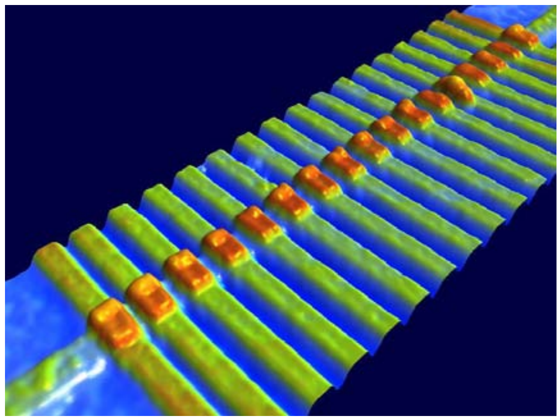
Written Testimony of Dr. Stanley Williams,
Hewlett-Packard Quantum Research Group
on behalf of
ASTRA, The Alliance for Science & Technology Research in America
Before the House Science & Technology Committee
Subcommittee on Technology and Innovation
February 15, 2007



An atomic force microscope image of a 'serial implication logic circuit'. Each switch in this circuit (orange) is about the size of the smallest known virus (i.e. ~25 nm). Image courtesy HP Labs.

Chairman Wu, Representative Gingrey and distinguished members of the House Subcommittee on Technology and Innovation; I thank you for this opportunity to testify before you today on behalf of ASTRA, the Alliance for Science and Technology Research in America. My name is Stan Williams, and I am a Hewlett-Packard Senior Fellow and the founding Director of H-P's Quantum Science Research Group in Palo Alto, California. Our laboratory was created in 1995 at the behest of David Packard to prepare HP for the major challenges and opportunities ahead in electronic device technology as feature sizes continue to shrink to the nanometer scale, where quantum mechanics dominates the behavior of matter.

I. Background

Benjamin Franklin has been called by many people the "first American." He was also the first American scientist of world renown. Franklin understood that science was not just a pastime to demonstrate wealth or satisfy curiosity, but rather a force that could generate wealth and be utilized for the public good. He performed careful experiments to characterize electrical phenomena: he was the first to understand the nature of electrical conduction and he utilized his knowledge to invent the lightning rod. Thus, Franklin created the distinctly American paradigm for technological innovation: If you measure something that has never been quantified before, you can discover something that has never been known before, which enables you to invent something that has never existed before. He was also prescient about the funding of research when he said "An investment in knowledge always pays the best interest."

Benjamin Franklin Tercentennary
$1 Commemorative Coin from U.S. Mint, 2006

Over a period of two centuries, technological innovation became the goose that laid the golden eggs for American society. Inventions such as the telephone, light bulb, radio, phonograph, vacuum tube, transistor, laser, and integrated circuit, among many others, have created huge industries that employ our citizens, improve our lives, and supply a large fraction of the tax dollars collected by the US government.

However, toward the end of the last century, we started to become complacent and neglectful. Our wonderful goose was slowly being starved, and the consequences of that were alarming indeed. This situation brought scientists like me to Washington in a new role – rather than trying to obtain a research grant, we had to learn to represent the entire scientific enterprise in the annual budgetary process so familiar to you but foreign to us.

ASTRA was founded in 2000 to work on behalf of, and provide a more effective voice for, industry, academe, and professional and trade associations involved in the technology enterprise. Our members, in turn, represent an underlying constituency of more than 2.4 million scientists and engineers in the United States. We have had the pleasure of working with many of you on bipartisan efforts over the years, and together we have accomplished a great deal. But as you know, this work is never done, and there have been a significant number of emergencies and distractions that have prevented us from reaching our goals.

We must succeed in revitalizing the math, physical science and engineering infrastructure of the United States. The cost of failure is too grim to contemplate. One necessary component of this revitalization is the doubling of the budgets of the National Science Foundation, the Department of Energy's Office of Basic Energy Sciences, Department of Defense 6.1 research and the National Institute of Standards and Technology, preferably on a five year time frame. We must do this before we lose an entire generation of American scientists and engineers and become completely reliant on other countries for our technology. I have appended several graphs to my presentation to illustrate the situtation we face today, especially in the context of global competition.

The primary focus of today's testimony is NIST. I gratefully acknowledge the extensive collaborations that HP in general, and my research group in particular, have enjoyed with NIST scientists over the years, and the crucial contributions they have made to American industry. ASTRA has paid special attention to NIST because of its unique role and strategic importance to our country's research "ecosystem."

II. NIST in Context

The mission of NIST is "To promote U.S. innovation and industrial competitiveness by advancing measurement science (or metrology), standards, and technology in ways that enhance economic security and improve our quality of life." As a government agency, it does so objectively, without favor or advantage to any preferred technology or enterprise. NIST has been described before this Committee — by representatives of both Republican and Democratic Administrations — as the "crown jewel of the federal laboratories," since it is recognized as the broadest and strongest national metrology institution in the world. Unfortunately, the essential role NIST plays in enabling the competitiveness of American industry has often been under-recognized. [1]

Among other activities, NIST develops and improves measurement technologies, supplies critical reference standards used across industries to calibrate their products and services, and provides verified and reliable technical data to the scientific community. NIST scientists act as a critical check on the often conflicting claims coming out of various research labs on the discovery of new phenomena. In our group at HP, we consider it to be the ultimate validation of our claims when NIST scientists reproduce our experimental results. We are eager to collaborate with NIST to ensure our measurements are as good as they can be. These activities are the keystone for technological innovation – before we can discover and invent today, we must measure with extraordinary precision and trust the results.

Metrology is also an essential enabler of standards, especially those standards that describe the properties and performance of products. A customer can make wise choices among competing products only when the specifications of those products are determined accurately, using the same or consistent methods. [2]

III. The Need for Additional [1]Resources and Avoiding Mission Creep

I would like, first of all, to compliment NIST on the extent of its efforts to understand and respond to the needs of its industrial constituency and on the quality of its oversight programs. These efforts start at the highest levels of NIST management, with the statutory (15 U.S.C. 278) NIST Visiting Committee on Advanced Technology (VCAT). VCAT members are high level executives and managers, two-thirds of whom must, by law, represent U.S. industry. They advise the NIST Director on broad policy issues and report their views to the Secretary of Commerce and Congress.

For more detailed advice, NIST contracts with the National Research Council (NRC) to review, annually and in depth, the technical direction of its individual scientific programs. The results of this review are reported to NIST staff at all levels, and are publicly available through the NRC. And as in many large organizations, each organizational unit of NIST develops its own strategic and tactical plans.

Recently there has been a noteworthy effort at NIST to structure its knowledge of industrial measurement needs. The first result was a special report issued last year called “An Assessment of the United States Measurement System: Addressing Measurement Barriers to Accelerate Innovation.” NIST should be commended for this proactive effort to understand measurement needs and to promote greater dialog with industry.

All this said, it is my observation that the scientific staff at NIST are now overwhelmed by the volume of work that they face. In the past, the number of new programs and responsibilities that have been added to the NIST portfolio has dramatically over-reached their funding increases. This mission creep has stretched the staff very thin, and has made their response time quite long. [3]

In some cases, it has taken several years to complete key measurements, which can make them ineffectual in an era in which a new technology can become obsolete in a single year. Some projects have taken so long they have not survived reorganizations or staff reassignments. In order to respond to new opportunities, NIST scientists often have to compete for grant funding from other government agencies, which creates even more demands on their time.

According to the NIST web site, in FY 2006, roughly 25% of the approximately $520 million NIST expended for Scientific and Technical Research and Services was from such contracts. While these activities can meet important governmental needs, they diminish the Institute’s flexibility in responding to the industrial priorities it identifies. Dependence on such short-term funding also diminishes the opportunity to plan long term programs of broader benefit.

Thus, ASTRA strongly recommends that all current NIST missions and programs, including the newly created NIST Center for Nanoscale Science and Technology, the Advanced Technology Program and the Hollings Manufacturing Extension Partnership (MEP) Program, should be adequately funded and supported by Congress and the Administration under the "doubling" initiative. These programs are sound investments with high potential returns for American taxpayers, and should be seen in the context of managing a vital portfolio of assets and talents for the country's economic and security needs. We must resist the temptation of adding any new programs in 2008 to justify the increase in funding until we know that current missions are adequately served.

IV. Construction and Facilities

I am pleased to note that $94 million of the NIST budget proposal for FY 2008 is devoted to "Construction and Research Facilities," roughly half for maintenance and repairs and the remainder for new construction. Most of the facilities on the NIST Gaithersburg campus date from the 1960's and all of the facilities on the Boulder campus date from the 1950's.

All too often, maintenance and repairs are deferred year after year in difficult budget times, leading to buildings and facilities that are obsolete. When most of the current buildings were dedicated, nobody anticipated the manipulation of matter atom-by-atom or metering of light photon-by-photon. Such research requires facilities with extreme mechanical and thermal stability. The proposed state-of-the-art facilities will enable NIST to meet these and other emerging industrial needs.

V. NIST Involvement with Industry Must be Maintained and Expanded

Something that makes NIST exceptional among Federal laboratories is the extent of involvement by NIST staff in industry activities and industrial researchers in NIST. Historically, NIST management has encouraged staff at all levels to participate in technical conferences and the activities of professional societies and trade associations, and through these activities to become well informed about industrial trends and measurement needs. Even more importantly, it empowers staff to act on what they learn, providing channels through which any professional staff member can propose and advocate new projects. This culture of gathering information and acting on it is effective, and it is essential that it be maintained.

An example of NIST collaboration with industry is its participation in the International Technology Roadmap for Semiconductors. The roadmap process brings together over 800 experts from around the world to identify technical barriers that would prevent continued advances in semiconductor technology. Almost three quarters of the roadmap participants are from industry, with the remainder from universities, research institutes and consortia, and from government. NIST cochairs and has 4 scientists on the Metrology technical working group, and also has experts on the Emerging Research Devices and Materials, Assembly and Packaging, Factory Integration, and RF for Wireless working groups. Through this interaction, NIST is very familiar with the industry's needs and can direct internal NIST metrology research to address these challenges. NIST should continue to host user facilities for both academic researchers and industry. Areas like the neutron facility for materials testing and the new nano metrology laboratory should be user friendly without a lot of bureaucratic interference.

VI. Future NIST Staffing and Workforce Development

NIST must attract and hire a continuous stream of world-class researchers in order to carry out its mission and to maintain its position as the premier metrology institute in the world. The three Nobel prizes awarded to NIST staff in the past ten years demonstrate the quality of the current staff, and have brought overdue recognition to NIST. However, the current climate at NIST is strained, with the technical staff having to work harder and longer to accomplish less. The budget doubling should be accomplished in a manner that the research support and infrastructure is improved to make the staff more flexible and productive, rather than erecting barriers and increasing red tape.

VII. Conclusion

In summary, ASTRA would like to see NIST maintain its world leadership in researching and understanding the infrastructure of emerging technologies. Increased funding and proper planning executed now will give our country vital resources that it will need to remain a major competitive force in the world economy.

The range of activities at NIST is quite broad and it should remain so. The example of nanotechnology is an ideal area to focus on because of the tremendous potential it has for the US to be very competitive in a new field and the extreme demands it places on metrology. However, we have to ensure that NIST can perform its current responsibilities before tacking on any more.

Finally, there will always be debate in the science and engineering community over the details of how NIST should best use additional resource. In any case, ASTRA recognizes the need for increased support at NIST and is pleased that Congress and the Administration have recognized the importance of metrology. And we fervently hope that Congress will be able to provide NIST with the funds requested as we embark upon this exciting journey.

NIST holds the key to American technological innovation and competitiveness – measurement is necessary discovery and invention.

I thank you for the opportunity to speak to you today on these important issues.

Footnotes

1. Example of How Advances in Metrology Boost U.S. Competitiveness

Example of How Advances in Metrology Boost U.S. Competitiveness

As conventional integrated electronics continue to shrink, our ability to continue to increase the performance of the circuits on each chip is on a collision course with the laws of physics. A good example of the importance of advances in the science of metrology is offered by the recent HP announcement of research that could lead to integrated circuits with eight times the logic density of current chips without having to shrink the transistors on the circuit. In a paper that I published with Greg Snider in the January 24 issue of ***Nanotechnology***, a publication of the British Institute of Physics, we documented how a nanoscale crossbar switch structure could be layered on top of a conventional layer of transistors to create significantly more capable field programmable gate arrays (FPGAs). A FPGA is a type of semiconductor chip that can be adapted by end-users for specific applications, and is used in a wide range of industries, including communications, automotive and consumer electronics.

To actually produce this chip in the lab, and then to introduce it into the commercial marketplace requires numerous measurements, including the width and alignment of the crossbars, the electrical characteristics of the connection between the crossbar and the conventional semiconductor device, and the presence of defects in the crossbar and substrate material. In our paper, we presented a chip model using 15-nanometer-wide crossbar wires which could be technologically viable by 2010, and a model based on 4.5-nanometer-wide crossbar wires, which could be ready by 2020. To shrink the crossbars and connect them to the semiconductor devices will require improvements in the accuracy of all of the required measurements. NIST metrology research is absolutely essential if we are to continue to improve our electronic circuits at the traditional rates that have made America the leader in this technology.

2. Semiconductor Industry of Association Written Testimony for this Hearing

Written testimony submitted to this hearing by the **Semiconductor Industry Association**, an ASTRA Founding Member, discusses other measurements needed to continue to increase the circuit density on each semiconductor chip, the productivity and competitiveness effects resulting from these advances, the industry-university-government collaboration through the Nanoelectronics Research Initiative to find a new technology to replace our current semiconductor logic switch, and NIST's role in keeping U.S. leadership in this area.

3. Concern About NIST Workforce Preparedness and New Missions

In my capacity representing ASTRA (and not H-P), I would like to express concern about NIST moving into fields in which they have no history or prior expertise (e.g. climate science and geophysics), and which are arguably outside of NIST's mission in support of American industry. The fact that current NIST staff are stretched too thin might exacerbate the problem. NIST reliance on contract workers and guest researchers can be a two-edged sword. Such reliance may enable "scalability" for project needs, but also create an impermanence and *ad hoc* nature to NIST as an institution. Currently, contract worker and guest researcher numbers are almost as large as the permanent S&T staff.

According to public reports, NIST currently has a staff of about 2,800 — roughly half of whom are professionals in science and technology. In addition, about 1,200 guest researchers and contractors work at NIST. Though the guests and contractors are professionals who bring creativity and energy to the Institute, they are unable to participate in inherently governmental functions, such as measurement services performed for the public.

Neither can they participate in research under Cooperative R&D Agreements (CRADAs) with private sector collaborators, an important vehicle by which NIST research is transferred to industry.

In terms of our concern about "mission creep" all of which are laudable goals, ASTRA cites the agency's own Web Site which identifies 5 new initiatives which have been added to the Fiscal Year 2008 Budget Request as well as 12 Initiatives described in the FY 2007 Budget. They are:

Major components of the '08 budget request include five new initiatives in the following areas:

Enabling Nanotechnology from Discovery to Manufacture (+$6 million)

Measurements and Standards for the Climate Change Science Program (+$5 million)

Enabling Innovation Through Quantum Science (+$4 million)

Disaster Resilient Structures and Communities (+$4 million)

National Earthquake Hazards Reduction Program (+$3.25 million)

Plus continuation of 12 initiatives previously described in the FY 2007 budget:

Enabling Nanotechnology from Discovery to Manufacture

NIST Center for Neutron Research Expansion and Reliability Improvements: A National Need

Enabling the Hydrogen Economy

Manufacturing Innovation through Supply Chain Integration

Quantum Information Science: Infrastructure for 21st-Century Innovation

Structural Safety in Hurricanes, Fires, and Earthquakes

Synchrotron Measurement Science and Technology: Enabling Next Generation Materials Innovation

International Standards and Innovation: Opening Markets for American Workers and Exporters

Innovations in Measurement Science

Bioimaging: A 21st-Century Toolbox for Medical Technology

Cyber Security: Innovative Technologies for National Security

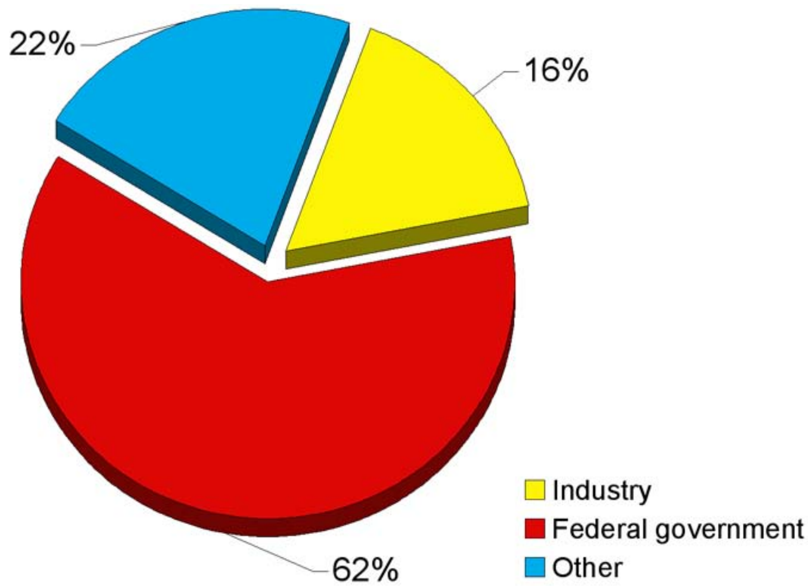
Biometrics: Identifying Friend or Foe

Facts About R&D Funding in the U.S.

Source: Unless otherwise indicated, all data in the following chart series is sourced to either the National Science Foundation's (NSF) *Science & Engineering Indicators 2006* or ASTRA.

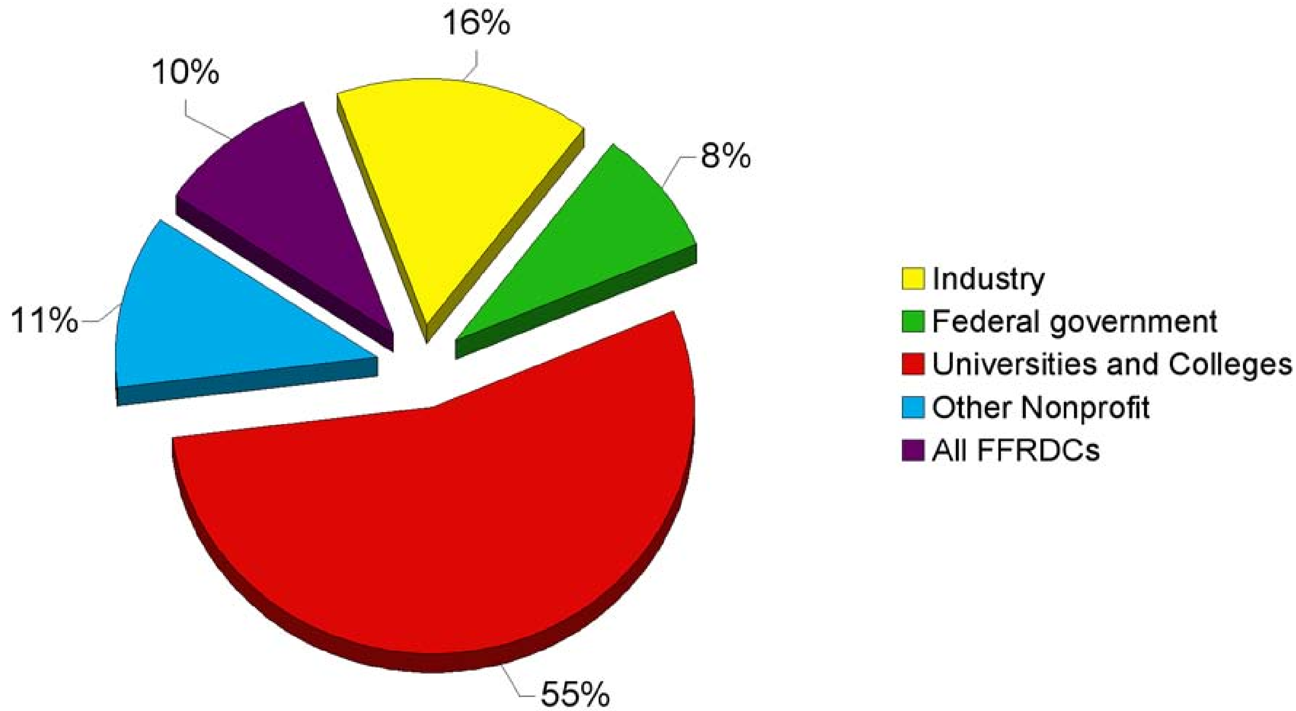
U.S. R&D Funding System Trend 1980-2005

The Federal share of total U.S. R&D has plateaued over the past generation, while industry share has increased. Most industry R&D is in applied research, not basic or "frontier" research. For 2003, the Federal share of basic research was approximately 62% of total funding. With the exception of the pharmaceutical sector, Wall Street and the investment community overall provide Industry little incentive to perform frontier research. Institutional investors tend to focus on short-term profitability and quick shareholder "return of value."



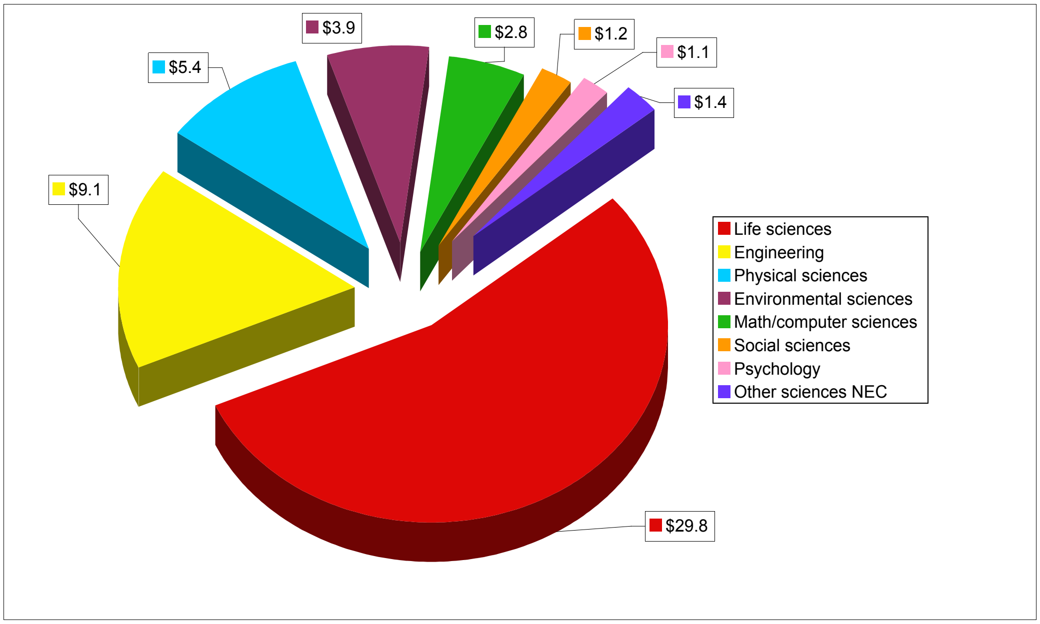
Who performs Federal R&D in the U.S.?

The bulk of Federal R&D funds go to universities and colleges — about 55%. Industry share is only 16%. This is one reason that the capability of universities to provide access to intellectual property discovered in the academic setting is a critical topic. Congress is expected to hold hearings during 2007 on the effectiveness of the *Bayh-Dole Act,* which governs many aspects of this strategic intersection of private and public scientific research funding.



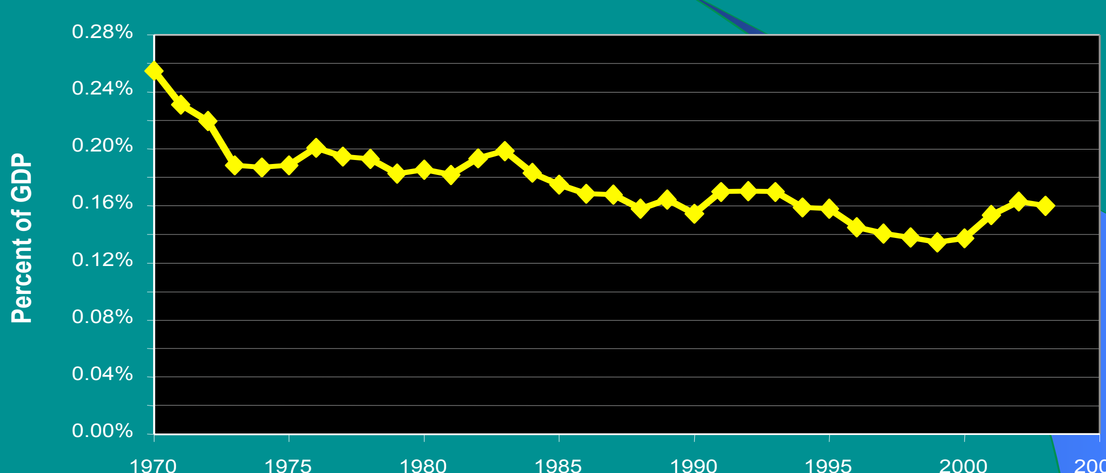
Facts About R&D Funding in the U.S.

Federal Obligations for Research by Agency and Major S&E Discipline: FY 2005 in Current Dollars (Billions)



	Total	HHS	DOE	DOD	NASA	NSF	USDA	DOC	Other
Life sciences	29.7	25.5	0.3	0.7	0.3	0.6	1.4	0.1	0.9
Engineering	9.1	0.3	2.0	3.0	2.4	0.7	0.1	0.2	0.6
Physical sciences	5.4	0.5	2.3	0.5	1.1	0.7	0.1	0.2	0.1
Environmental sciences	3.9	0.5	0.3	0.3	1.2	0.7	0.0	0.4	0.5
Math/computer sciences	2.8	0.1	0.9	0.8	0.1	0.8	0.0	0.1	0.0
Social sciences	1.2	1.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
Psychology	1.1	0.3	0.0	0.0	0.0	0.1	0.2	0.0	0.4
Other sciences NEC	1.4	0.6	0.0	0.3	0.2	0.2	0.0	0.0	0.1

Ratio of Federal Funding for Physical, Mathematical & Engineering Sciences as % of GDP



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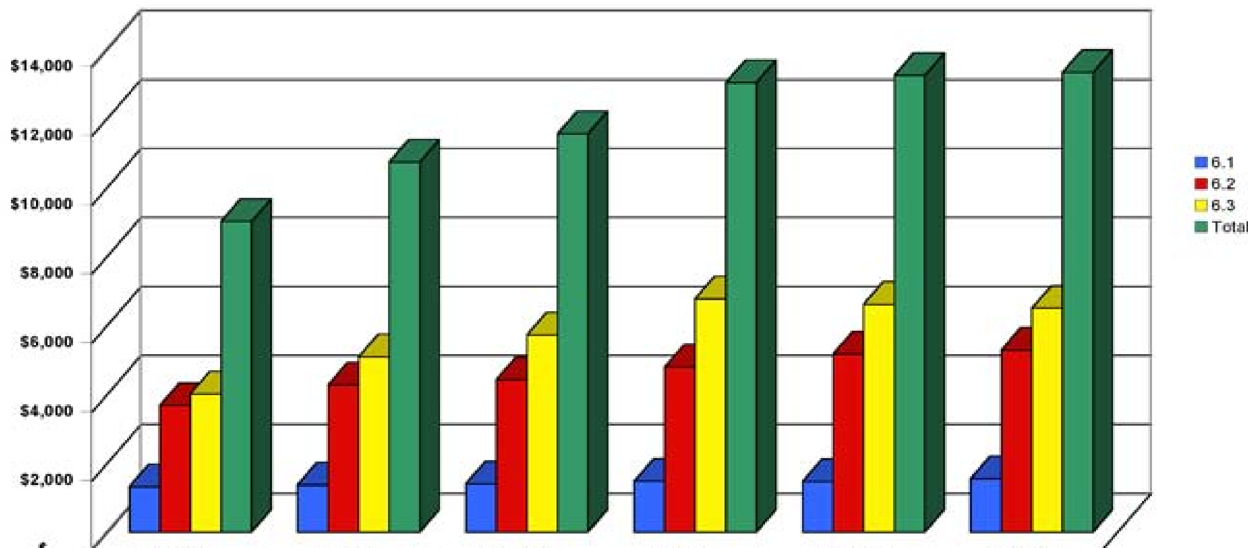
Budget Focus: DOD R&D Trends 2002 - 2007

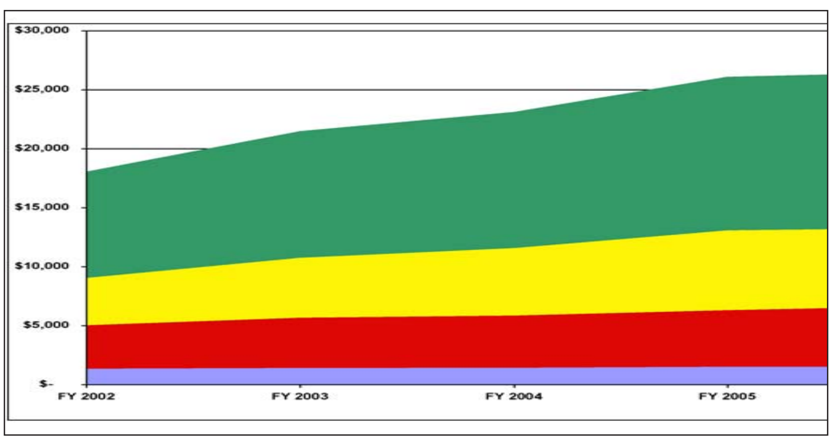
With final passage of FY 2007 Department of Defense (DOD) funding legislation in late September 2006, ASTRA has created a five-year trend chart. It characterizes DOD's R&D spending by the type of research being performed. DOD Basic Research (so-called "6.1" research) continues to languish. Long term under-funding of 6.1 research is a source of concern within the S&T community because of the disproportionate role DOD funding plays in engineering and physical sciences basic research ...

Department of Defense Science & Technology 6.1 — 6.3 Research & Development Expenditures FY 2002 - 2007*



	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007*
6.1	$1,317	$1,369	$1,403	$1,484	$1,470	$1,552
6.2	$3,676	$4,269	$4,424	$4,788	$5,168	$5,282
6.3	$4,015	$5,091	$5,721	$6,768	$6,603	$6,494
Total	$9,008	$10,729	$11,548	$13,040	$13,241	$13,329

Overview of 6-year Trend



Notes:

* FY 2007 data includes final Congressional appropriations for FY 2007.

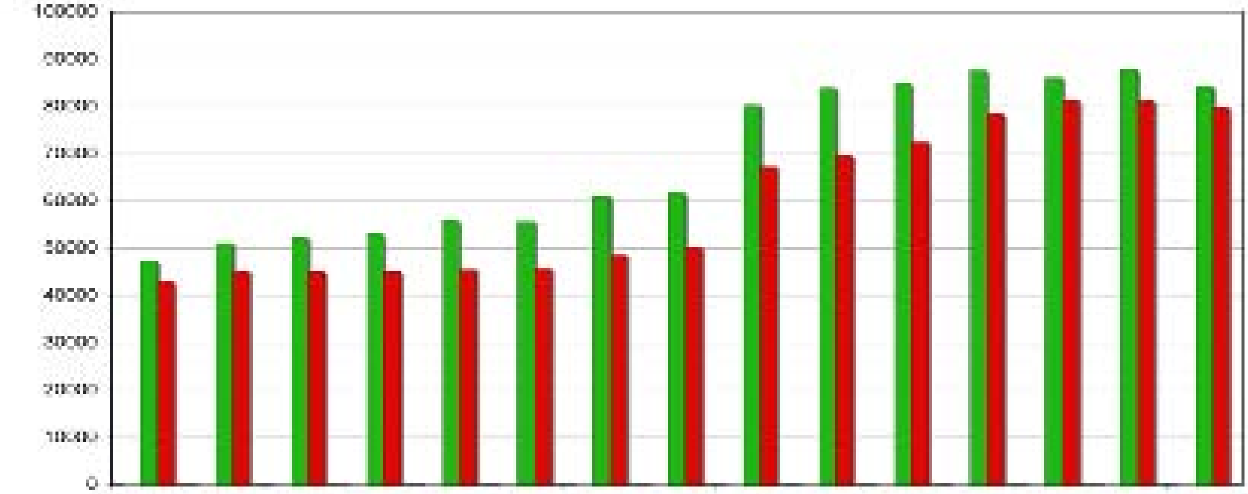
Medical Research Programs are not included in "6.2" Programs.

Source: U.S. Office of Management & Budget, Budget of the United States

Compiled by ASTRA, The Alliance for Science & Technology Research in America 2007 • www.aboutastra.org

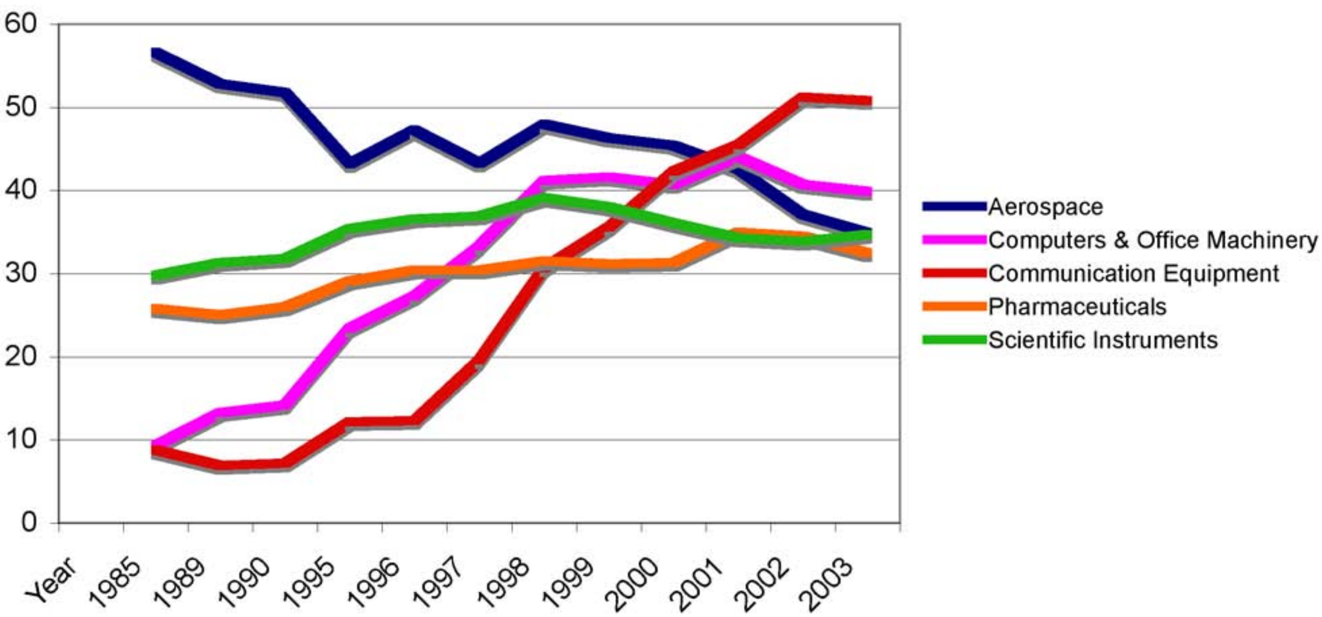
Consequences of R&D Funding in the U.S.

U.S. Patents and Intellectual Property Creation 1990 - 2004



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
U.S. Residents	47391	51177	52253	53231	56066	55739	61104	61705	80289	83906	85068	87601	86072	87901	84271
Foreigners	42974	45331	45191	45111	45610	45719	48541	50276	67399	69580	72426	79436	81289	81125	80022

Global Trade: U.S. Share Of Selected High Tech Market Sectors 1985 - 2003



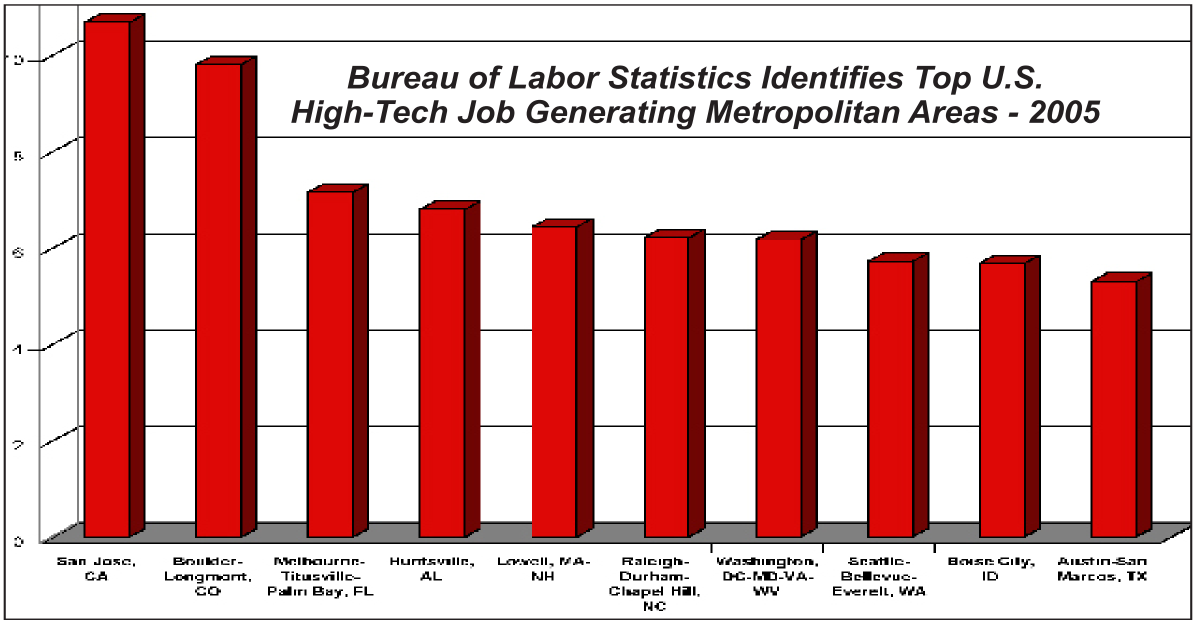
What is Happening to U.S. High Tech Exports? With the exception of communications equipment, export markets for key high tech sectors of the U.S. economy continue a decline begun in the late 1990's. **Global outsourcing** and **highly competitive foreign entities** may explain these trends, but **trade protectionism, currency manipulation, standards "gaming" by foreign governments and other non-tariff barriers to trade** are also thought to be causative factors ...

R&D Spending and R&D Gross State Product (GSP) Ratios by State 2003
Evidence of a Growing "Knowledge Divide" and Economic Gap

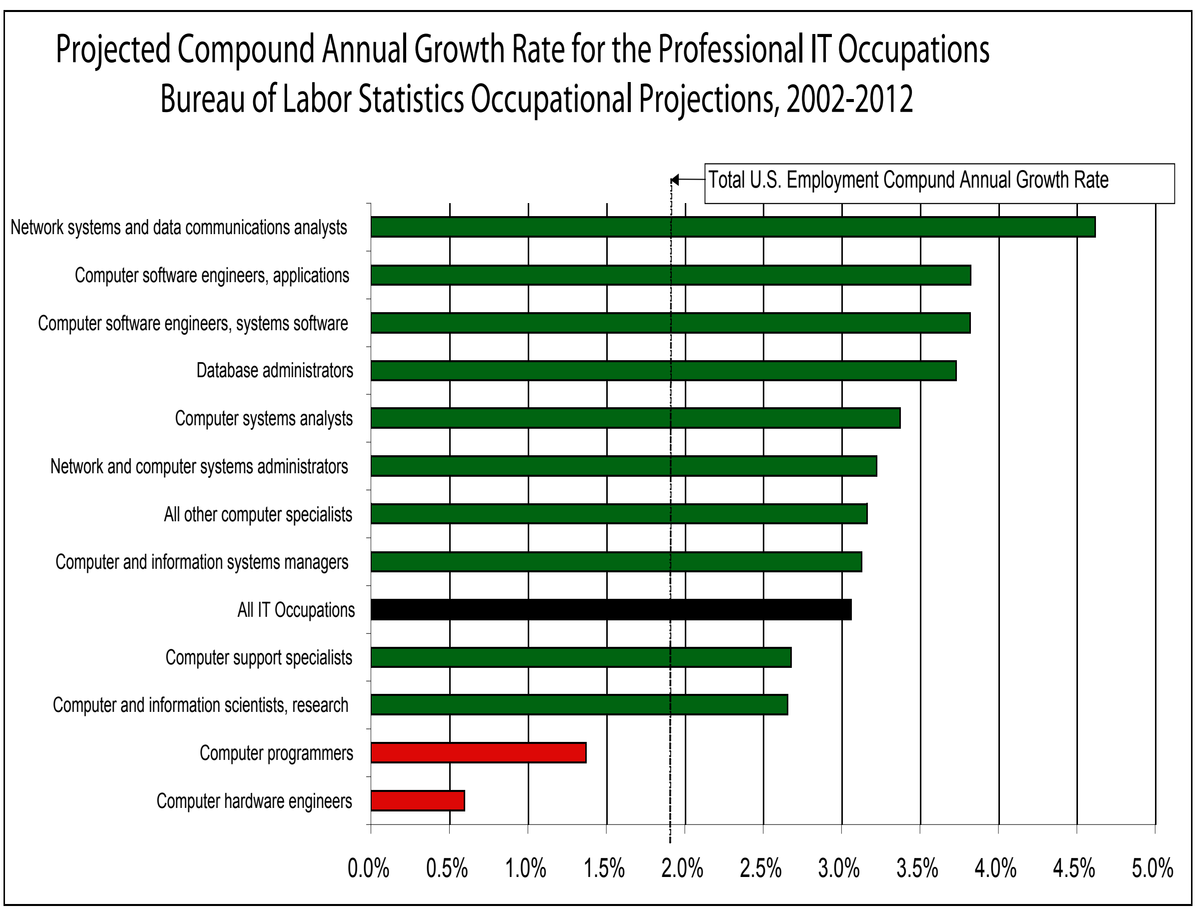
Only a handful of U.S. states benefit from the lion's share of technology-based development. What consequences will this have on future income distribution and economic opportunity for all Americans in an increasingly dynamic, competitive world market place?

State Rank	Name of State		R&D (current $ millions)	GSP (current $ millions)	R&D/GSP(%)
1	California		59,664	1,438,134	4.14
2	Michigan		16,884	359,440	4.69
3	Massachusetts		15,638	297,113	5.26
4	Texas		14,785	821,943	1.79
5	New York		13,031	838,035	1.55
6	New Jersey		12,795	394,040	3.24
7	Washington		11,469	245,143	4.67
8	Illinois		11,045	499,731	2.21
9	Maryland		10,162	213,073	4.76
10	Pennsylvania		9,944	443,709	2.24
11	Ohio		8,583	398,918	2.15
12	Virginia		7,582	304,116	2.49
13	Connecticut		6,548	174,085	3.76
14	North Carolina		6,343	315,456	2.01
15	Minnesota		5,842	210,184	2.77
16	Florida		5,172	553,709	0.93
17	Colorado		5,012	188,397	2.66
18	New Mexico		4,977	57,078	8.72
19	Indiana		4,487	213,342	2.10
20	Georgia		3,923	321,199	1.22
21	Wisconsin		3,642	198,096	1.83
22	Arizona		3,578	183,272	1.95
23	Oregon		3,572	119,973	2.97
24	Tennessee		2,998	203,071	1.47
25	Missouri		2,731	193,828	1.40
26	District of Columbia		2,686	70,668	3.80
27	Alabama		2,543	130,792	1.94
28	Kansas		2,024	93,263	2.17
29	Rhode Island		1,757	39,363	4.46
30	New Hampshire		1,664	48,202	3.45
31	South Carolina		1,616	127,963	1.26
32	Mississippi		1,519	71,872	2.11
33	Utah		1,506	76,674	1.96
34	Iowa		1,451	102,400	1.41
35	Delaware		1,414	50,486	2.80
36	Idaho		1,209	40,358	2.99
37	Kentucky		1,014	128,315	0.79
38	Oklahoma		968	101,168	0.95
39	Louisiana		954	144,321	0.66
40	Nebraska		710	65,399	1.08
41	Nevada		579	89,711	0.64
42	West Virginia		538	46,726	1.15
43	Arkansas		509	74,540	0.68
44	Vermont		492	20,544	2.39
45	Hawaii		438	46,671	0.93
46	North Dakota		382	21,597	1.76
47	Maine		372	40,829	0.91
48	Alaska		321	31,704	1.01
49	Montana		247	25,584	0.96
50	South Dakota		149	27,337	0.54
51	Wyoming		113	22,279	0.50

How R&D Funding Affects Local Economies and the Work Force



Bureau of Labor Statistics Occupation Projections 2002 - 2012



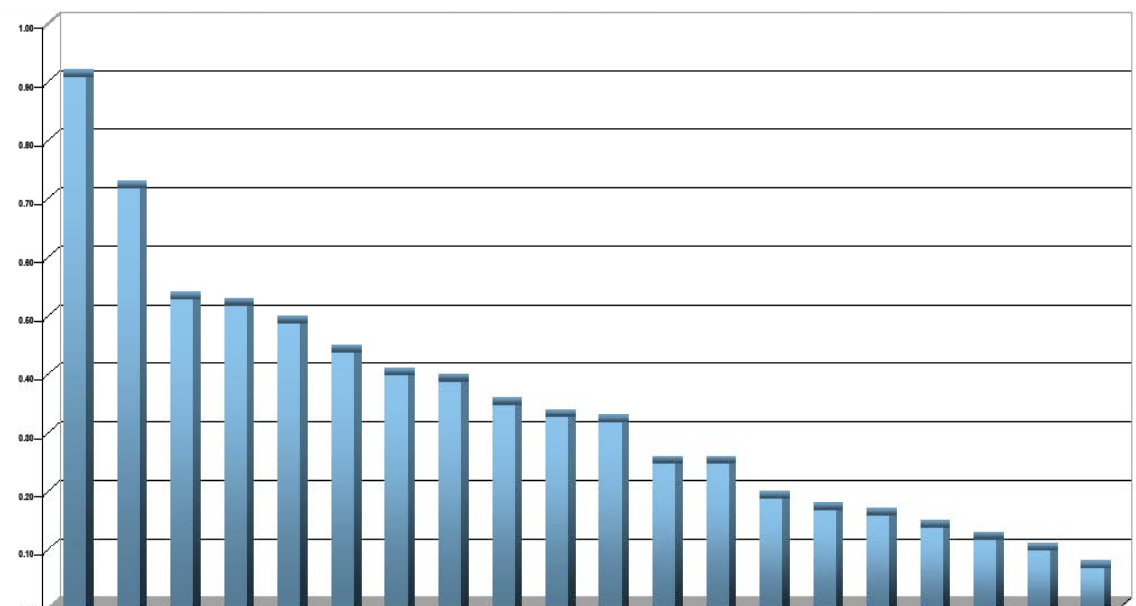
Why NIST Funding is Critical to Future U.S. Economic Health

Without expansion of NIST funding, U.S. industry and the innovation ecosystem which underpins U.S. competitiveness are at risk. ASTRA has compiled a variety of expert studies which link "technological progress" as a primary driver of economic growth. Without metrology leadership in promising new sciences, and the innovation occurring within existing cornerstone sectors of the U.S. economy, other players will command world markets and the advance of knowledge.

Experts: "Technological Progress" is the Primary Driver of Economic Growth.

Author (Year)	Time Period	% of Economic Growth Due to Capital	Labor	Tech. Progress
Abramovitz (1956)	1869-1953	22	33	48
Solow (1957)	1909-1949	21	24	51
Kendrick (1961)	1889-1953	21	34	44
Denison (1962)	1909-1929	26	32	33
	1929-1957	15	16	58
Denison (1967)	1950-1962	25	19	47
Kuznets (1971)	1950-1962	25	19	56
	1929-1957	8	14	78
	1889-1929	34	32	34
Jorgenson (1972)	1950-1962	40	8	51
Kendrick (1973)	1948-1966	21	24	56
Denison (1979)	1929-1976	15	26	50
Denison (1985)	1929-1982	19	26	46
Jorgenson (1987)	1948-1979	12	20	69

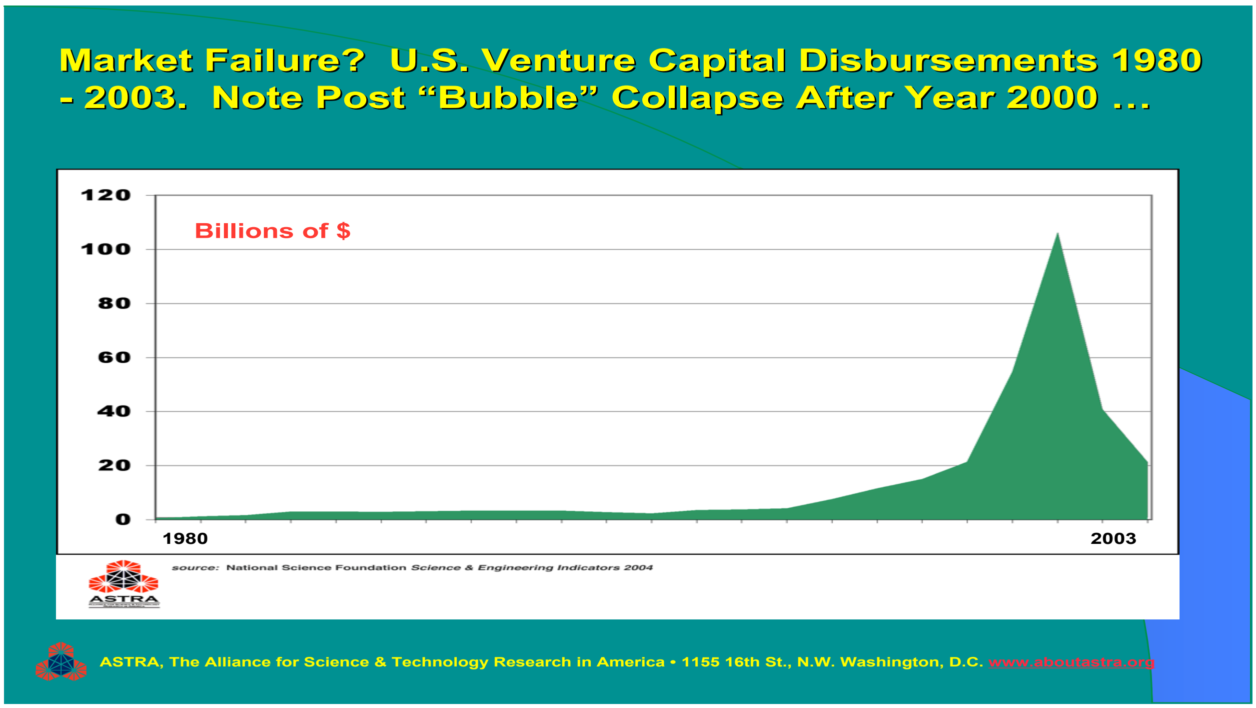
International Comparison of R&D Spending to GDP (latest year)

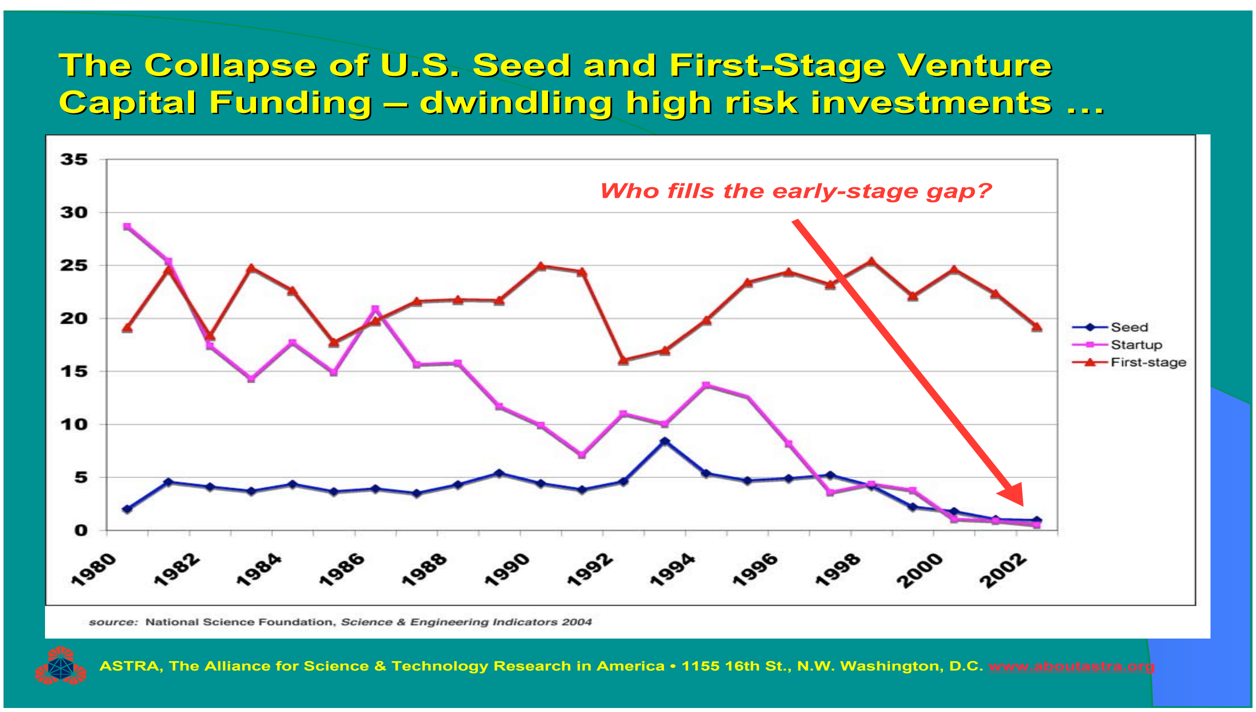


	Israel (2002)	Switzerland (2000)	France (2002)	New Zealand (2001)	United States (2002)	Denmark (2001)	Australia (2000)	Japan (2002)	South Korea (2002)	Singapore (2002)	Czech Republic (2002)	Taiwan (2002)	Hungary (2002)	Poland (2002)	Russian Federation (2002)	Spain (2002)	Ireland (2000)	Mexico (2001)	Argentina (2002)	China (2002)
Series1	0.91	0.72	0.63	0.62	0.49	0.44	0.40	0.39	0.35	0.33	0.32	0.25	0.25	0.19	0.17	0.16	0.14	0.12	0.10	0.07

Why NIST Funding is Critical to Future U.S. Economic Health

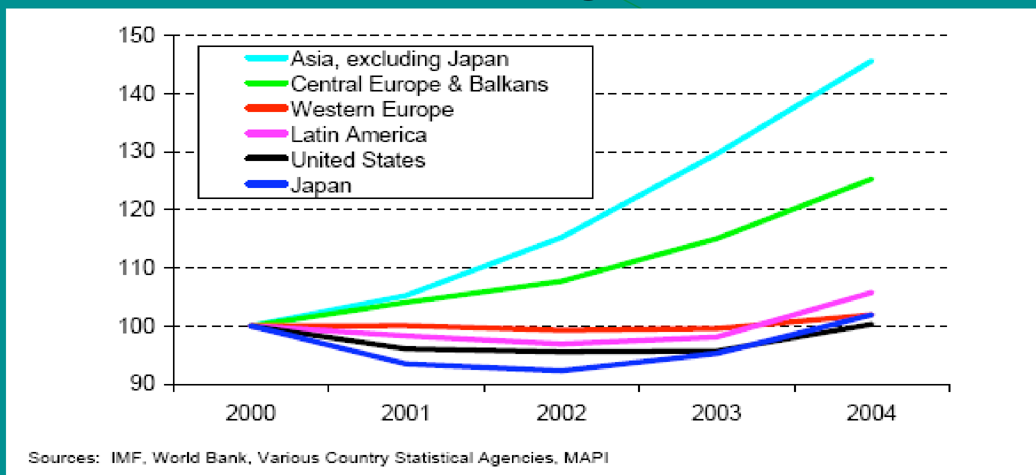
Market failure — in this case, the plight of U.S. venture capital after the Year 2000 bubble — puts the U.S. innovation ecosystem at severe risk. Global predation on U.S. intellectual accomplishments is a likely result of inadequate funding of such NIST activities as the **Advanced Technology Proegram (ATP)** and the **Hollings Manufacturing Extension Partnership Program (MEP)**. It may take years to discover what damage was done to U.S. economic interests while our entrepreneurial private sector languished following year 2000. Recent revival of the sector cannot re-capture lost opportunities ...





NIST Metrology is Essential to Advanced Manufacturing and World Competitiveness of New and Emerging Enterprises in the U.S.

Manufacturing Production by Region of the World: Index year 2000 = 100



Sources Compiled by Egils Milbergs, Center for Accelerating Innovation

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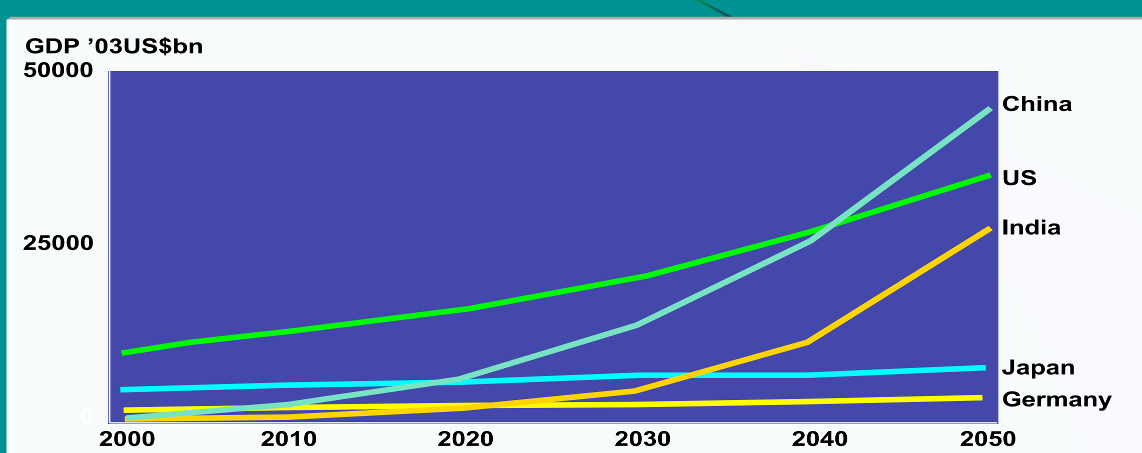
High Stakes Game: U.S. loss of world economic leadership is at stake with momentous consequences for the U.S. economy, national security and the well being of our citizens. NIST plays critical if unappreciated role in our future ...

GDP Race: U.S. Falls Behind China by 2040, India Closing in ...



Source: Goldman Sachs, Report 99 as compiled by Egils Milbergs, Center for Accelerating Innovation

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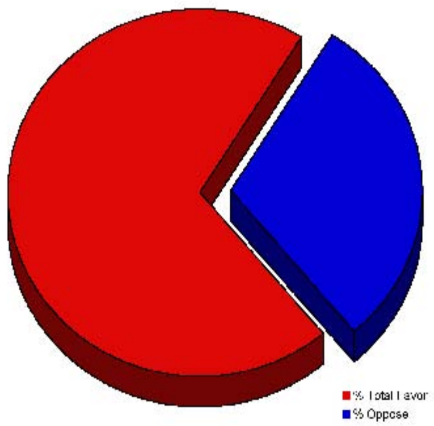
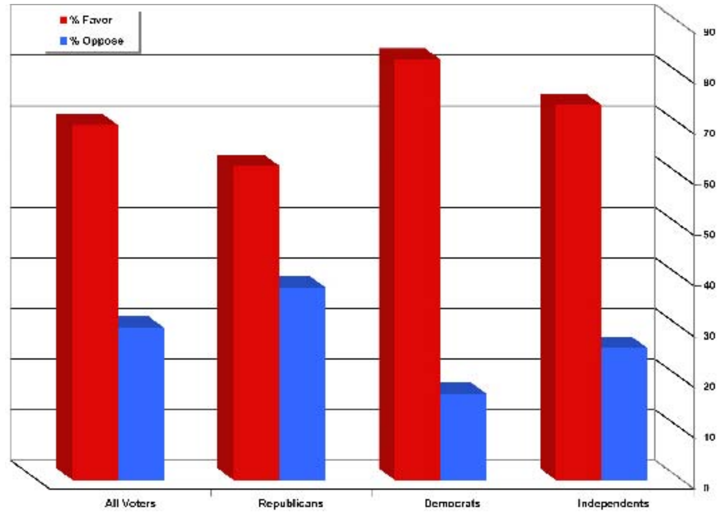
Who Supports NIST Doubling?

70% of all voters favor a "doubling" of Federal science spending ...





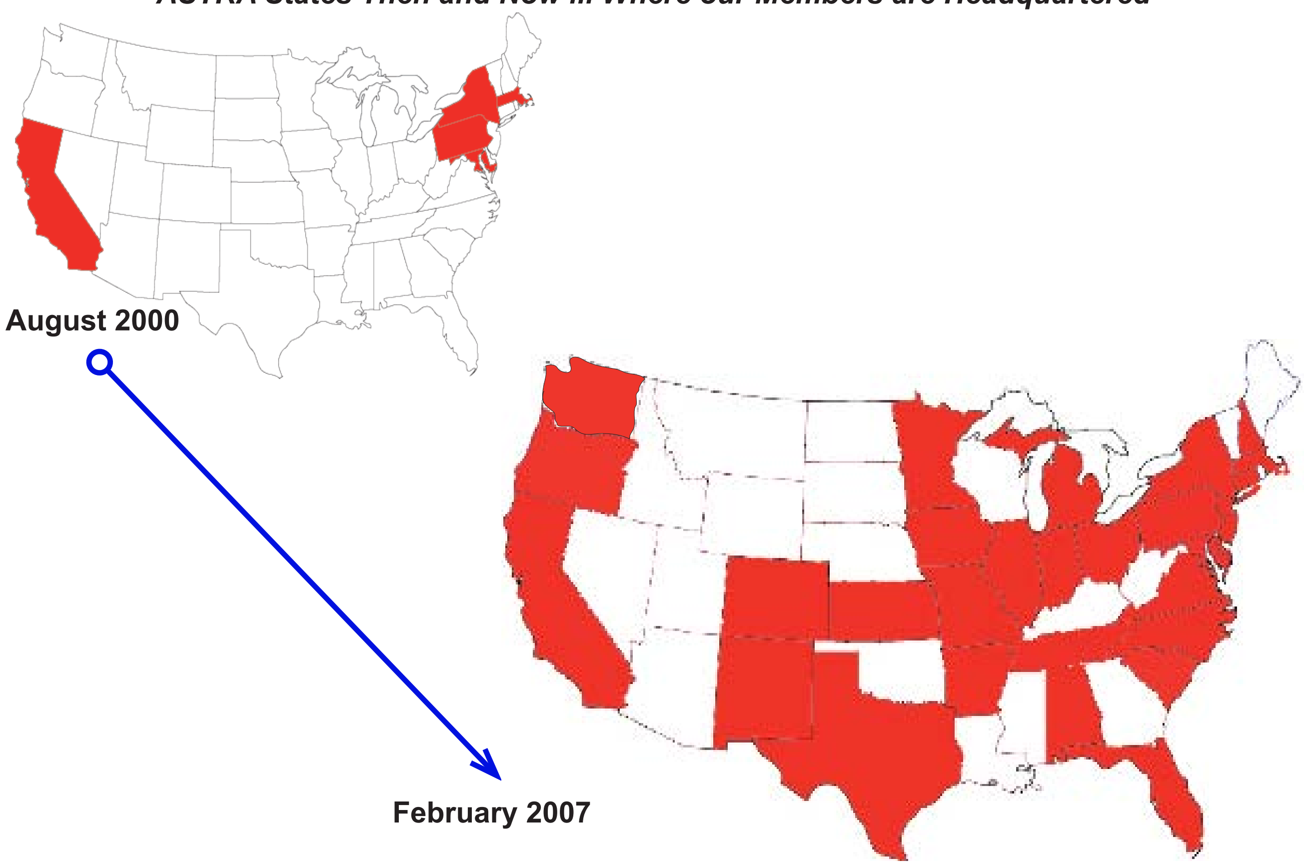
Who supports "Doubling?" By party affiliation, Republicans favor doubling by 62-30%, Democrats by 83-17%, and Independents by 74 - 26%.

A 2005 national survey conducted by Public Opinion Strategies for the ASTRA-supported **Task Force on the Future of American Innovation** found overwhelming support for increasing federal funding by ten percent a year for the next seven years for university research for all sciences and engineering. A Summary of the Survey, completed on November 17, 2005 shows:

1 - Voters increasingly think America's ability to compete economically in the world has gotten worse since 1991.

2 - There is overwhelming support for federal funding of scientific research at universities.

ASTRA States Then and Now ... Where our Members are Headquartered



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University of California, Santa Barbara
University of Central Florida
University of Florida
University of Illinois, Chicago
University of Illinois, Springfield
University of Illinois, Urbana-Champaign
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University of South Carolina
US Car

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American Association for the Advancement of Science
American Association of Engineering Societies
American Chemical Society
American Institute of Chemical Engineers
American Institute of Physics
American Physical Society
American Mathematical Society
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National Association of Manufacturers
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Rensselaer Polytechnic Institute
Sandia National Laboratories
The Science Coalition
Semiconductor Industry Association
The Minerals, Metals and Materials Society (TMS)
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