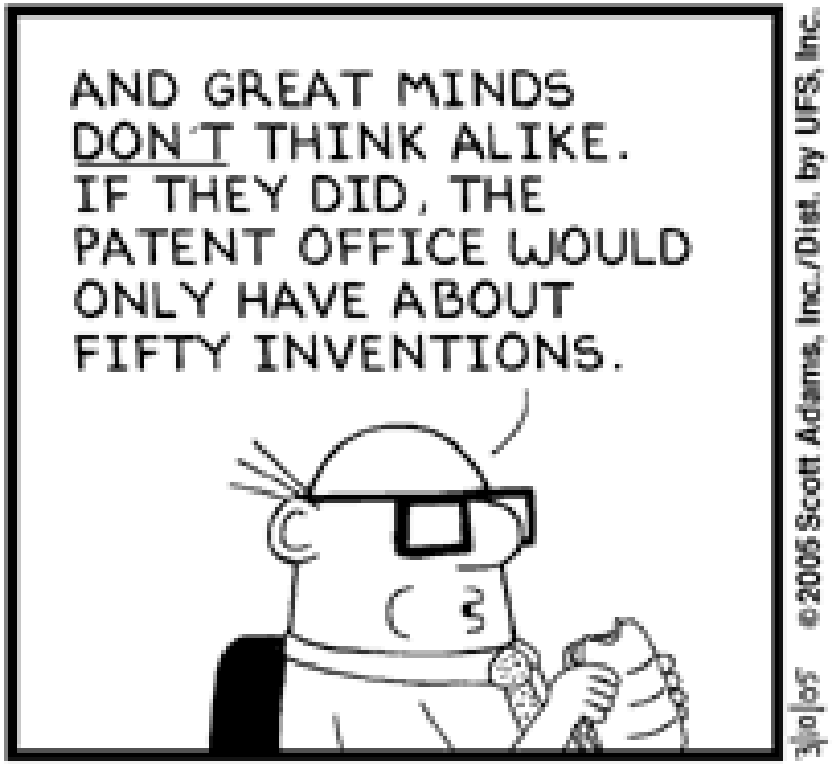

AND GREAT MINDS
DON'T THINK ALIKE.
IF THEY DID, THE
PATENT OFFICE WOULD
ONLY HAVE ABOUT
FIFTY INVENTIONS.
3/9/05
©2005 Scott Adams, Inc./Dist. by UFS, Inc.

Innovating Innovation

(Now *There's* a Good Idea)

Hratch G. Semerjian

Acting Director, NIST

Bucknell University

March 29, 2005

Innovation In The News …

"Innovation will be the single most important factor in determining America's success through the 21st century."

Report of the "National Innovation Initiative",
Council on Competitiveness
December 2004

"We conclude that although the United States still leads the world in research and discovery, our advantage is eroding rapidly as other countries commit significant resources to enhance their own innovative capabilities."

Task Force on the Future of American Innovation
February, 2005

… Innovation In The News

"The balance of innovation has begun to tilt eastward, as China and India start taking their own products to market. For the first time, other nations are about to produce more U.S. patents per year than the United States."

Craig R. Barrett, CEO of Intel
USA Today, Feb. 24, 2005

"INNOVATION IS A GLOBAL PHENOMENON AND THE FUTURE IS UP FOR GRABS …
Our nation's technological and economic leadership cannot be taken for granted."

TechNet Innovation Initiative
March 2005

We are not alone!

Business Life

FT SERIES: REFORMING EUROPE PROTECTING IDEAS

Europe lacks vision on innovation

Intellectual property rights, especially over software development, remain a thorny legal issue for Brussels, say **Bob Sherwood** and **Nikki Tait**

In the European Union's drive to become more competitive, few issues are more central, or more prone to political infighting, than intellectual property protection.

It is an age-old criticism – which many insist still holds

FINANCIAL TIMES MONDAY MARCH 21 2005

Comment & Analysis

The dollar has fallen far enough
See Comment

FT SERIES: REFORMING EUROPE RESEARCH AND DEVELOPMENT

A mountain to climb: Brussels is trying to improve the results from innovation

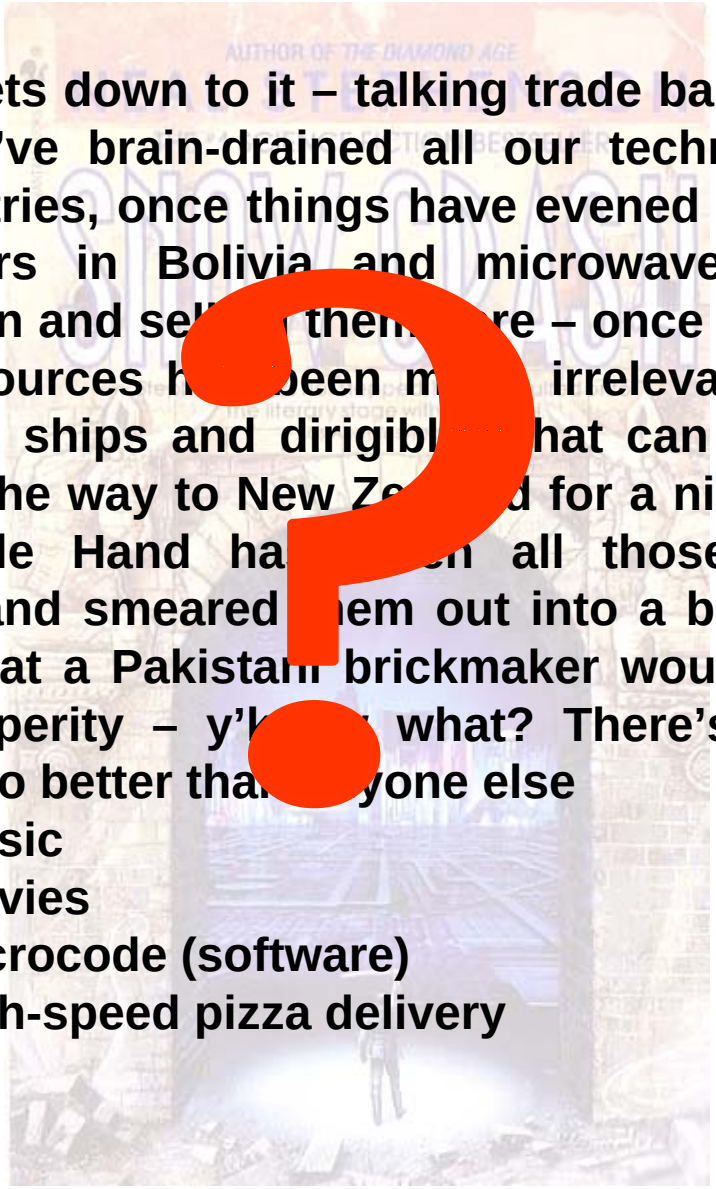
Assessing the state of European competitiveness, **Ralph Atkins** and **George Parker** examine efforts to boost innovation and create better links between scientists and suppliers of capital

Ever since the collapse of communism in eastern Europe, Tamás Ladoméry has worked with colleagues to build up his company, Diatron, which manufactures blood cell counters in Hungary, part of the European Union since last year. Facing stiff competition from the US

that the US was falling behind in mathematics and science and needed to boost spending on basic research.

None of this makes any easier the task of raising the EU average, however. In the private sector, R&D spending decisions will depend on commercial factors

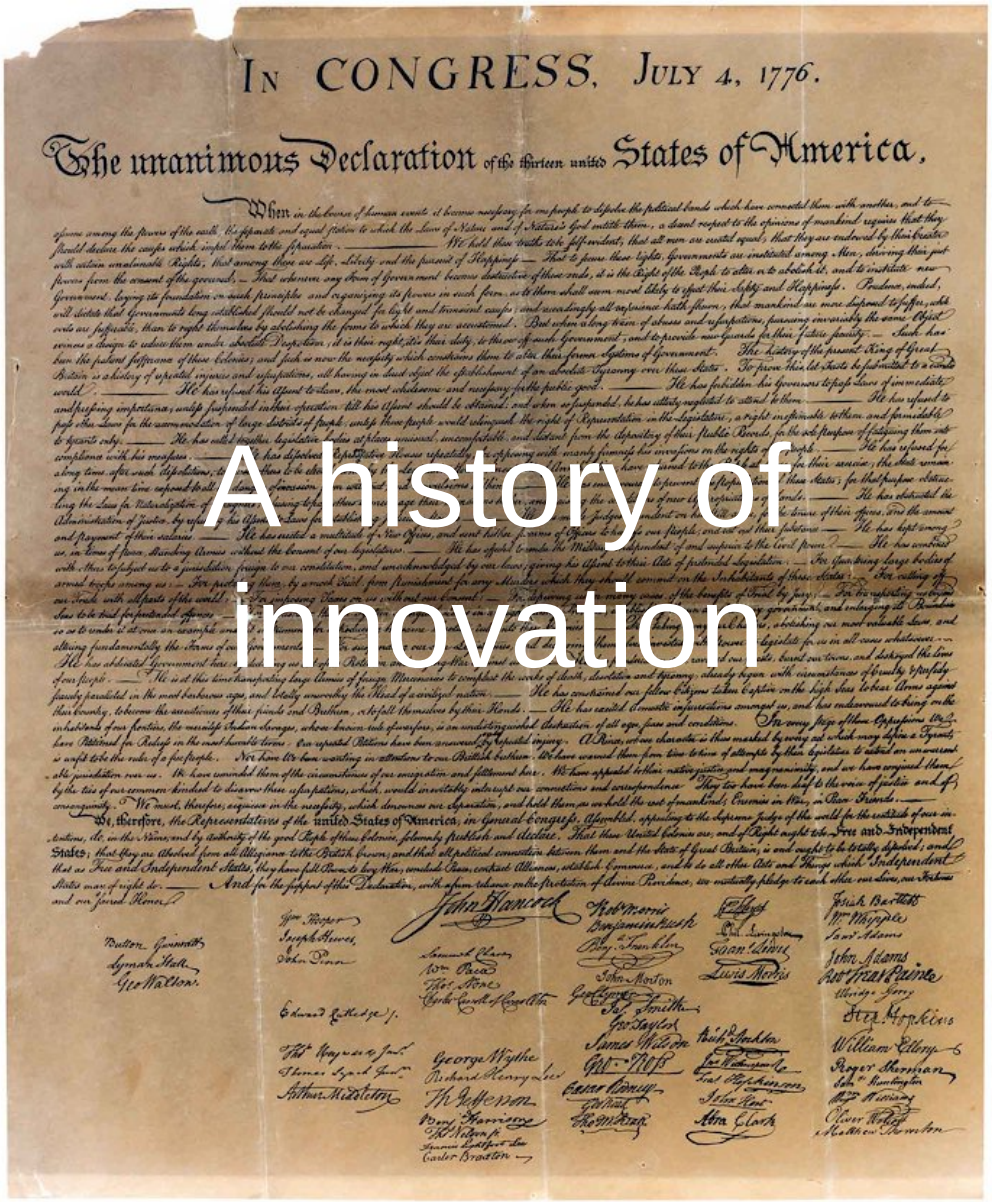
always obvious. In Hungary, a public argument has erupted over the issue. In the imposing 19th-century Budapest building that houses the Hungarian Academy of Sciences on the banks of the Danube river, Norbert Kroo, secretary-general, argues that the "profit



"When it gets down to it – talking trade balances here – once we've brain-drained all our technology into other countries, once things have evened out, they're making cars in Bolivia and microwave ovens in Tadzhikistan and sel[illegible] them[illegible]re – once our edge in natural resources h[illegible]been m[illegible] irrelevant by giant Hong Kong ships and dirigibl[illegible]hat can ship North Dakota all the way to New Ze[illegible]d for a nickel – once the Invisible Hand ha[illegible]n all those historical inequities and smeared [illegible]em out into a broad global layer of what a Pakistani brickmaker would consider to be prosperity – y'k[illegible] what? There's only four things we do better tha[illegible]yone else

music
movies
microcode (software)
high-speed pizza delivery

Snow Crash
Neal Stephenson
1992


IN CONGRESS, JULY 4, 1776.
The unanimous Declaration of the thirteen united States of America,
A history of innovation

Technological Innovation and Growth

Economic studies over several decades have shown that:

1. **Technology accounts for *one-half of output (GDP) growth* in all industrialized nations (except Canada).**
2. **Technology accounts for *three-quarters of productivity growth*.**
3. **The increase in U.S. productivity growth that began in the mid-1990s is *entirely due to technology investments*.**
4. **The productivity advantage of the U.S. economy over other OECD countries accounts for *three-quarters of the per capita income gap*.**
5. **The rate of return to basic science is about *three times* that for applied R&D, which, in turn, has *twice* the return on physical capital.**

A High-Tech Economy

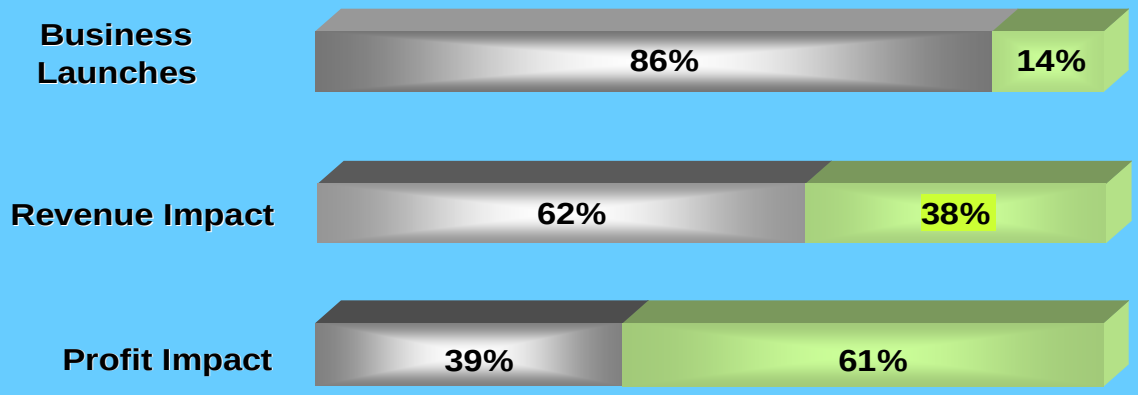
The most high-tech segments of the U.S. economy…

- Electronics
- Pharmaceuticals
- Communication services
- Software and computer-related services

… Account for *7 to 10 percent of our Gross Domestic Product*.

Radical Innovation Yields Disproportionate Profit Impact

The Sources of Profitable Growth



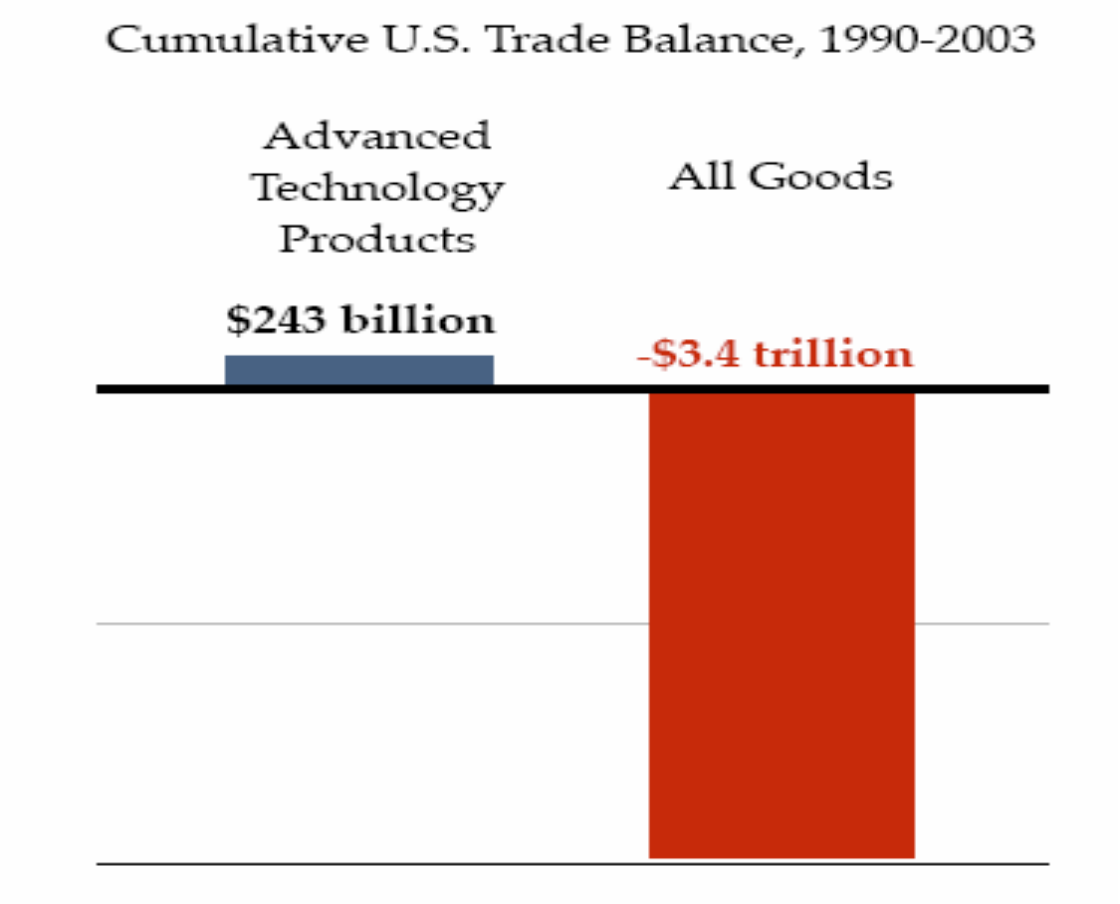
Me-too or incrémental improvement: 86 : 62 : 39

Value or radical innovation : 14 : 38 : 61

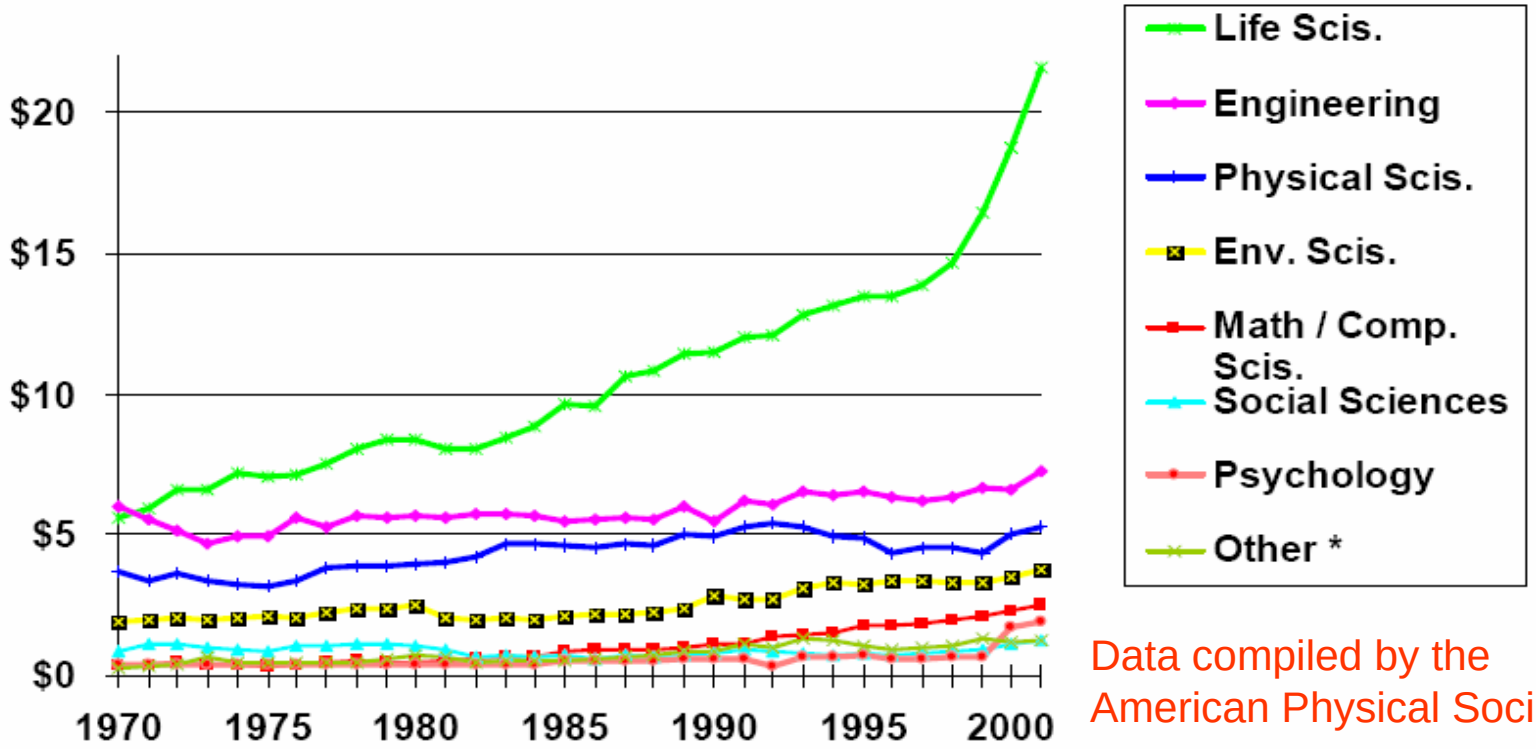
3b

Kim and Mauborgne, Harvard Bus. Rev, 1/97,
Cited: E.Milbergs, Innovation Metrics, NII, 1/2004

High-Tech Contribution to Trade Balance



Flat Funding for Physical Science R&D

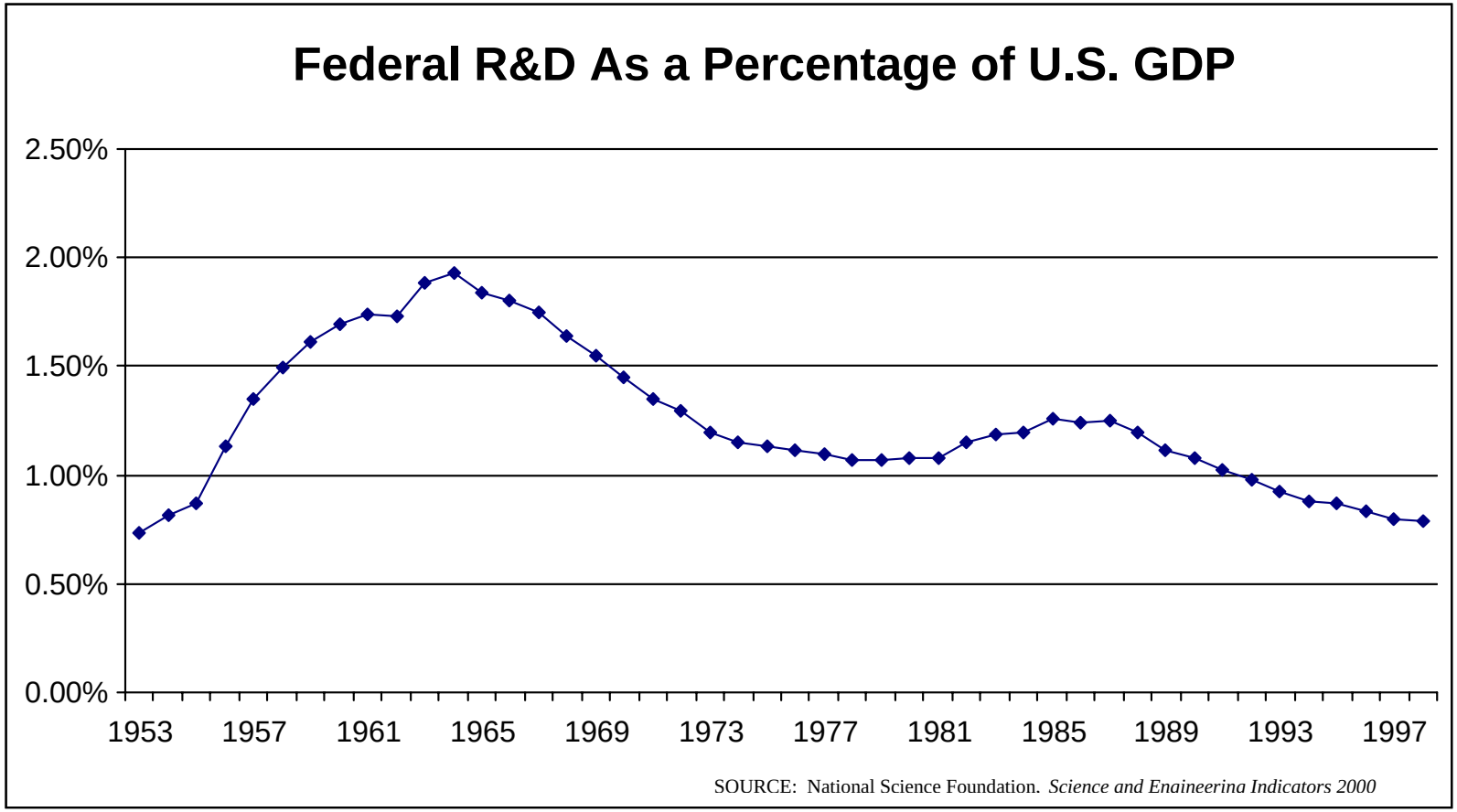


Data compiled by the American Physical Society

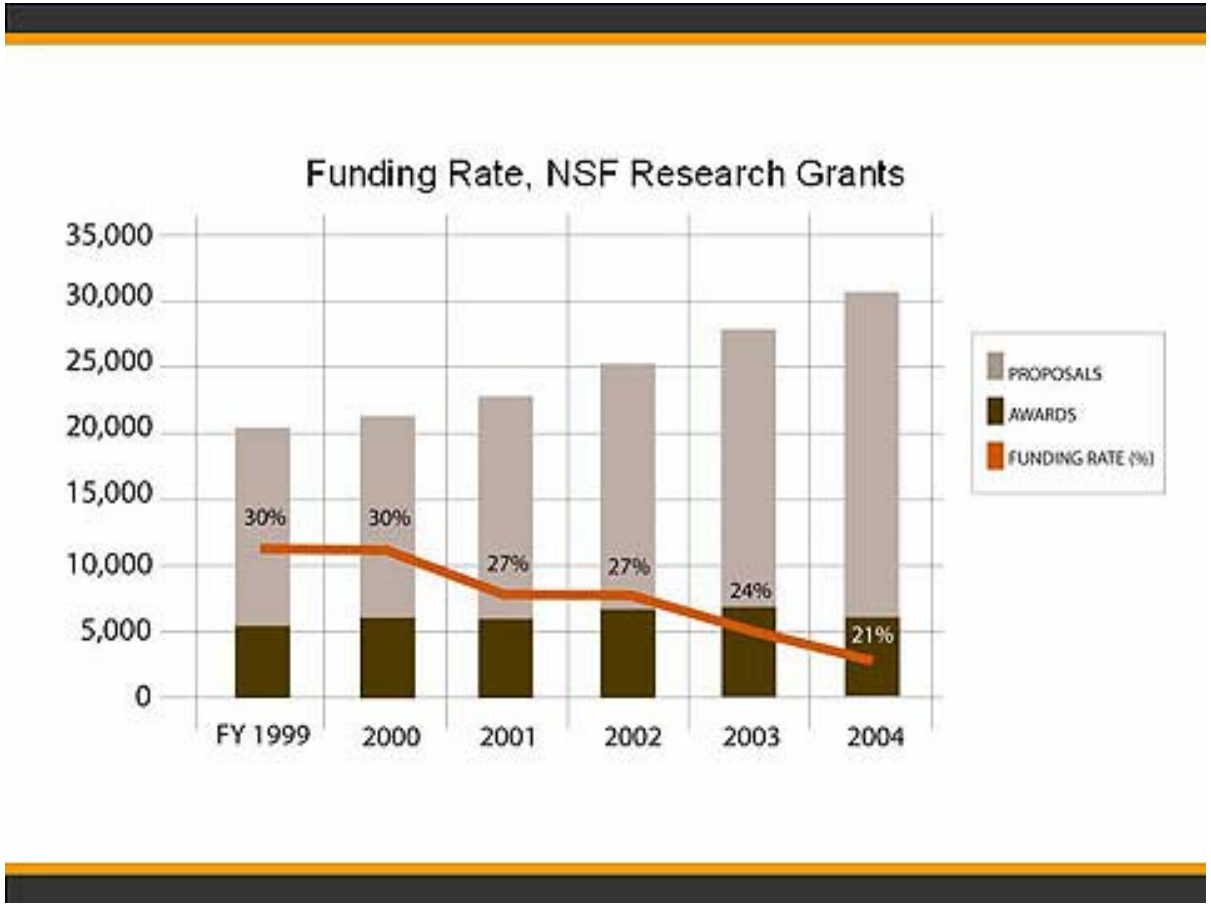
Trends in Federal Research by Discipline, FY 1970-2001

obligations in billions of constant FY 2002 dollars

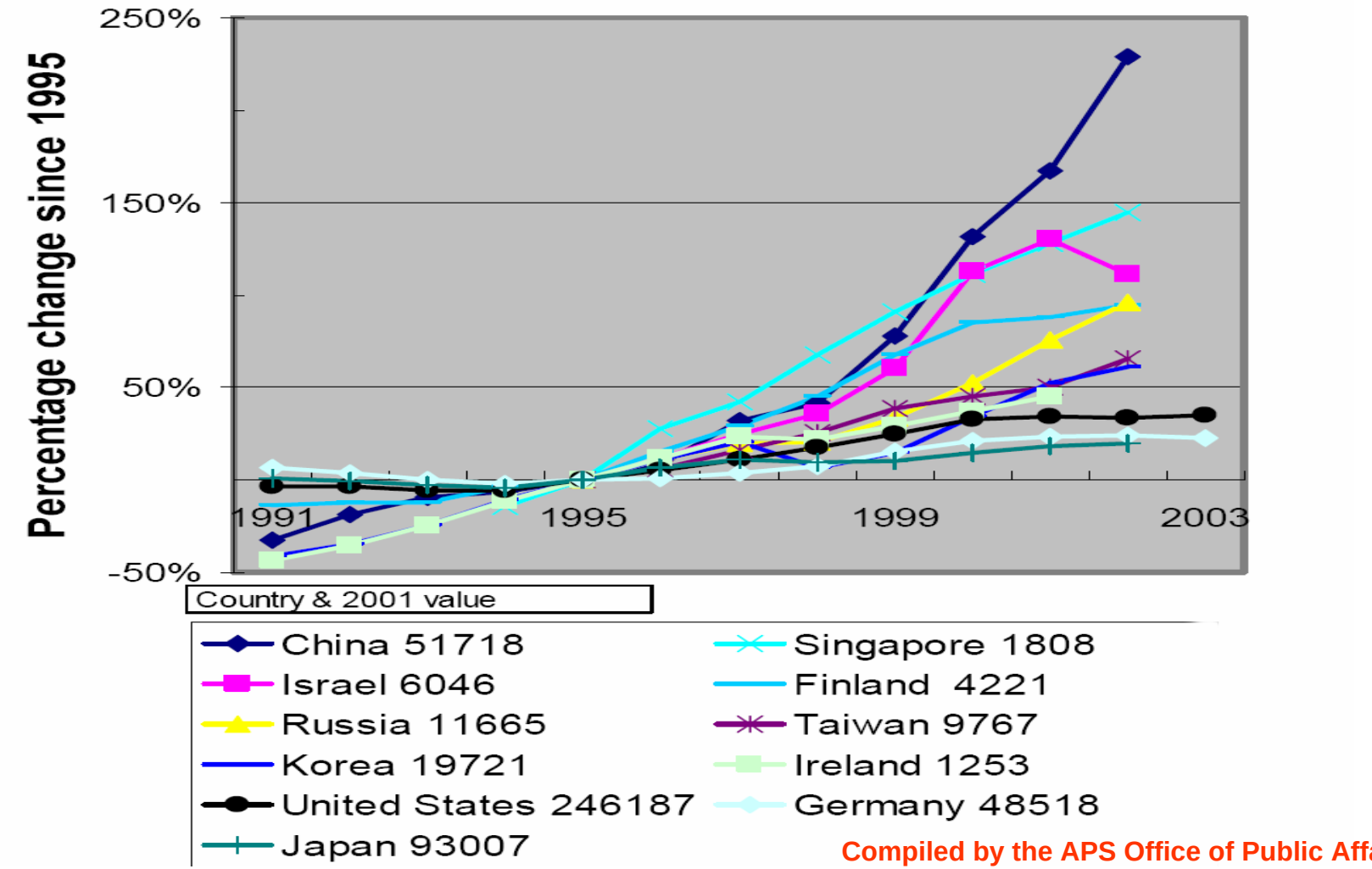
… and Long-Term Decline



National Science Foundation Funding Rates

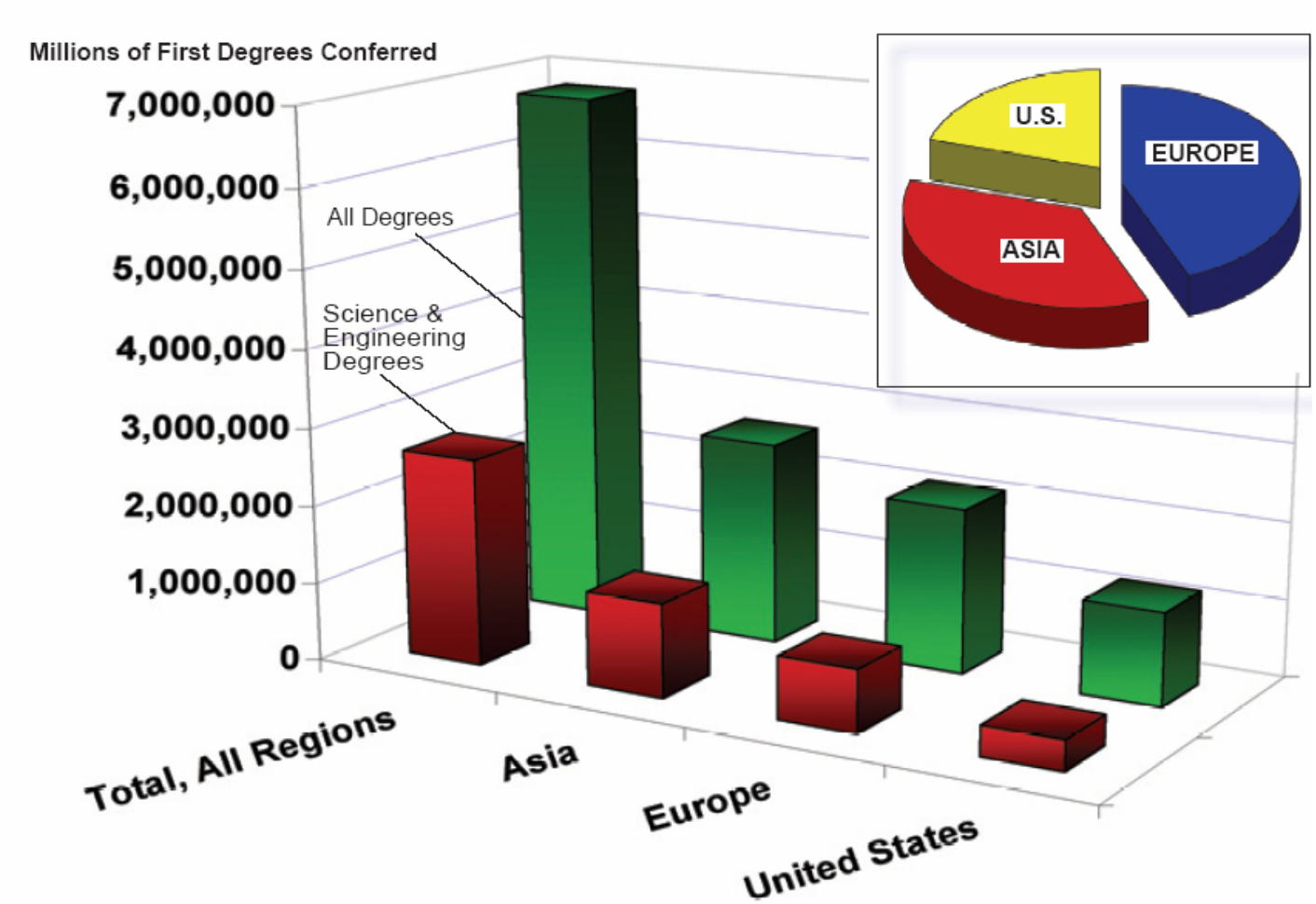


Other Countries Are Also Building S&T Infrastructure



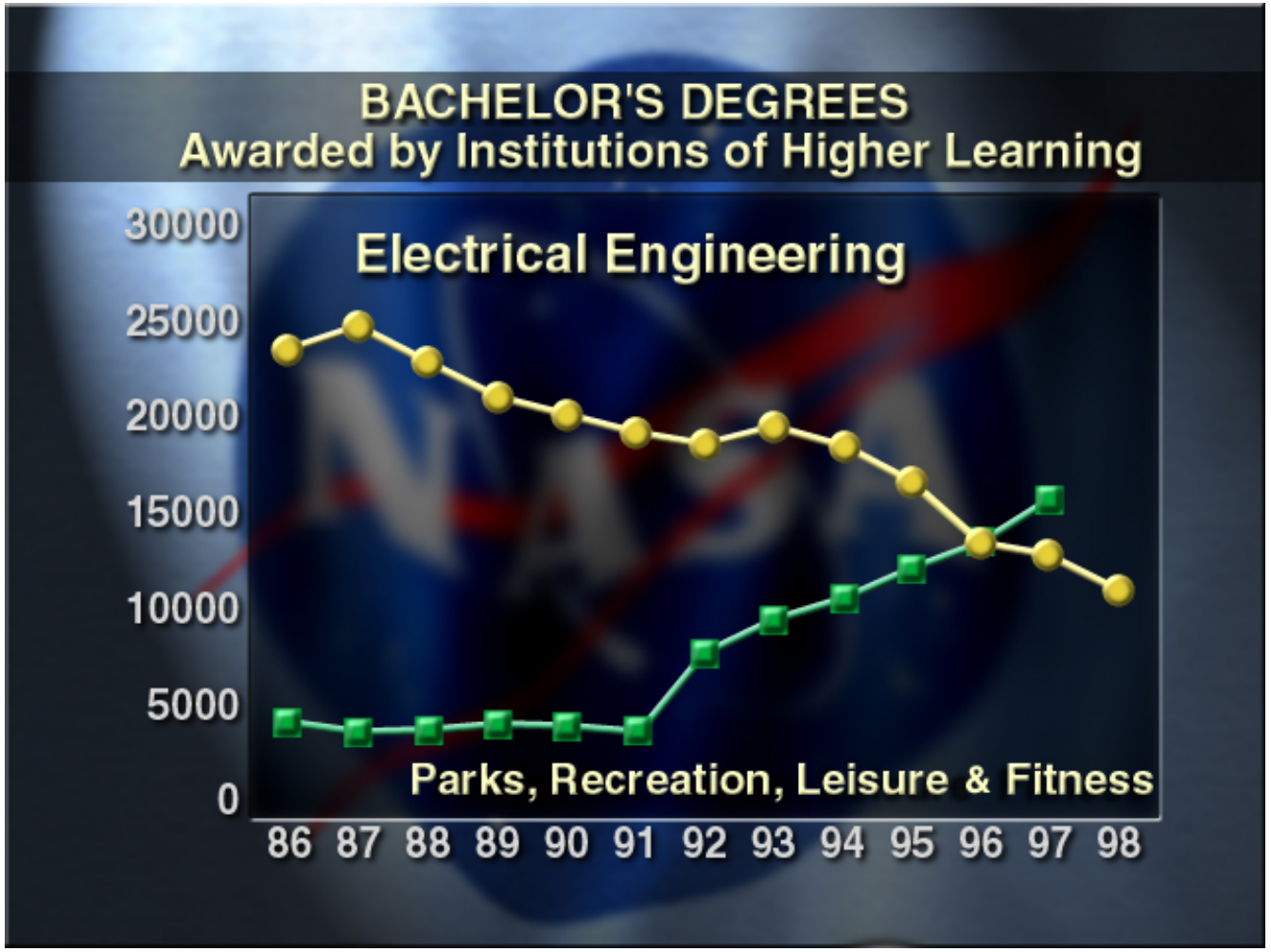
Compiled by the APS Office of Public Affairs.

S&T Education: U.S. Lags



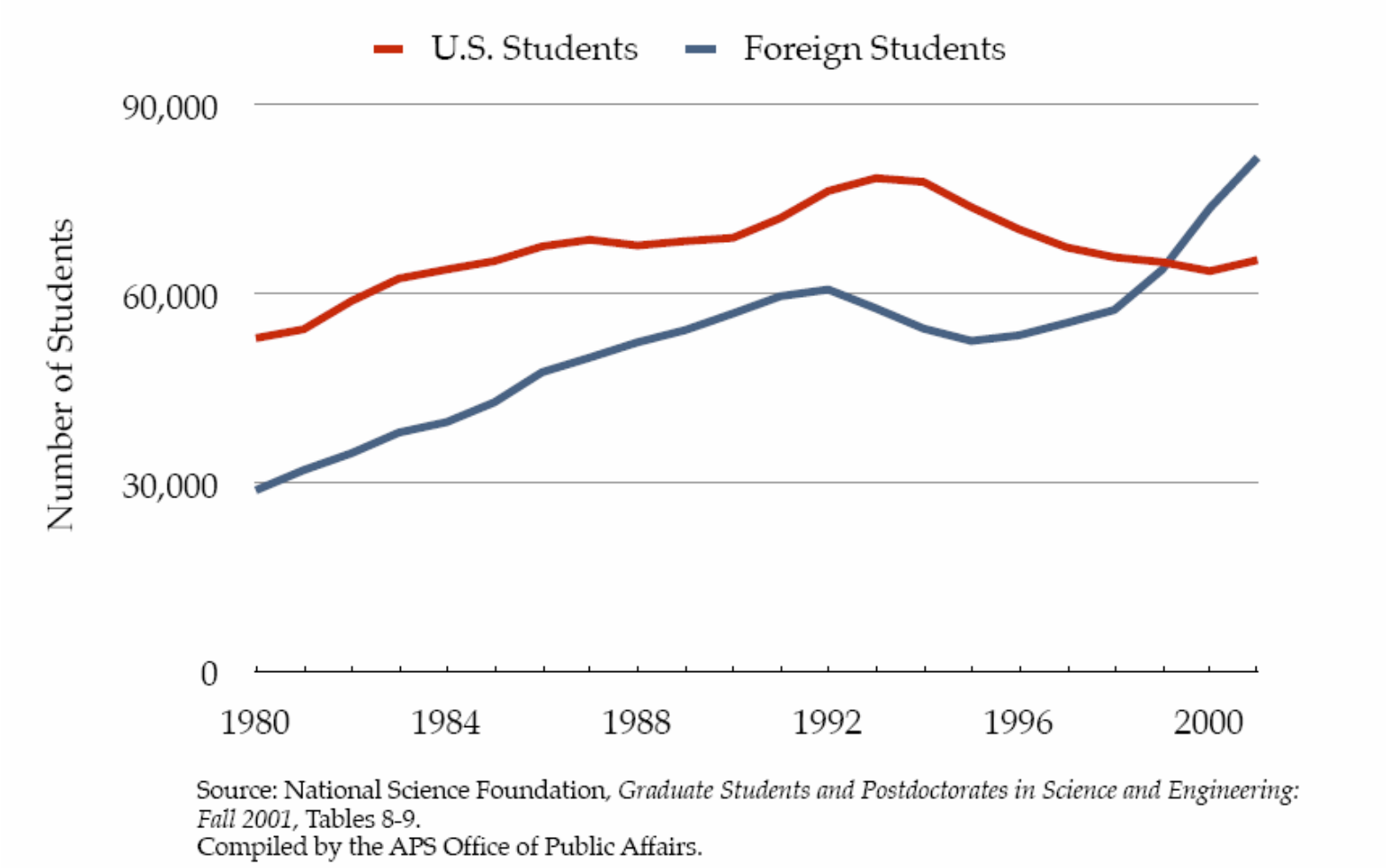
source: National Science Foundation's Science & Engineering Indicators 2002

Students See No Future in Engineering



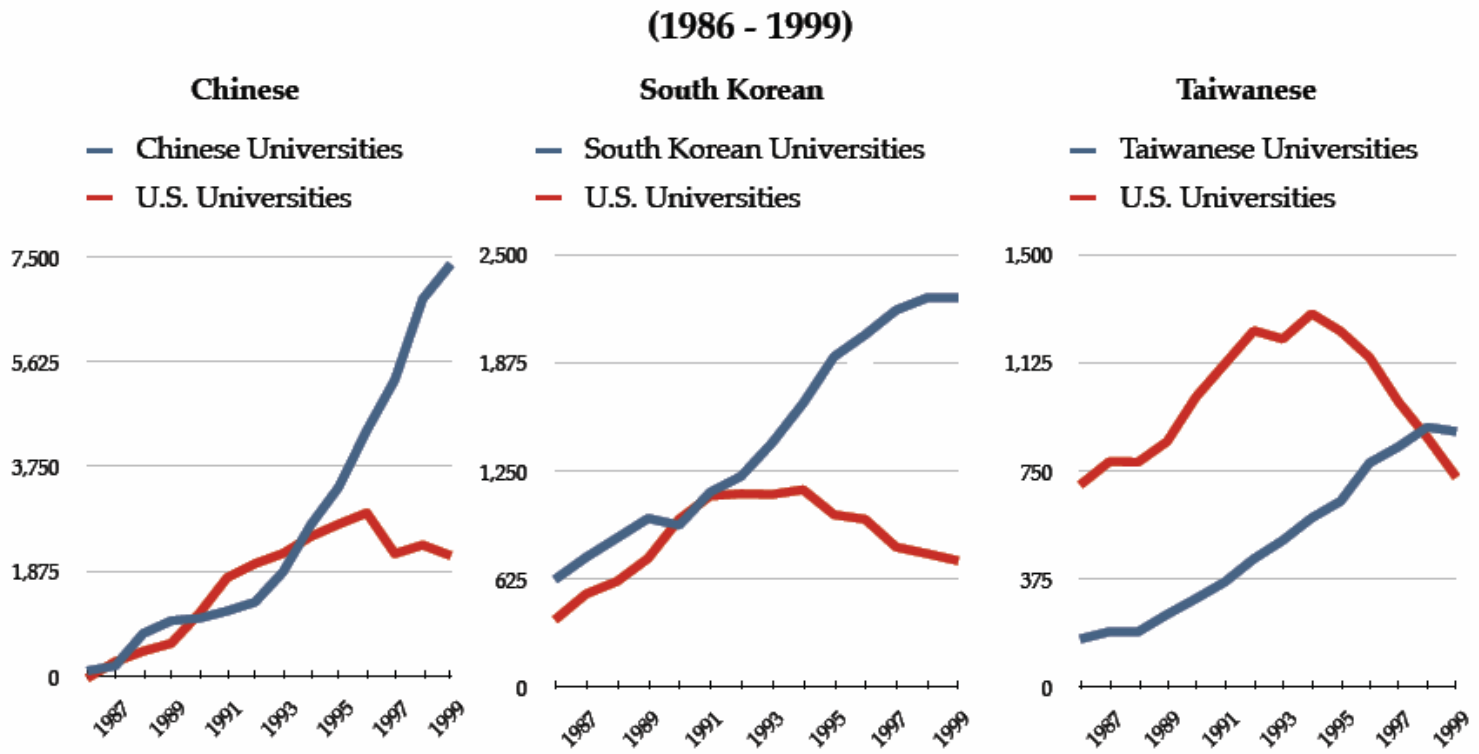
Slide courtesy of Kathie Olsen, NASA, by way of ASTRA

U.S. Graduate Schools:
Foreign Students Outnumber U.S. Students



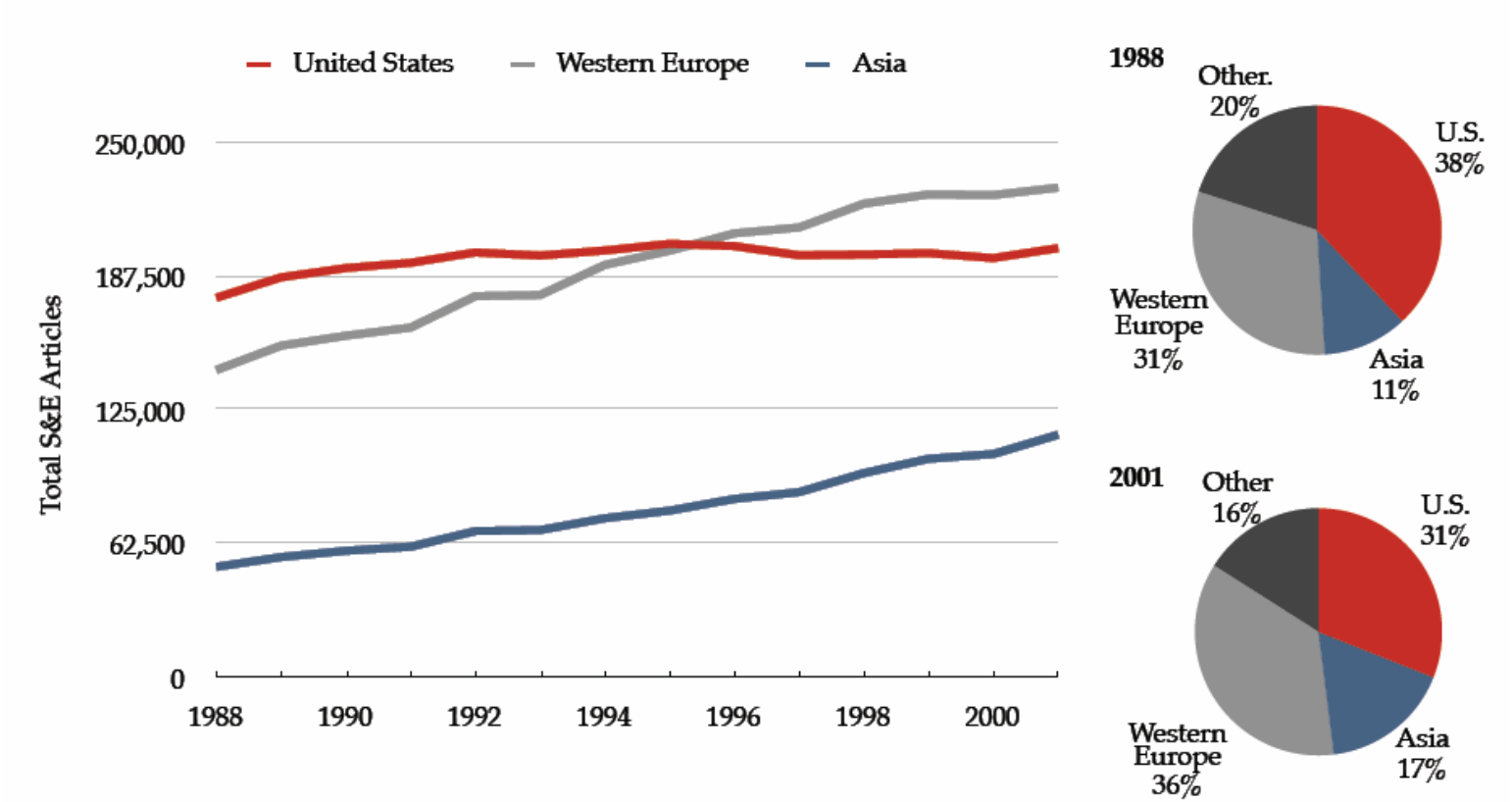
Source: National Science Foundation, *Graduate Students and Postdoctorates in Science and Engineering: Fall 2001*, Tables 8-9.
Compiled by the APS Office of Public Affairs.

More and More Foreign PhD Students Are Staying Home



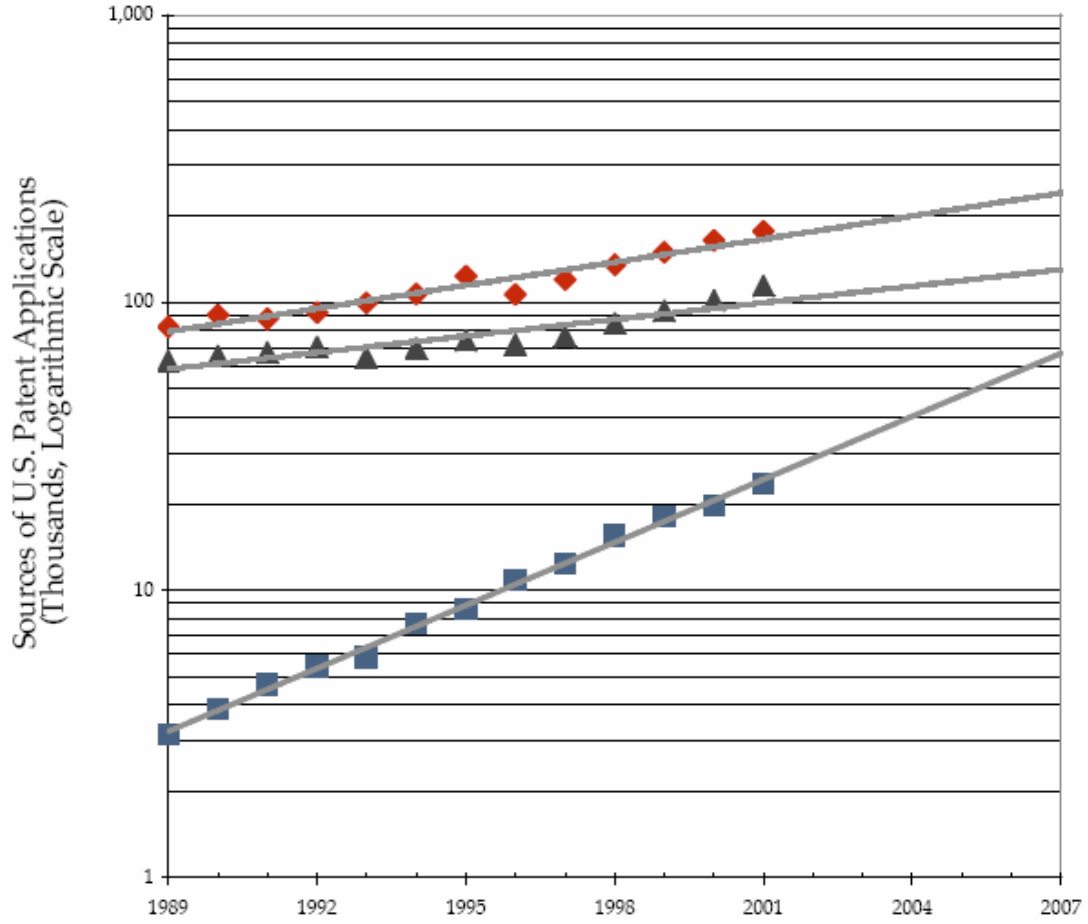
Source: National Science Foundation, *Science and Engineering Indicators 2002*, Appendix Table 2-41.
Adapted from Diana Hicks, "Asian countries strengthen their research," *Issues in Science and Technology*, Summer 2004.
Compiled by the APS Office of Public Affairs.

Science & Engineering Articles: Losing Market Share



Source: National Science Foundation, *Science and Engineering Indicators 2004*. Appendix Table 5-35.
Compiled by the APS Office of Public Affairs.

U.S. Patent Applications



United States

Other Established Economies

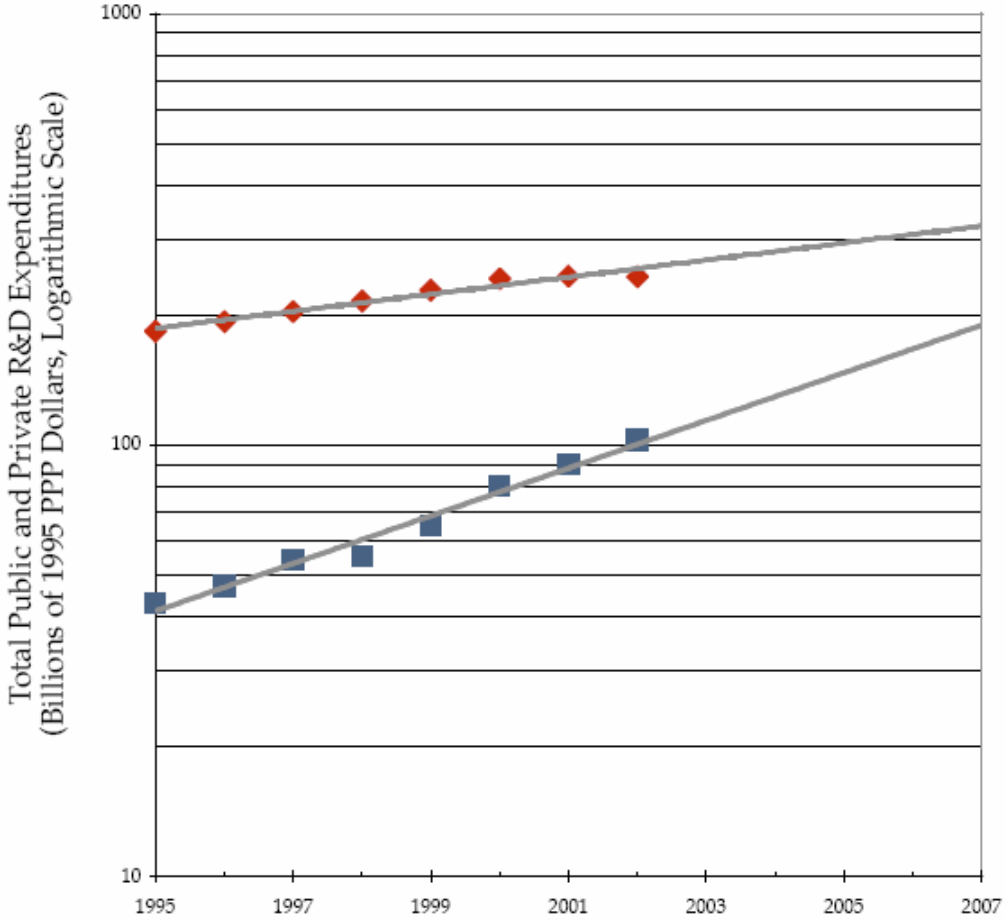
Fastest Growing Economies

Other Established Economies:
Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom

Fastest Growing Economies:
China, Hong Kong, India, Ireland, Israel, Singapore, South Korea, Taiwan

Source: National Science Foundation, *Science and Engineering Indicators 2004*, Appendix Table 6-11.
Compiled by the APS Office of Public Affairs

Total R&D Investments



United States

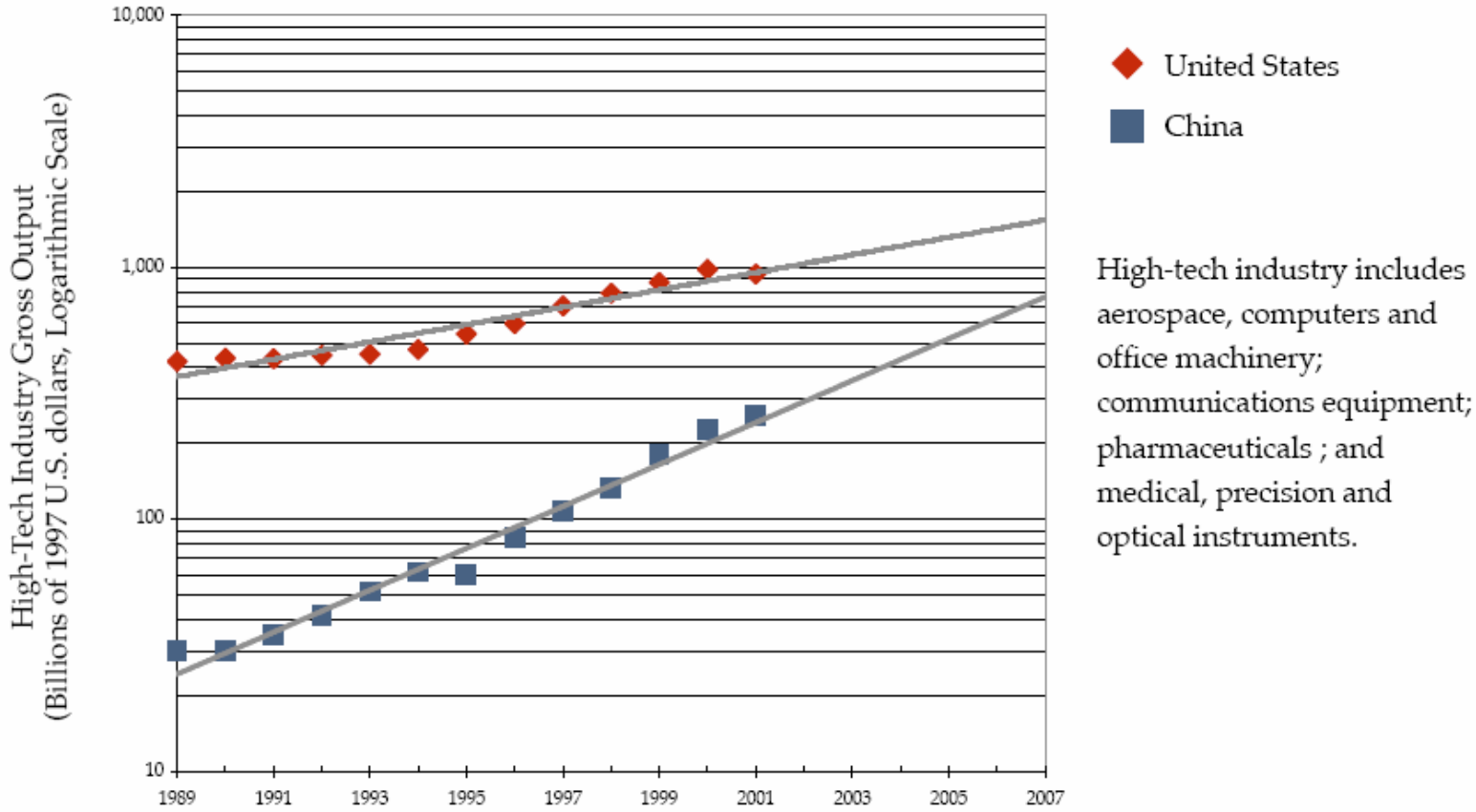
Fastest Growing Economies

Fastest Growing Economies:
China, Ireland, Israel, Singapore, South Korea, Taiwan

(India and Hong Kong data not available)

Source: Organisation for Economic Cooperation and Development, *Main Science and Technology Indicators*, May 2003.
Compiled by the APS Office of Public Affairs

High-Tech Industrial Output



High-tech industry includes aerospace, computers and office machinery; communications equipment; pharmaceuticals ; and medical, precision and optical instruments.

Source: National Science Foundation, *Science and Engineering Indicators 2004*, Appendix Table 6-1.
Compiled by the APS Office of Public Affairs

Bottom line: *"Innovate or abdicate"*

"... we live in a competitive world ... We shouldn't take our preeminence as the world's greatest economy for granted. We've constantly got to make sure the economic environment here is strong. We've got to make sure that we're innovative."

President G.W. Bush (April 5, 2004)

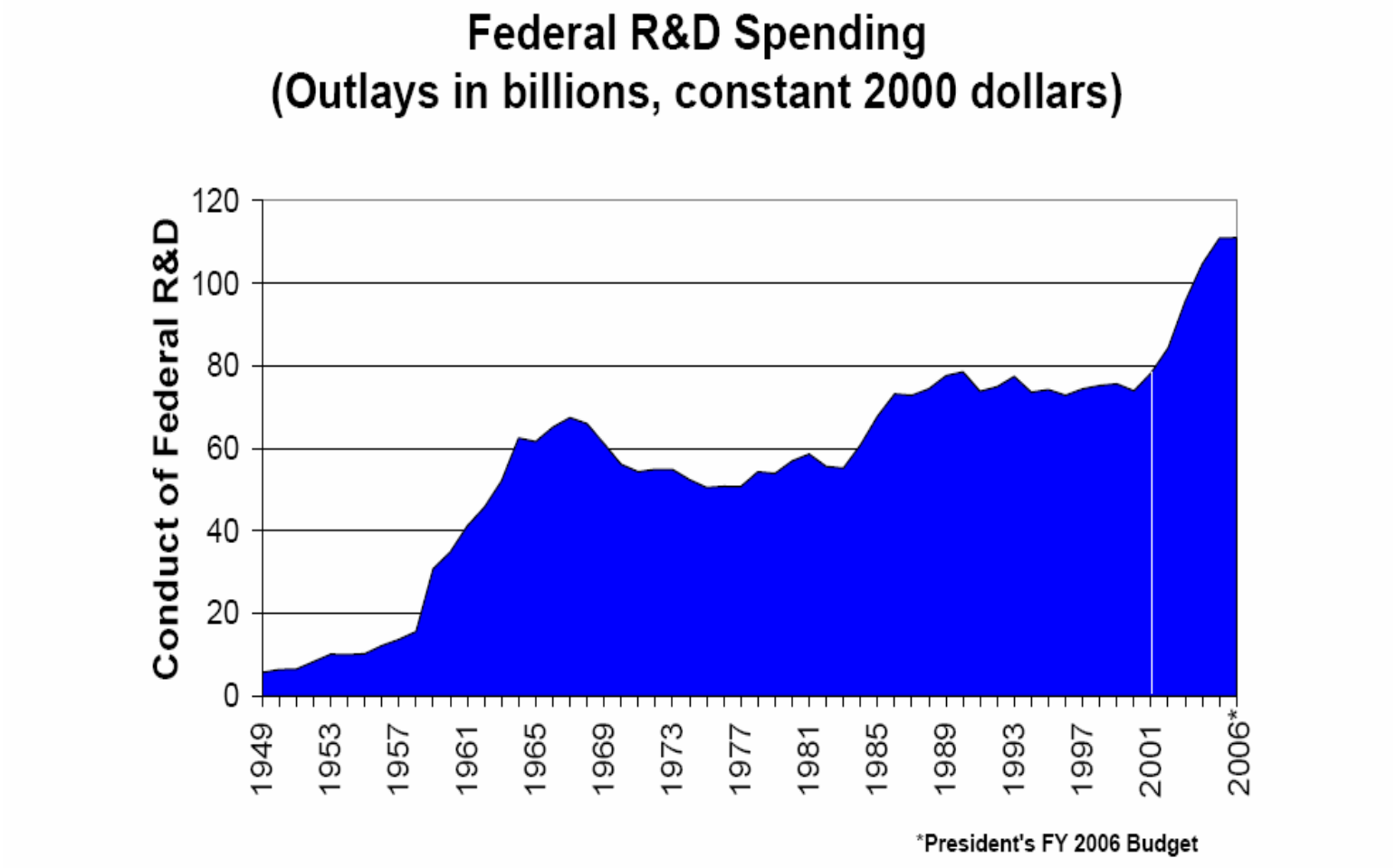
A National Innovation Policy

- Supporting Innovation through R&D
- Manufacturing
- Stimulating Private Investment in R&D
- Protecting Intellectual Property
- Measurements and Standards

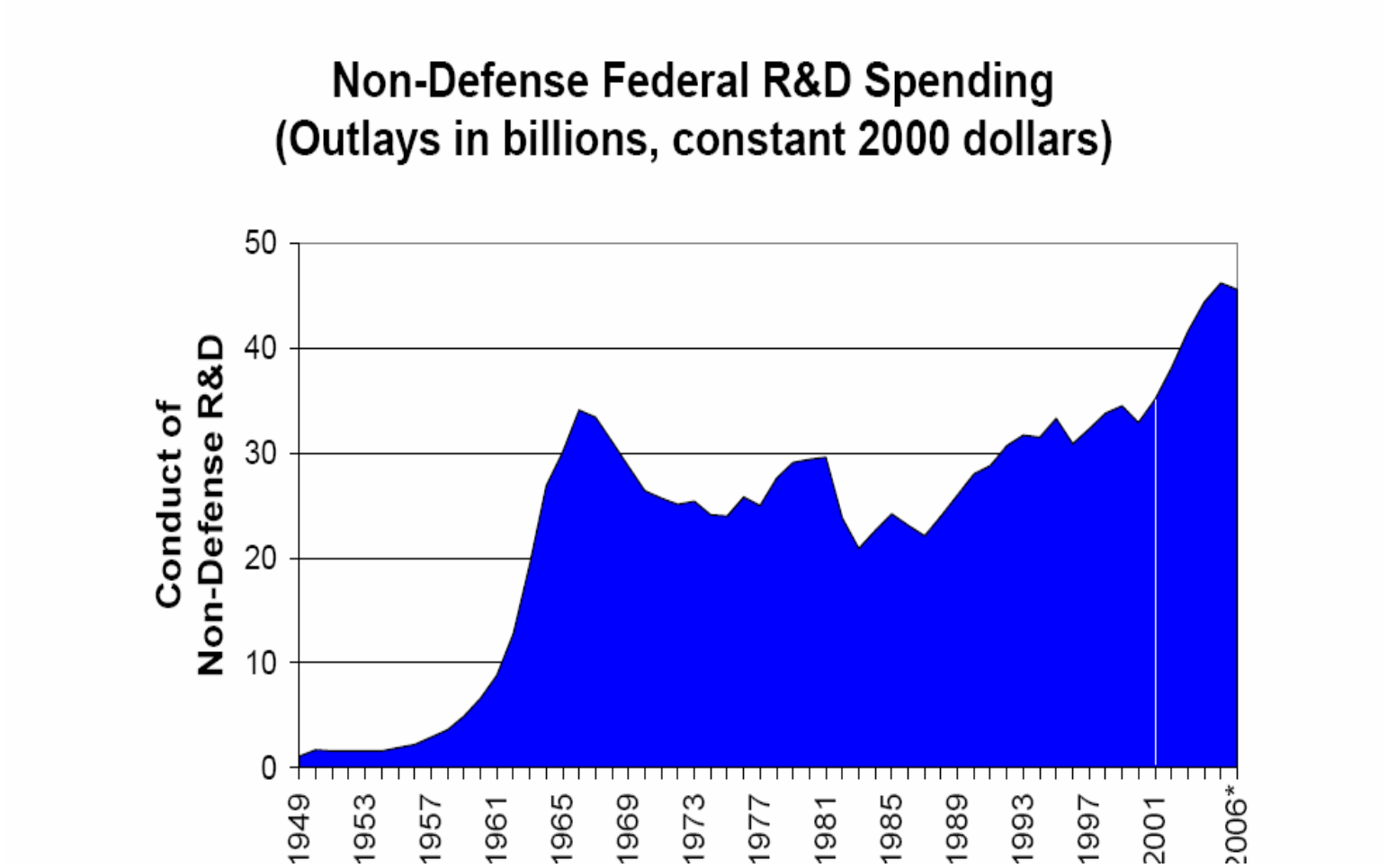
A National Innovation Policy

- **Supporting Innovation through R&D**
- Manufacturing
- Stimulating Private Investment in R&D
- Protecting Intellectual Property
- Measurements and Standards

Federal R&D Budget Increasing…
… even in a tough budget climate



Non-Defense R&D Down Slightly …
…but Still High by Historic Standards



A National Innovation Policy

- Supporting Innovation through R&D
- **Manufacturing**
- Stimulating Private Investment in R&D
- Protecting Intellectual Property
- Measurements and Standards

A National Innovation Policy

- Supporting Innovation through R&D
- Manufacturing
- **Stimulating Private Investment in R&D**
- Protecting Intellectual Property
- Measurements and Standards

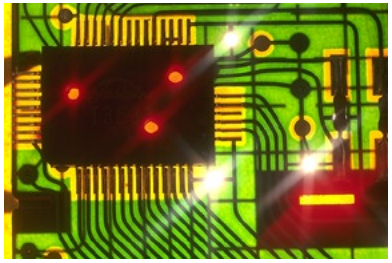
A National Innovation Policy

- Supporting Innovation through R&D
- Manufacturing
- Stimulating Private Investment in R&D
- **Protecting Intellectual Property**
- Measurements and Standards

A National Innovation Policy

- Supporting Innovation through R&D
- Manufacturing
- Stimulating Private Investment in R&D
- Protecting Intellectual Property
- **Measurements and Standards**

NIST – Cornerstone of U.S. Innovation Infrastructure



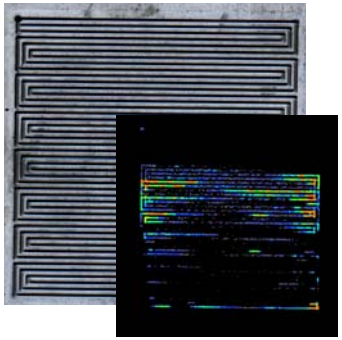
semiconductor electronics

“lean manufacturing” of plastics

automobile manufacturing interoperability

pharmaceuticals

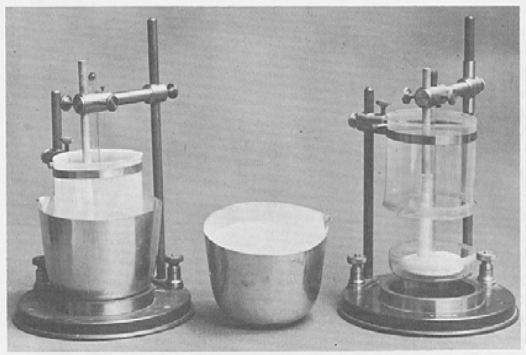
chemicals



fuel cell technology

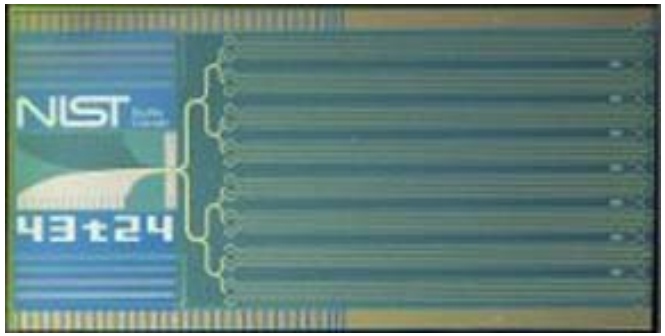
healthcare

Innovation in Measurement - *The Volt*

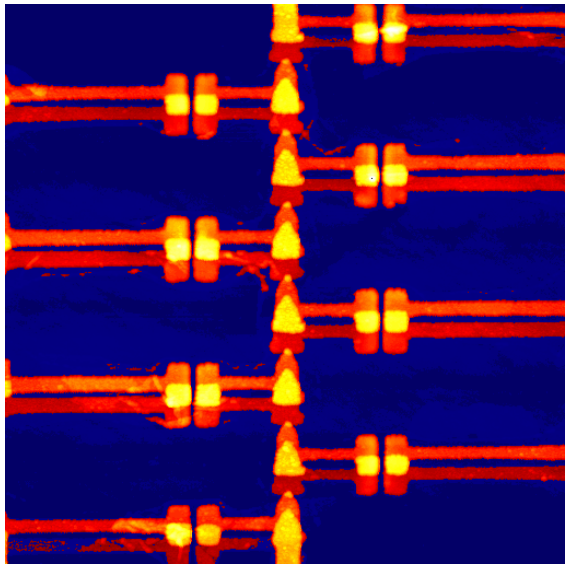


Silver Voltmeter Standard

10 V Josephson Voltage Standard



Single electron counter

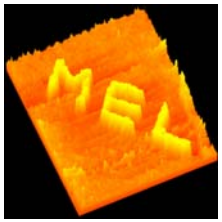


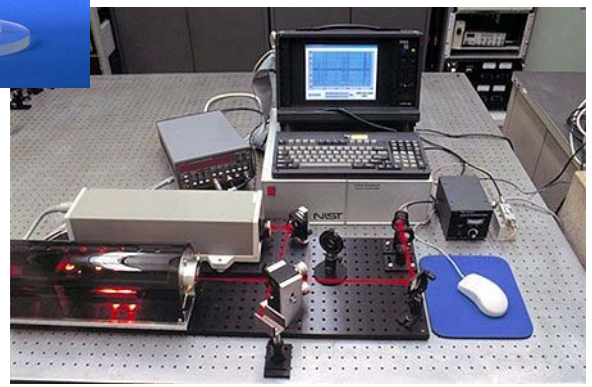
Innovation in Measurement - *The Meter*

1889 - Platinum iridium meter bar

1960 – Krypton-86 lamp

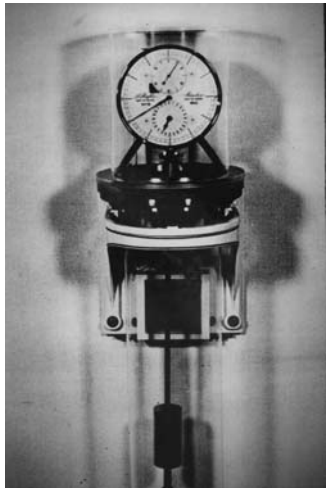
Atomic-scale Standards



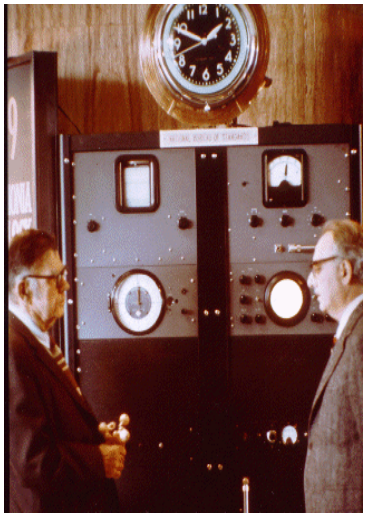


1983 – Iodine stabilized He-Ne laser

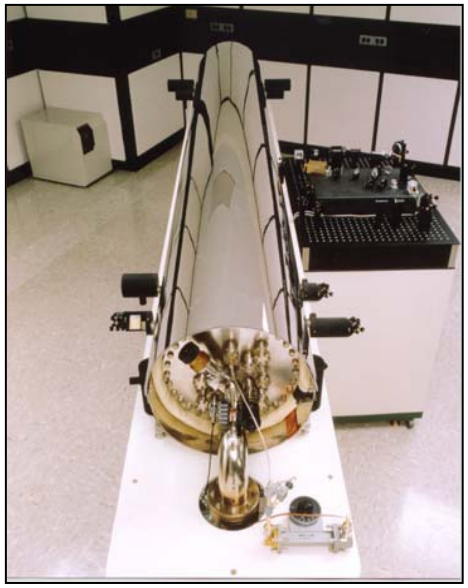
Innovation in Measurement - *The Second*



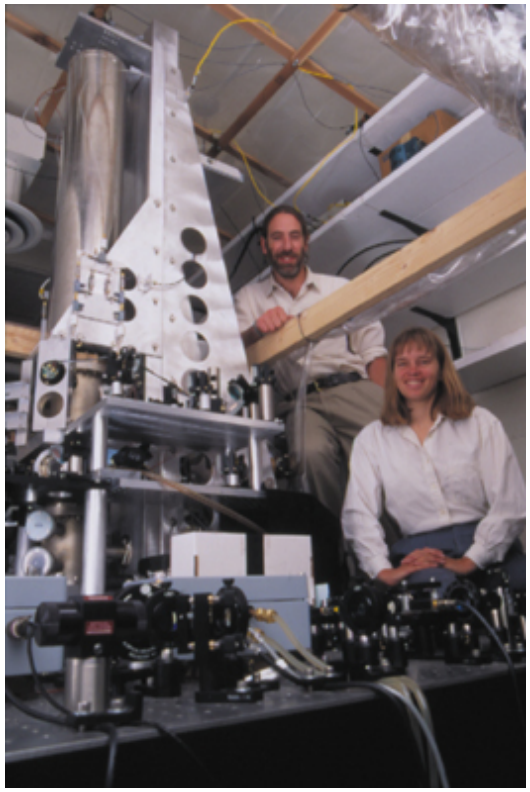
NBS Pendulum clock 1s in 3 years (1904)



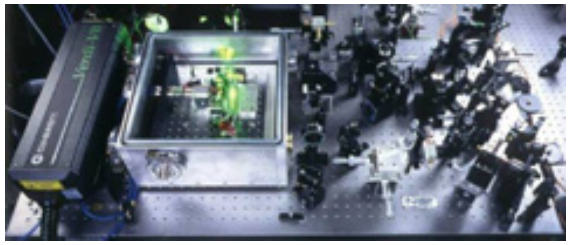
Ammonia resonator 1s in 300 years (1949)



NIST 7 1s in 6 million years (1993)

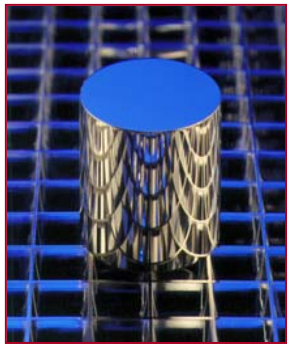


NIST F1 1s in 30 million years (1999)

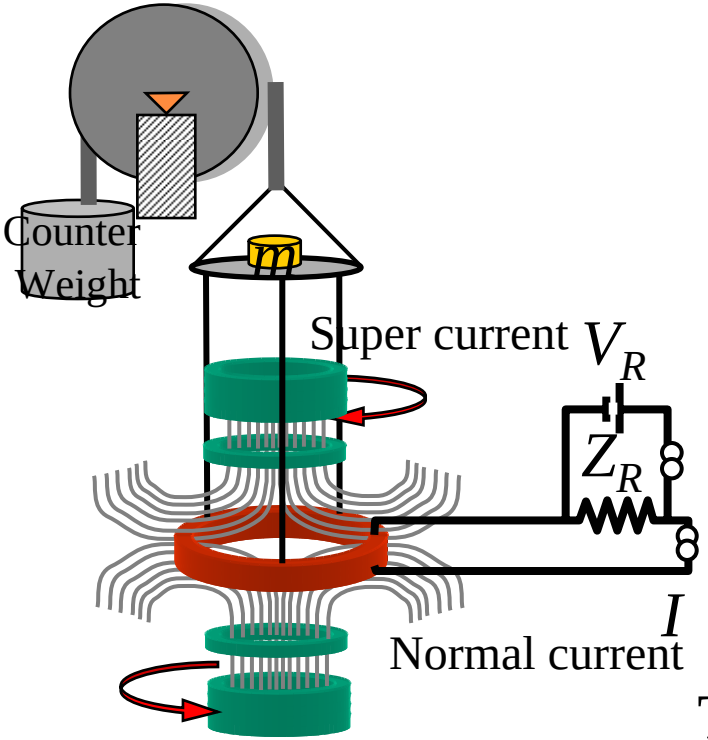


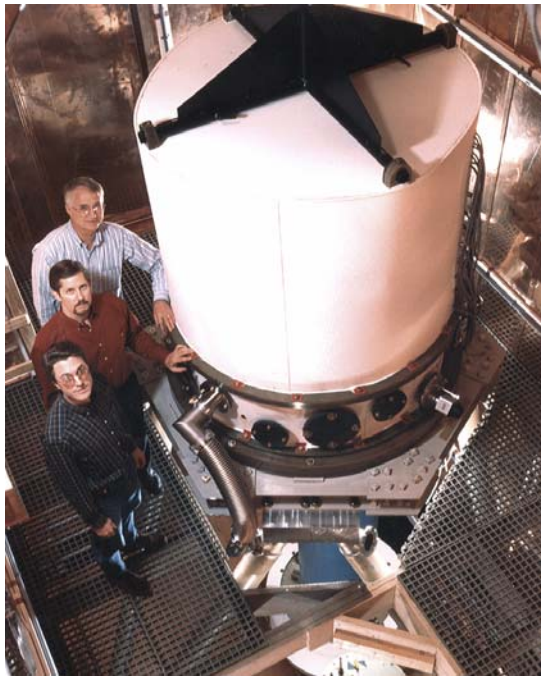
Optical clock: 1s in 30 billion years (?)

Innovation in Measurement - *The Kilo*



$$F = -\partial \Phi / \partial z \, I$$





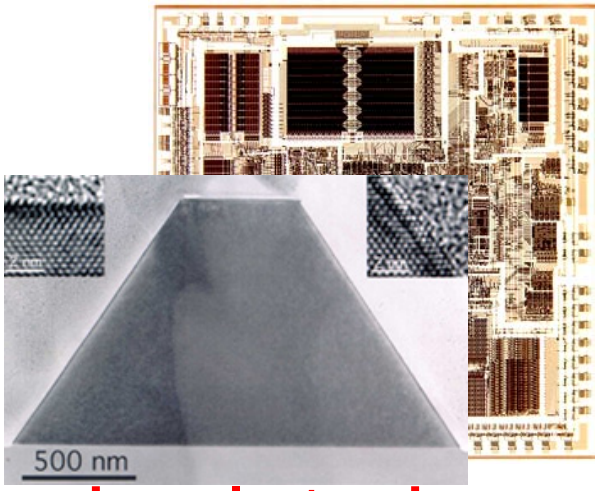
The Electronic Kilogram

NIST enables innovation in…

…electronics

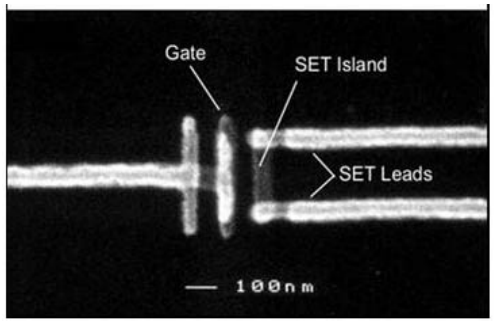
milli electronics
vacuum tubes & discrete transistors
1900 - 1960
copper, glass, barium, germanium

First neon signs



micro electronics
integrated circuits
1960 - 1990
silicon, aluminum

s*ingle crystal silicon critical dimension artifact*

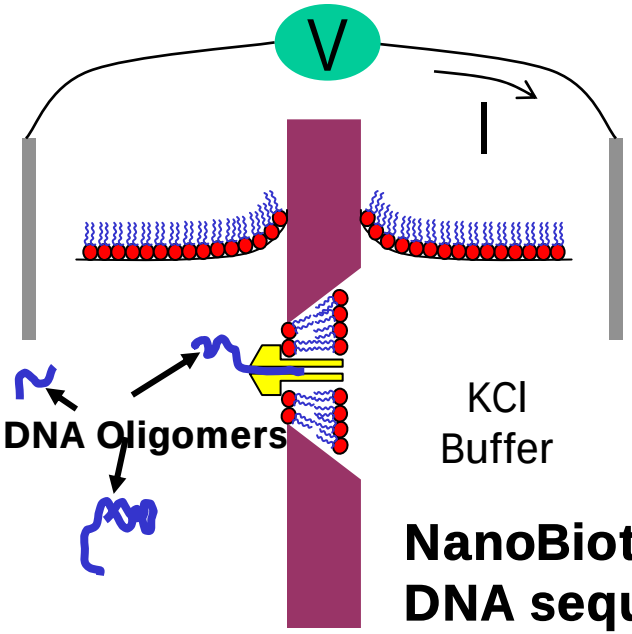


nano electronics
integrated circuits
1990 - 20xx
silicon, copper, exotic dielectrics, single molecules, …

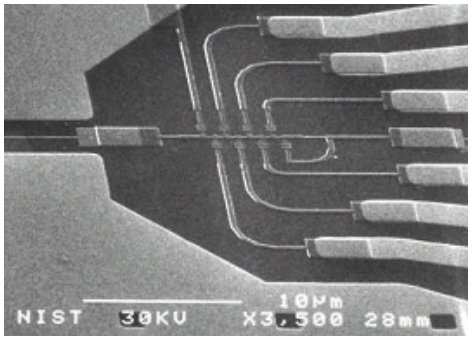
NIST *single electron tunneling device*

NIST enables innovation in…

…nanotechnology

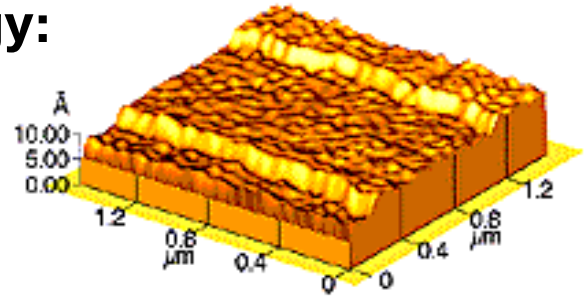


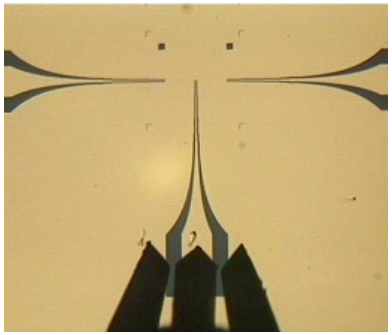
NanoBiotechnology: DNA sequencing through nanopores



NanoElectronics: manipulation of paired electrons

NanoMetrology: atomic scale dimensional standard





NanoMagnetics: precessional switching in spin valve devices

NIST enables innovation in…

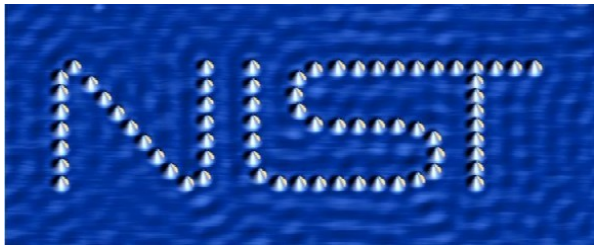
...manufacturing

1920

Experimental cotton mill

2004 **Simulation technology for manufacturing operations**

Testbeds



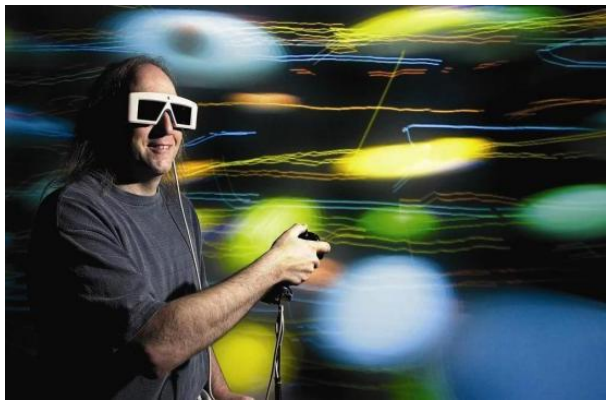
20xx

Automated and optimized assembly of single atom constructions

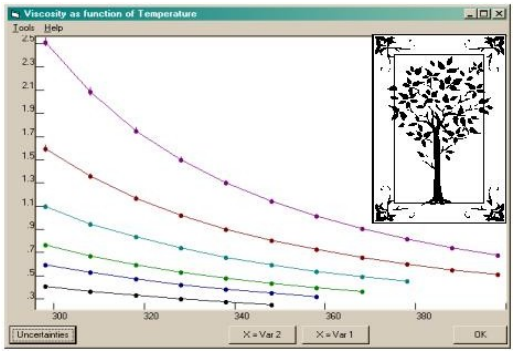
Interoperability and data exchange

NIST enables innovation in…

…information technology



immersive visualization



Guided Data Capture Software

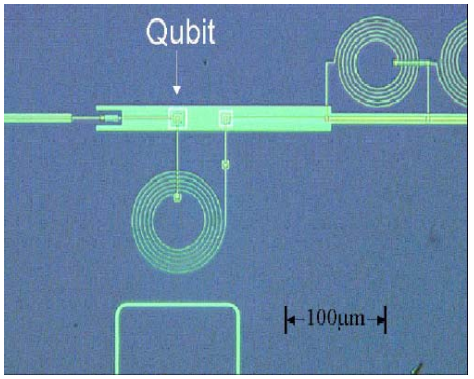
NIST Security Configuration CHECKLISTS http://checklists.nist.gov CSD

AES
A Crypto Algorithm for the Twenty-first Century . . .

"Working closely with industry"

128 bit key: *NIST@100NIST@100*

95285ac3f244a6ef4a466b03d7af1275
b8f8e0db1f14c9d33e72d598f12a14fc

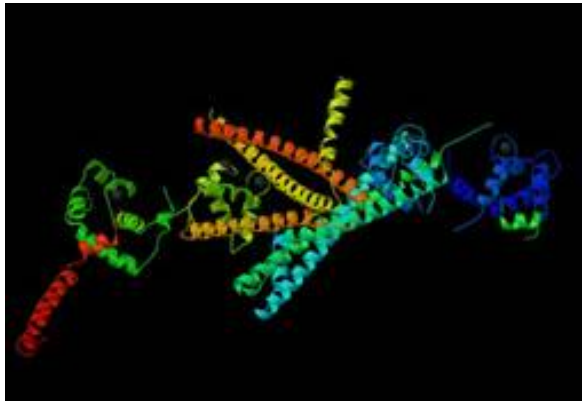


Quantum computing

NIST **Chemistry WebBook**

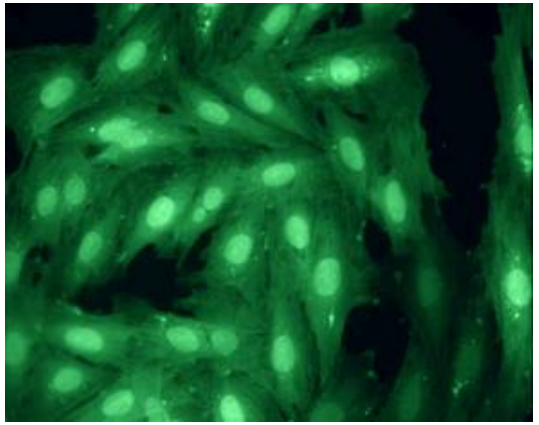
NIST enables innovation in…

…health science

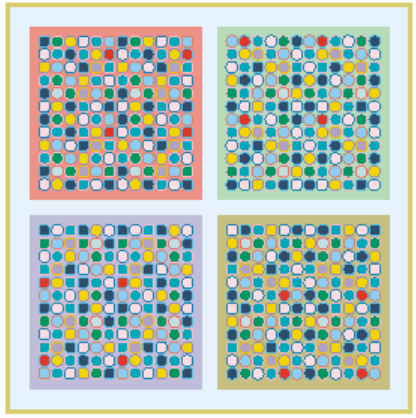


NIST Standard Reference Material 2921 helps diagnose heart attacks.

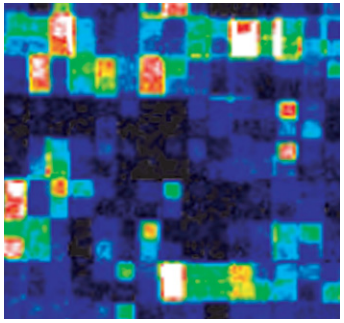
PDB
PROTEIN DATA BANK



Tissue Engineering: Quantitative microscopy verifies response of indicator cells.



Standards for microarrays promise to bring order to gene expression profiling.



Affymetrix's GeneChip microarray

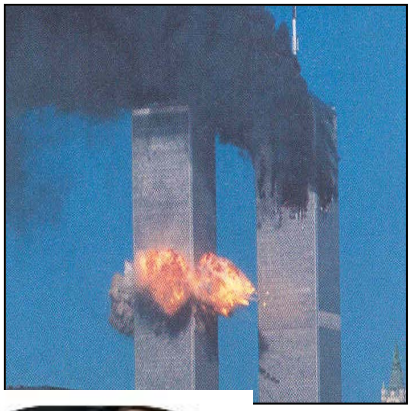
NIST enables innovation in…

…public safety and security

Measurements and standards infrastructure that ensures the accuracy, reliability, and security of systems critical to public safety and homeland security

Develop, compare, and test new technologies.
Enable safe and effective response to incidents.

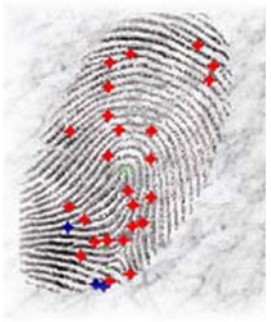
World Trade Center Investigation



mail irradiation

gas mask performance standards

biometrics



DNA standards

NIST enables the future...

by strengthening the innovation infrastructure to:

- **advance manufacturing and services**
- **facilitate trade**
- **enhance public safety & security**
- **improve quality of life**

...and create jobs

...through effective partnerships with industry, academia, and other government agencies.

The rest is up to you…

(…but we'll help!)