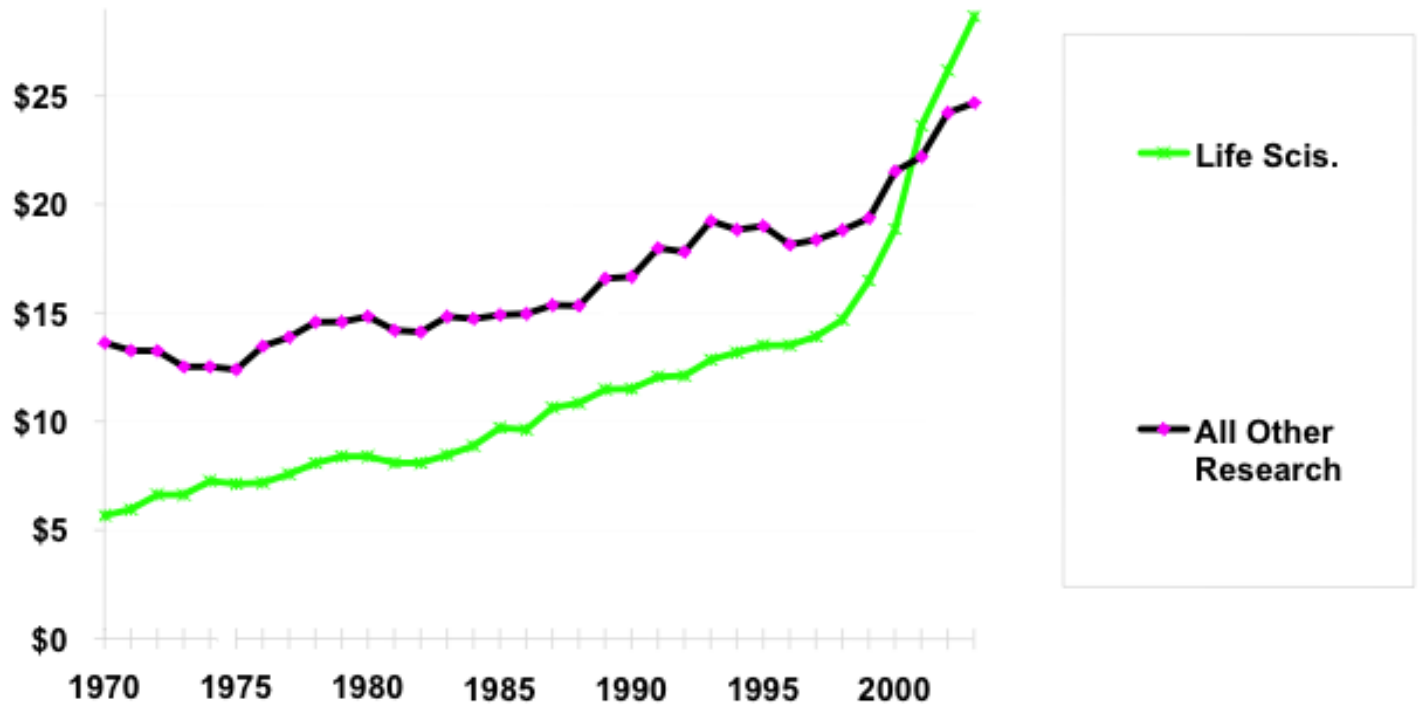


Source: National Science Foundation, *Federal Funds for Research and Development FY 2001, 2002, and 2003,* 2003. FY 2002 and 2003 data are preliminary. Constant-dollar conversions based on OMB's GDP deflators. AUGUST '03 © 2003 AAAS

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Trends in Federal Research by Discipline, FY 1970-2003

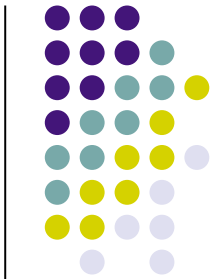
obligations in billions of constant FY 2002 dollars



Source: National Science Foundation, *Federal Funds for Research and Development FY 2001, 2002, and 2003,* 2003. FY 2002 and 2003 data are preliminary. Constant-dollar conversions based on OMB's GDP deflators. AUGUST '03 © 2003 AAAS

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

FS&T by Discipline



	Change
Field	*1982-2003*
Math & computer science	718.7%
Life sciences	504.2%
Other sciences	454.7%
Psychology	337.4%
Environ Sciences	237.8%
Social sciences	172.2%
Engineering	170.5%
Physical Sciences	108.0%

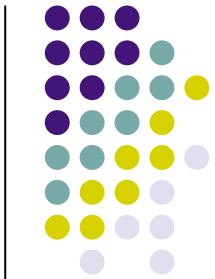
CRITICAL CHOICES: SCIENCE, ENERGY, AND SECURITY

Final Report of the
Secretary of Energy Advisory Board's
Task Force on the Future of Science Programs
at the Department of Energy

October 13, 2003

Secretary of Energy Advisory Board
U.S. Department of Energy

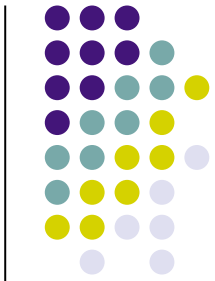
Findings



American cannot retain its freedom, way of life, or standard of living in the 21st century without secure, sustainable, clean, and affordable sources of energy.

American can meet its energy needs if and only if we make a strong and sustained investment in physical science and engineering.

Yet…

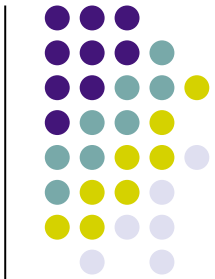


During the last 30 years, the federal investment in research in the physical sciences and engineering has been nearly stagnant.

In 1970, physical science, engineering, and life sciences each were funded at an annual level of $5 B (2002 $).

Today, physical science and engineering are funded at $5 B and $7.5B, while life science is funded at $22 B!

Furthermore…

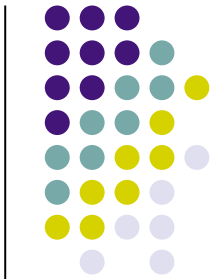


The budgets of DOE science suffer from the Department's historically poor reputation as badly managed, excessively fragmented, and politically unresponsive. They have not received the priority merited by their importance to our Nation's future energy, security, and economy.

The current organization of DOE is not appropriate to the magnitude and centrality of scientific and advanced technological research.

DOE's labs increasingly suffer from decay and deferred maintenance, unpredictable funding, poorly understood missions, and their perception as independent actors.

Recommendations

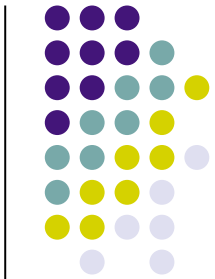


DOE should establish an Under Secretary for Science (with attendant organization changes).

DOE mission agencies devoted to our energy future and national security should be well informed by the best available knowledge in science and advanced technology.

Each DOE R&D initiative should have a regular review to assess whether it is consistent with the Department's 20-year strategy to produce secure, sustainable, clean, and affordable sources of energy, to enhance our national security, and/or maintain U.S. scientific leadership in areas stewarded by DOE.

A few more things…

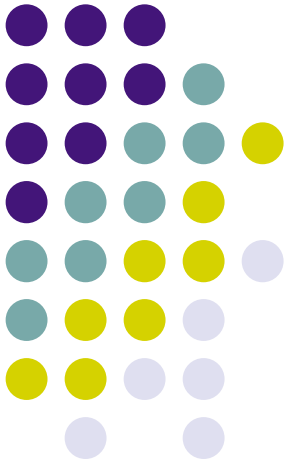


DOE should enhance the quality of research through greater use of merit-based competition, seek the best balance of national laboratory, university, and industrial research, and form partnerships with industry and academia to drive innovation in its mission areas.

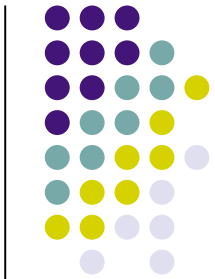
DOE should establish and sustain a program for renewing its laboratories, facilities, and infrastructure. It should transfer the funds necessary to achieve this objective from other, non-science accounts.

DOE should play a key role in strengthening federal investment in physical sciences and advanced engineering research.

Growing Concerns



Concern 1

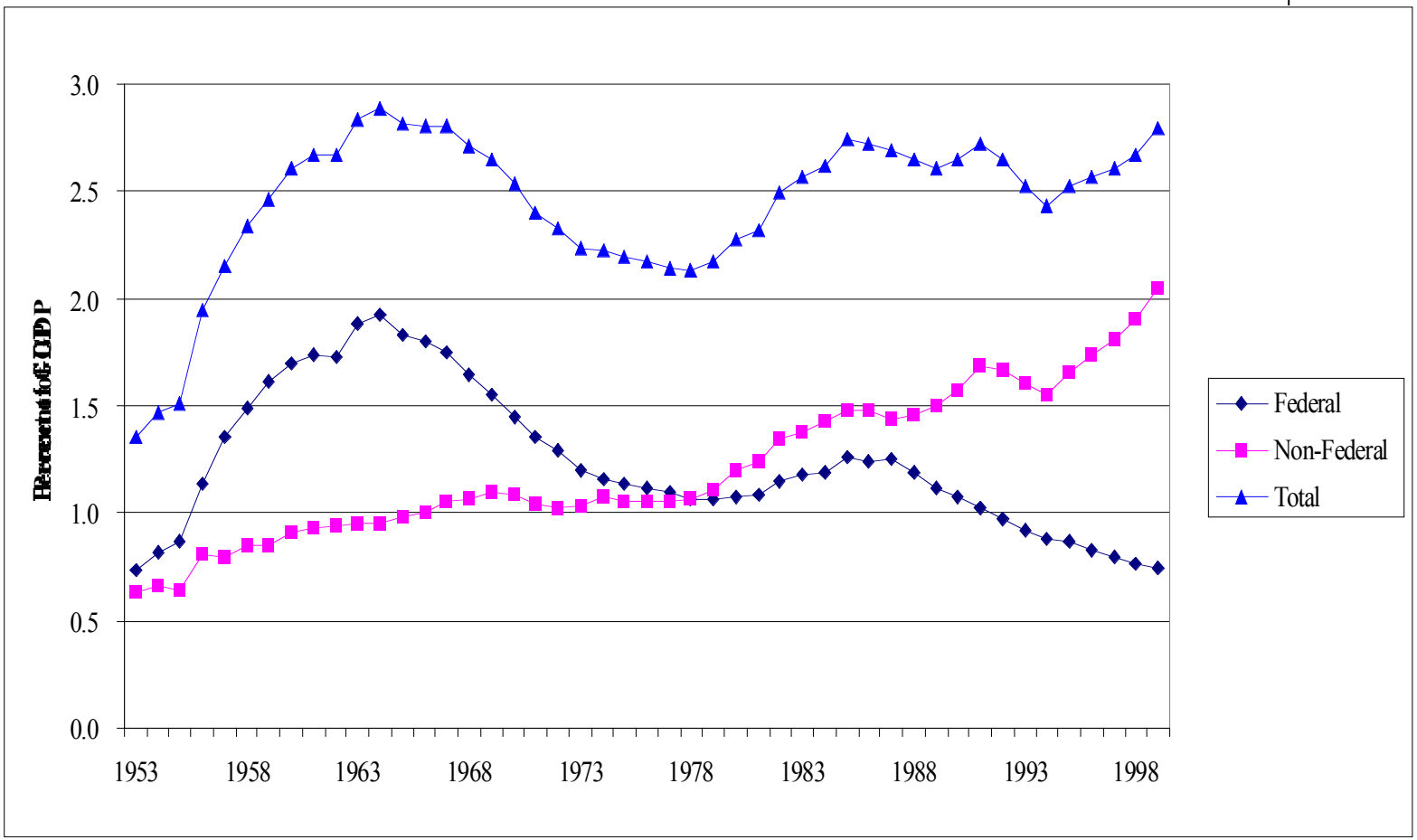


The federal government's share of R&D has fallen far below that of industry, dropping from 65% in 1970 to 25% in 2000.

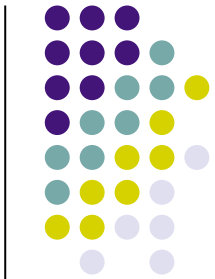
While the growth in industrial R&D is positive, most of this has been product development (particularly in the pharmaceutical industry).

There is a serious question as to whether the nation's current investment in basic research, primarily funded by the federal government, is adequate to sustain an increasingly technology-dependent private sector, particularly in the physical sciences and engineering.

Federal vs. Non-Federal R&D



Concern 2

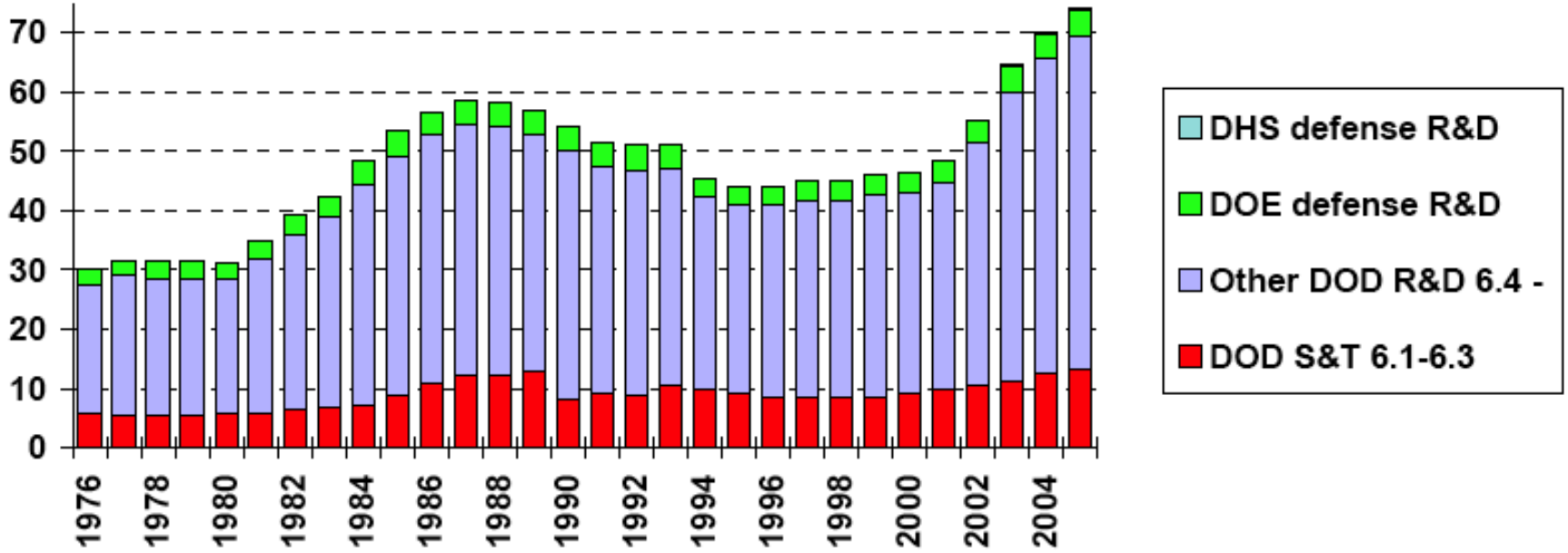


The record breaking totals for federal investment in R&D in recent years have occurred because of the doubling of NIH coupled with the enormous increases in weapons procurement and creation of new homeland security R&D programs.

R&D funding for all other areas has remained stagnant or declined. The FY05 recommendation continues this trend, with flat or declining funding for almost all of the R&D portfolio (and only a 2.6% increase for NIH and 3.0% for NSF.

Trends in Defense R&D, FY 1976-2005

in billions of constant FY 2004 dollars

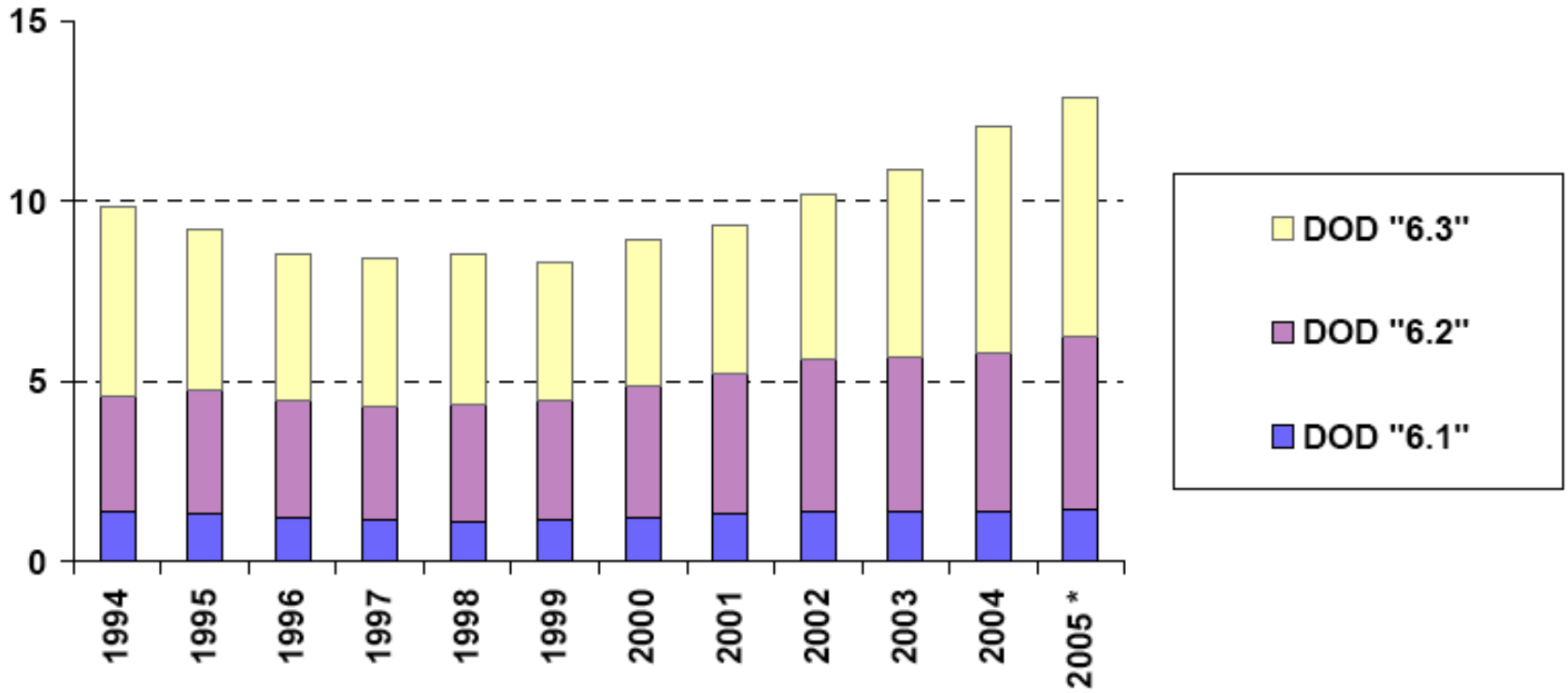


Source: AAAS analyses of R&D in *AAAS Reports I- XXIX*. FY 2005 figures are AAAS estimates of final FY 2005 appropriations; FY 2004 figures are latest estimates. DOD S&T figures are not strictly comparable for all years because of changing definitions. Includes conduct of R&D and R&D facilities. DOE and DHS FY 2005 figures are AAAS estimates of House appropriations.

AAAS

Trends in DOD "S&T", FY 1994-2005

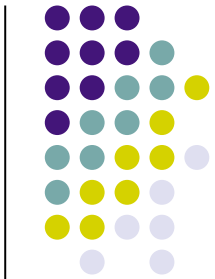
in billions of constant FY 2004 dollars



Source: AAAS analyses of R&D in *AAAS Reports VIII-XXIX*. FY 2005 figures are AAAS estimates of final FY 2005 appropriations.

AAAS

Concern 3

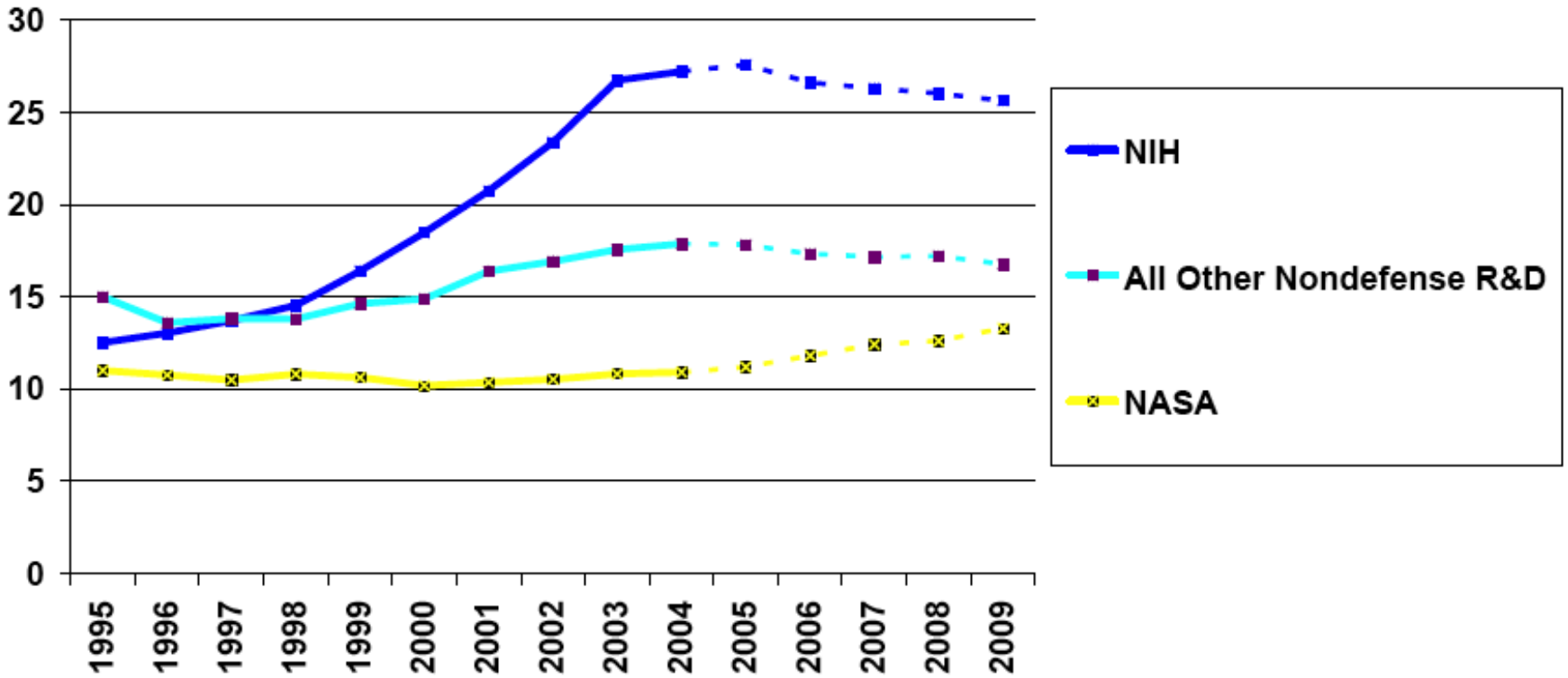


There is growing concern about how administration priorities are affecting federal support of R&D and U.S. competitiveness around the world. Most research agencies will suffer budget cuts because future R&D increases are expected to go primarily to homeland security projects, defense development programs, and NASA.

The administration aims to cut research funding at 21 of 24 federal agencies over the next 5 years. Only those involved in space, national, and domestic security will be sustained (and this will be mostly applied research).

Projected Nondefense R&D in the President's Budget, FY 2004-2009

in billions of constant FY 2004 dollars

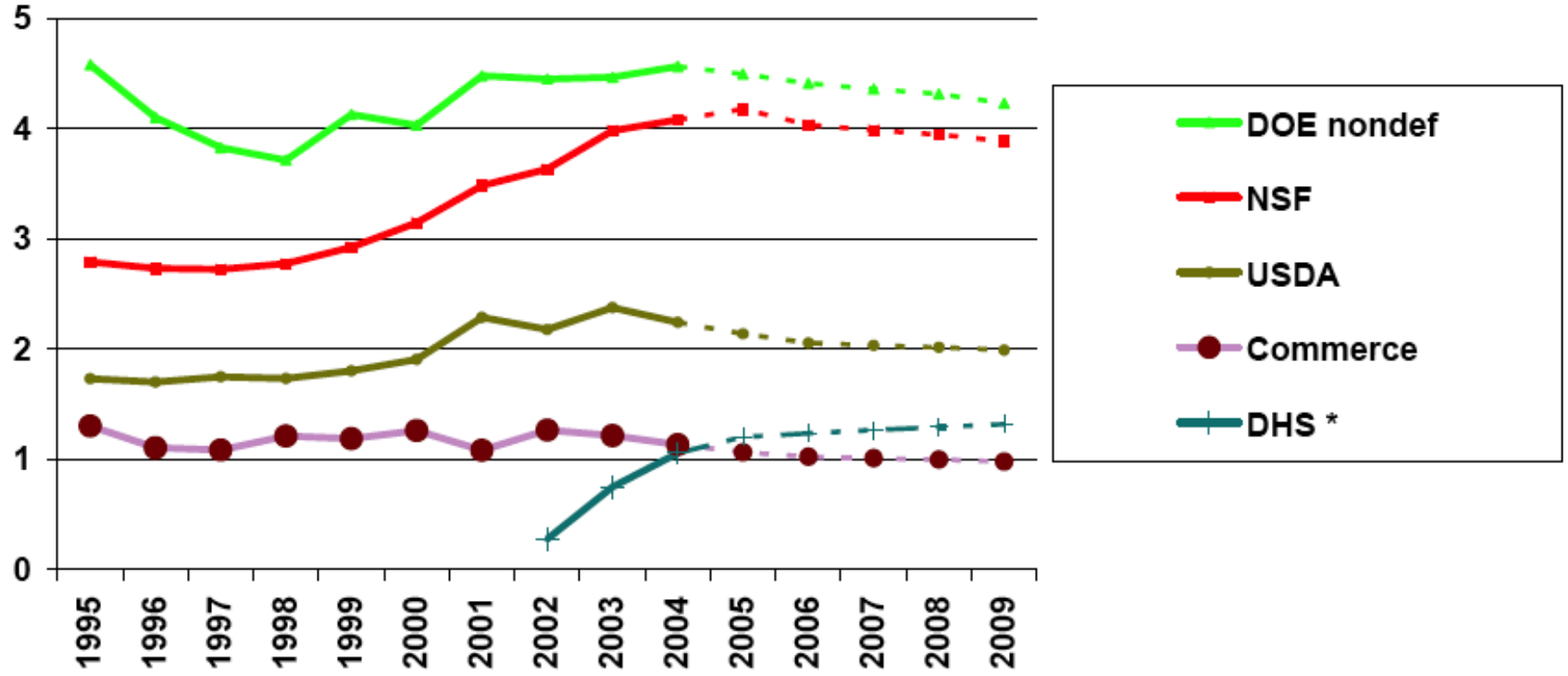


Source: AAAS analysis *Projected Effects of President's FY 2005 Budget on Nondefense R&D*

AAAS

Projected Nondefense R&D in the President's Budget, FY 2004-2009

in billions of constant FY 2004 dollars

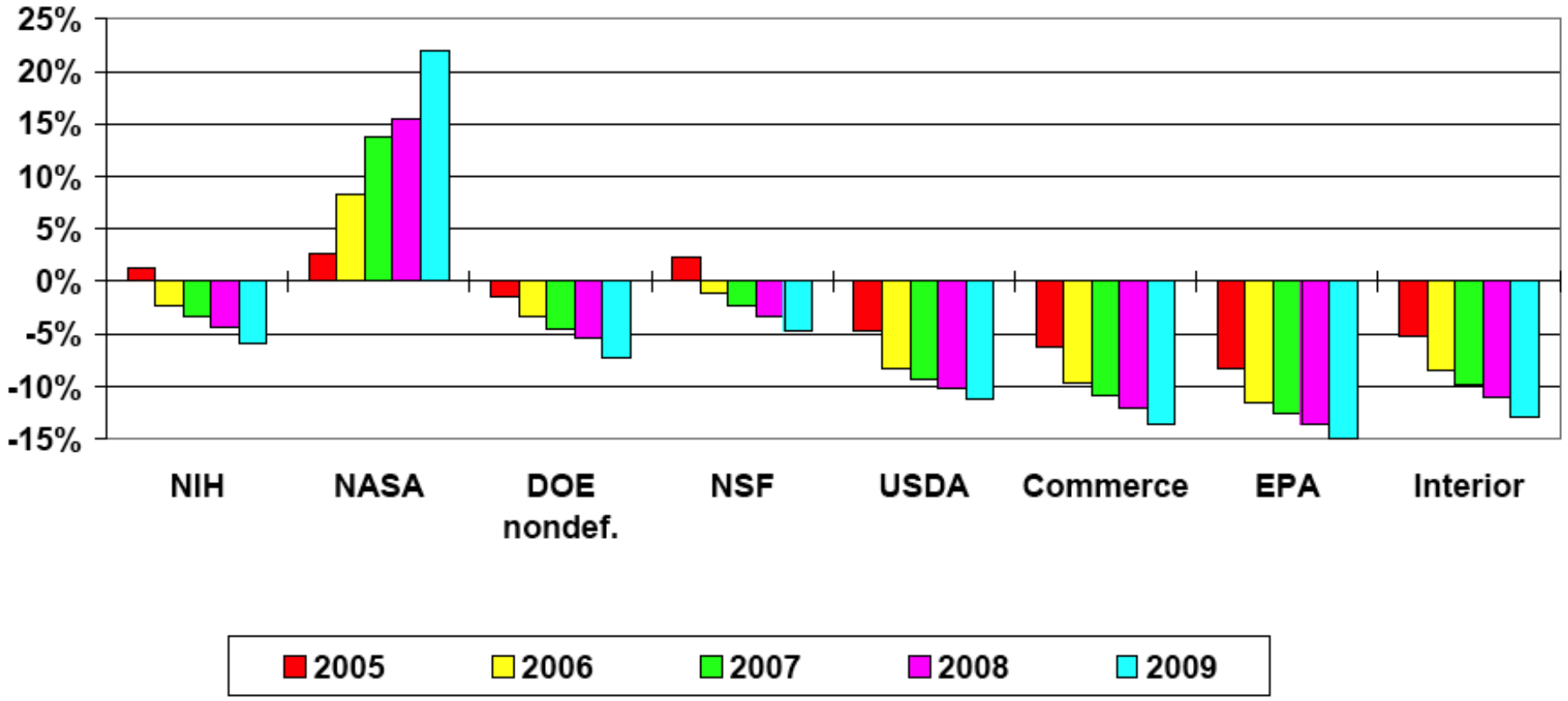


Source: AAAS analysis *Projected Effects of President's FY 2005 Budget on Nondefense R&D* . * - Includes DHS nondefense and defense R&D.

AAAS

Projected Nondefense R&D in the President's Budget, FY 2004-2009

% change from FY 2004 funding level in constant dollars

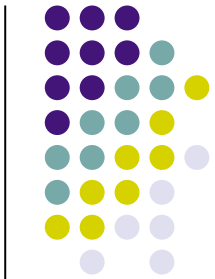


Source: AAAS analysis *Projected Effects of President's FY 2005 Budget on Nondefense R&D*

AAAS

	FY 2004 Estimate	FY 2005 Budget	FY 2006 Projected	FY 2007 Projected	FY 2008 Projected	FY 2009 Projected	% Change FY 04-09 current $	% Change FY 04-09 **constant $**
Total R&D (Conduct and Facilities)								
Defense (military)	65,970	69,928	72,005	71,735	72,669	71,661	8.6%	**0.0%**
DOD S&T ('6.1' - '6.3' & med.)	*12,567*	*10,622*	*10,534*	*10,899*	*11,044*	*11,211*	*-10.8%*	***-17.9%***
Health & Human Services	28,469	29,361	28,782	28,919	29,383	29,313	3.0%	**-5.2%**
Nat'l Institutes of Health	*27,220*	*27,923*	*27,353*	*27,481*	*27,713*	*27,852*	*2.3%*	***-5.8%***
NASA	10,909	11,334	12,142	12,970	13,417	14,448	32.4%	**21.9%**
Energy	8,804	8,880	9,030	9,239	9,374	9,461	7.5%	**-1.1%**
Defense	*4,244*	*4,333*	*4,502*	*4,689*	*4,783*	*4,870*	*14.7%*	***5.6%***
Science	*3,186*	*3,172*	*3,097*	*3,104*	*3,123*	*3,132*	*-1.7%*	***-9.5%***
Energy	*1,374*	*1,375*	*1,431*	*1,447*	*1,468*	*1,459*	*6.1%*	***-2.3%***
Nat'l Science Foundation	4,077	4,226	4,141	4,161	4,198	4,219	3.5%	**-4.7%**
Agriculture	2,240	2,163	2,110	2,121	2,143	2,160	-3.6%	**-11.3%**
Commerce	1,131	1,075	1,050	1,053	1,060	1,062	-6.1%	**-13.6%**
NOAA	*617*	*610*	*595*	*596*	*599*	*600*	*-2.8%*	***-10.5%***
NIST	*471*	*426*	*417*	*420*	*422*	*423*	*-10.1%*	***-17.3%***
Interior	675	648	635	636	639	639	-5.4%	**-12.9%**
Transportation	707	755	746	748	750	752	6.4%	**-2.1%**
Environ. Protection Agcy.	616	572	560	562	566	569	-7.6%	**-15.0%**
Homeland Security	1,053	1,216	1,267	1,319	1,374	1,430	35.8%	**25.0%**
Veterans Affairs	820	770	750	752	756	756	-7.8%	**-15.1%**
Education	290	304	296	297	298	299	3.1%	**-5.1%**
All Other	745	730	716	717	720	721	-3.2%	**-10.9%**
Total R&D	126,507	131,961	134,231	135,230	137,347	137,488	8.7%	**0.0%**
Defense R&D	70,501	74,668	76,922	76,847	77,885	76,974	9.2%	**0.5%**
Nondefense R&D	56,005	57,293	57,309	58,383	59,463	60,514	8.1%	**-0.5%**
Nondef. R&D minus DHS & NASA	*44,043*	*44,743*	*43,901*	*44,094*	*44,672*	*44,636*	*1.3%*	***-6.7%***

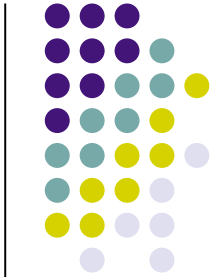
Concern 4



The staggering shift from of federal research priorities away from the physical sciences and engineering and into the biomedical sciences has created a situation where today roughly 62% of all federal R&D dollars flowing to the campuses are in biomedical research.

This is seriously distorting university priorities in an effort to position themselves for the NIH gravy train. Little wonder that there has been a significant erosion of U.S. citizens majoring in physical science and engineering over the past decade.

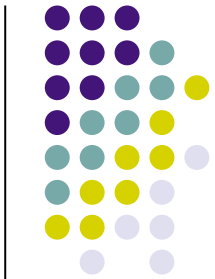
Concern 5



Beyond the fact that many other countries have realized that science and technology are key to economic growth and prosperity and are now catching up and passing us by, there are other issues.

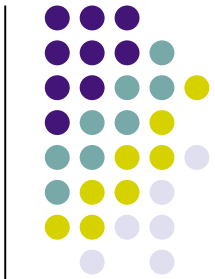
In a very real sense the American economy is running largely on a knowledge base developed during the Cold War, when major investments were made across the full spectrum of science and engineering rather than highly focused in a single area (biomedical research).

Concern 6



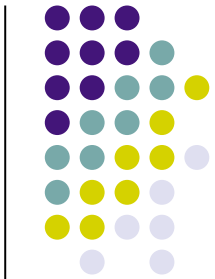
Major investments in academic science and engineering in these India, China, and Eastern Europe over the past two decades are creating a high quality workforce that can compete on even terms (or, in some cases, even better) with the U.S. workforce. The United States is well on its way toward losing its traditional advantage in workforce skills in an increasingly competitive, knowledge-driven global economy.

In the past we have compensated by attracting large numbers of talented foreign students into our graduate programs and our science and technology workforce. But with constraints imposed visas and immigration by homeland security concerns in the wake of 9-11, this pipeline of foreign talent is slowing to a trickle.



Is the Process for Determining and Funding Federal R&D Broken?

The Process



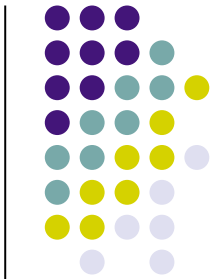
Retrospective:

- Shifting needs of society?
- Federal policies addressing strategic needs?
- Congressional sausage-making process?

Prospective:

- Press Report Approach (leadership)?
- Jeffersonian vs. Newtonian vs. Baconian science?
  - (Pasteur's Quadrant)

COSEPUP Hearings (03-04)



Participants: Key staff from OMB, Congress, NSF, NIH

1. Neither Congress nor Administration are capable of developing a strategic research budget. The budget is a political document. Hence science policy has to be politically driven. NIH growth has occurred because of exceptionally strong and effective lobbying.

2. It is not realistic to expect that the current science committee structure can be changed (e.g., shifting NSF out of HUD-Ind Ag). Lots of broken pickaxes on this.

COSEPUP Hearings (cont)

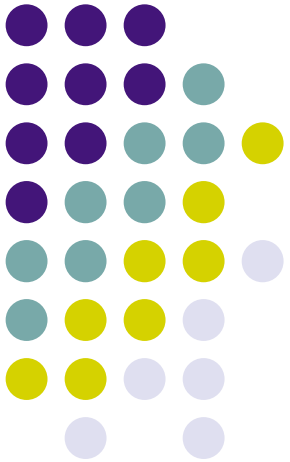
3. May be some opportunity to broaden the basic research mandates of federal agencies (e.g., NIH assuming more responsibility for research in physical sciences and engineering.)

4. Real key is for scientific community to get outside of the box, to move beyond Administration and Congress and build support for physical science and engineering similar to life sciences.

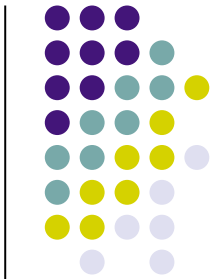
5. Congress seems increasingly aware of the linkage:

Basic Research → Attracts Best Minds → Trains Best Students → Start New Companies

A Gathering Storm?

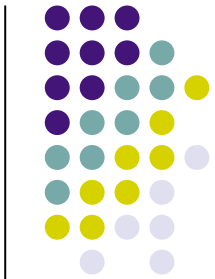


William Broad (NYT)



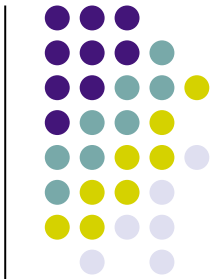
“ The US has started to lose its worldwide dominance in critical areas of science and innovation. The U.S. share of industrial patents has fallen steadily over the decades and now stands at 52%. Decline in Phys Rev papers is down to 29%, compared to 61% in 1983. Europe and Asia are making large investments in physical science and engineering research, while the U.S. has been obsessed with biomedical research to the neglect of other areas of science.”

Tom Friedman



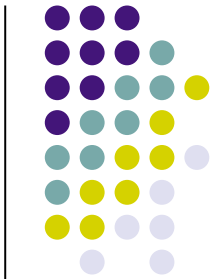
- “In Silicon Valley the sense is that American is losing its competitive edge vis-à-vis China, India, Japan, and other Asian tigers. U.S. companies are opening new plants offshore not because of cheaper labor, since labor is a small component of costs. Rather they are attracted by governments that are so eager for employment and transfer of technology to their young populations that they are offering huge incentives.”
- ”Furthermore the Department of Homeland Security is making it so hard for legitimate foreigners to get visas to study or work in American that many have given up the age-old dream of coming here. One of America’s greatest assets—its ability to skim the cream off the first-round intellectual draft choices from around the world and bring them to our shores to innovate will be diminished, and that in turn will shrink our talent pool.”

Tom Friedman (continued)



”The bottom line: we are actually in the middle of two struggles right now. One is against Islamist terrorists in Iraq and elsewhere, and the other is a competitiveness-and-innovation struggle against India, China, Japan, and their neighbors. And while we are fixated on the former, we are complete ignoring the latter. In the U.S., most PhDs are in biomedical fields. In Asia, most are in the physical sciences and engineering.”

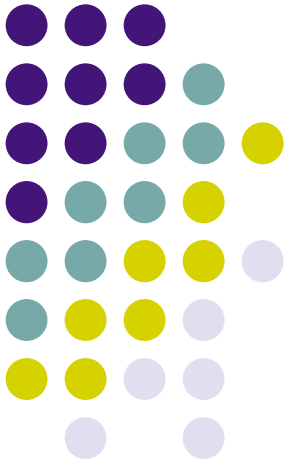
Craig Barret (Intel)



"The U.S. is not graduating the volume of scientists and engineers, we do not have a lock on the infrastructure, we do not have a lock on the new ideas, and we are either flat-lining, or in real dollars cutting back, out investments in physical science and engineering. The only crisis the U.S. thinks it is in today is the war on terrorism. It's not!"

NAE Task Force

Assessing the Capacity of the U.S. Engineering Research Enterprise

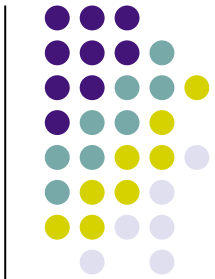


Assessing the Capacity of the U.S. Engineering Research Enterprise

DRAFT REPORT FOR EXTERNAL REVIEW

NATIONAL ACADEMY OF ENGINEERING
OF THE NATIONAL ACADEMIES

"Possible findings"…

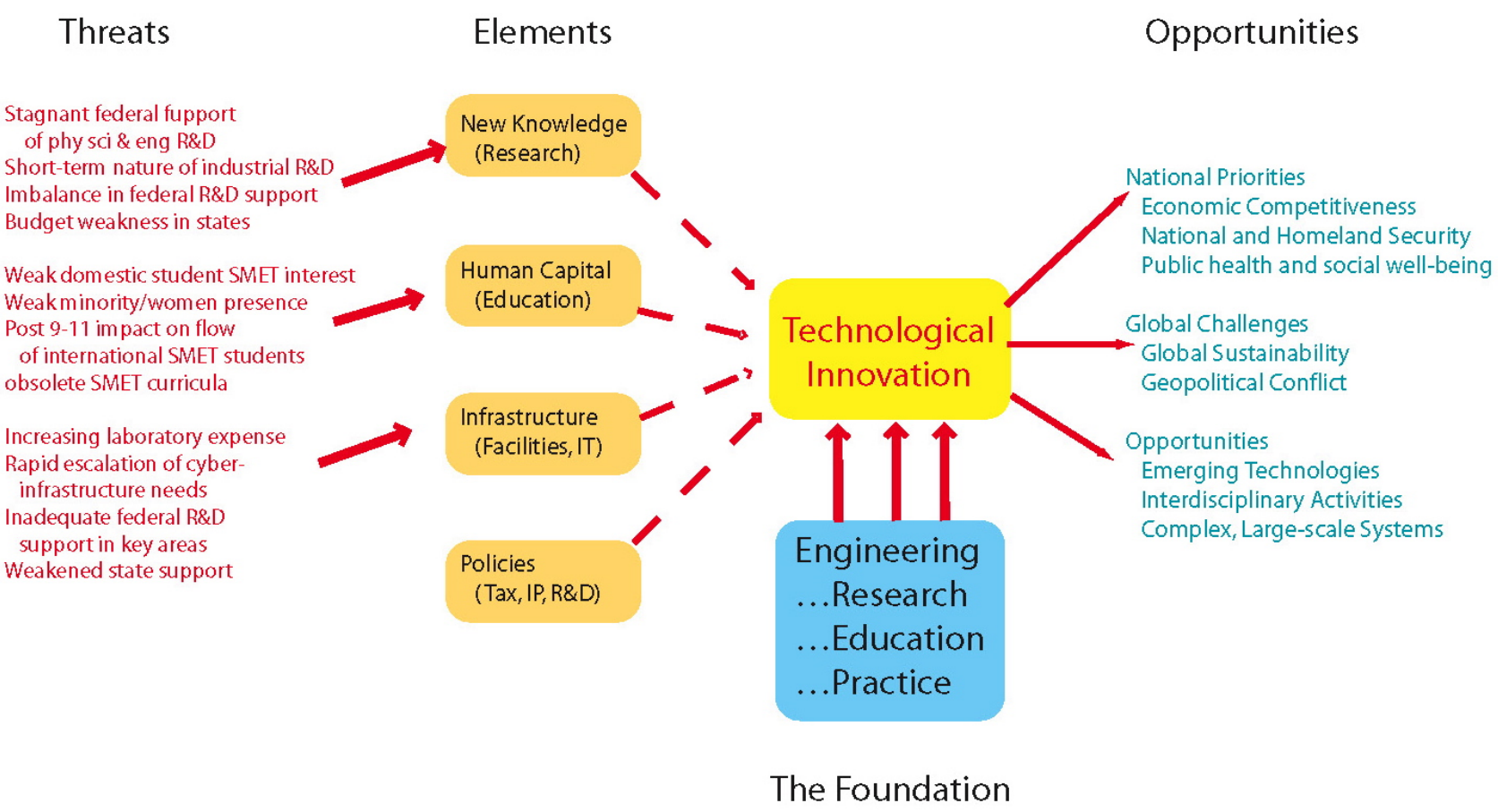


Leadership in technological innovation will be key to the nation's prosperity and security in a global knowledge driven economy.

Engineering research and education are essential elements of technological innovation.

Other nations are reaping the benefits of their investments in engineering research and education, which have stimulated and exploited technological innovation.

Numerous studies have concluded that federal investment in research in physical sciences and engineering have been stagnant for three decades.


Threats
Elements
Opportunities
Stagnant federal fupport
of phy sci & eng R&D
Short-term nature of industrial R&D
Imbalance in federal R&D support
Budget weakness in states
Weak domestic student SMET interest
Weak minority/women presence
Post 9-11 impact on flow
of international SMET students
obsolete SMET curricula
Increasing laboratory expense
Rapid escalation of cyber-
infrastructure needs
Inadequate federal R&D
support in key areas
Weakened state support
New Knowledge
(Research)
Human Capital
(Education)
Infrastructure
(Facilities, IT)
Policies
(Tax, IP, R&D)
Technological
Innovation
Engineering
…Research
…Education
…Practice
National Priorities
Economic Competitiveness
National and Homeland Security
Public health and social well-being
Global Challenges
Global Sustainability
Geopolitical Conflict
Opportunities
Emerging Technologies
Interdisciplinary Activities
Complex, Large-scale Systems
The Foundation

National Innovation
- NII Interim Report
- Background Documents
- Building Technical Talent

Regional Innovation

High Performance Computing

Global Initiatives

Competitiveness & Security

Benchmarking Competitiveness

World Class Workforce

Congressional Outreach

National Innovation

National Innovation Initiative

NII Working Group Web Portal

Vision

Innovation fosters the new ideas, technologies, and processes that lead to better jobs, higher wages and a higher standard of living. For advanced industrial nations no longer able to compete on cost, the capacity to innovate is the most critical element in sustaining competitiveness.

The United States stands apart from the rest of the world in its record of sustained innovation over decades, across industries, and through economic cycles. Why? What has made the United States an engine of innovation? A number of structural and economic advantages help explain this performance, including:

- Ready access to natural resources and labor
- The skills and work ethic of American workers
- Strong capital markets, a long tradition of the rule of law, a deep commitment to property rights, and a culture that encourages and rewards risk-takers
- A unique system of cooperation and collaboration among the federal government, national and military labs, private-sector R&D efforts, research universities and entrepreneurs

News

October 1, 2004
NII Co-Chairs Share Innovation Vision with BusinessWeek

September 30, 2004
Associated Press -- National Innovation Initiative heads expect recommendations to set agenda

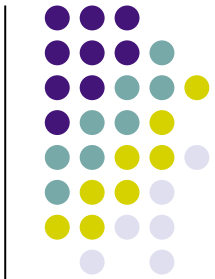
September 30, 2004
Professional science master's can fill gaps in federal scientific workforce, Sloan's Teitelbaum says

August 16, 2004
American Physical Society -- Workforce Issues Dominate Policy Briefing

July 30, 2004
California Computer News -- Innovate America...

July 22, 2004
Council On

"Possible recommendations"…

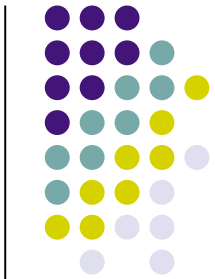


Federal investment in R&D should be more balanced among the disciplines.

High priority should be given to restoring adequate support for physical science and engineering necessary for technological innovation, key to security and economic competitiveness.

Business as usual is not enough, however.The technical challenges and opportunities facing the nation and the evolving nature of technological innovation and global competition will require change in the way we prioritize, fund, and conduct research.

A 21st Land Grant Act?



Very much in the spirit of the Land-Grant Acts of the 19th Century or the G.I. Bill and government-university research partnership of the 20th century, a bold initiative is needed to link fundamental scientific discovery with technological innovation.

This will involve a partnership among the federal government, the states, the private sector, the national laboratories, and higher education capable of both strengthening and transforming our scientific and engineering research enterprise to serve our nation in a 21st century, global, knowledge-driven society.