From the Laboratory to the Living Room

How the Results of Federally Funded R&D are Transferred to the Economy

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NetWorld+Interop Las Vegas 2003
Las Vegas, Nevada

May 1, 2003

The President's Top Priorities

- **Winning the War on Terrorism**
- **Securing the Homeland**
- **Strengthening the Economy**

Science and Technology:
Key Success Factors in Each

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America has a rich history of innovation and entrepreneurship that will be critical to achieving the goals of the Bush Administration. Those goals are:

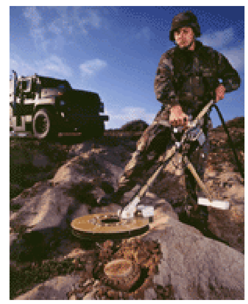
- Winning the war on terrorism
- Securing the homeland, and
- Strengthening the economy.

Clearly, science and technology are critical to accomplishing these goals, and President Bush is committed to supporting the research and development engine that will provide future technological solutions. In addition to conducting research and developing new technologies, the President's support for R&D helps transition those new ideas to the marketplace.

A few examples help illustrate the benefits of transferring R&D into marketable products.

Technology Transfer Impacts Homeland & National Security

- **Technology**: Detects explosives using Nuclear Quadupole Resonance (Navy)
- **Quantum Magnetics' Products**:
  - Luggage Screening Systems
  - Mine Detectors



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Researchers at the Naval Research Laboratory have developed a method based on Nuclear Quadrupole Resonance (or NQR) for detection of explosives. Quantum Magnetics has licensed the technology and is manufacturing luggage screening systems for use in airports. In addition, the company is manufacturing mine detectors for use in both military and humanitarian applications. The technology originally developed for Navy applications is helping to fight the War on Terrorism on multiple fronts and is helping to secure the homeland.

The best known commercial product resulting from technology transfer is Gatorade.

Technology Transfer Impact on Economic Security

Gatorade:

- **Developer**: U. Florida in 60's
- **Protection**: Patent, trademark
- **Revenue:**
  - Trademark Licensing: $76M to date
  - Sales in 2000: $2.1 billion
- **Sports Drink Market Share**: 84%

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The Gatorade story has its origins on the hot and humid playing fields at University of Florida. In the mid-1960's, Dr. Dana Shires and Dr. Robert Cade created a drink that was intended to help the football team avoid dehydration. They called it Gatorade. Use of the drink correlated with a remarkable improvement on the field—especially during the second half of the Florida Gator's games. The drink was so valued by the team that state troopers "escorted" it to each game. Many attributed the team's first Orange Bowl victory in 1967 to its "secret weapon"--Gatorade. Not only did the University patent the invention, it also registered the trademark. So, although the patent expired years ago, the university continues to receive royalties from the manufacturer of Gatorade for the use of the name. Over the years, Gatorade has generated over $76 million for the University of Florida. Although many other sports drinks have followed, with $2.1 billion in sales in 2000, Gatorade holds an 84% share of the market. This university-derived invention has certainly had a positive impact on the economy.

So what is technology transfer and how does it occur?

One key to technology transfer is the sharing of knowledge. Forums such as *Networld+Interop* are an important for the exchange of information and ideas related to what one might call the "central nervous system" of any organization—the computer network. The schedule includes sessions on network management, data storage & access, security, and on future network capabilities. Through conferences such as this one, technology professionals such as yourselves learn about new developments in the field and interact with your colleagues from other organizations. This flow of knowledge is one example of technology transfer.

Although I will not discuss them in detail today, there are many paths by which technology is transferred, including:

(1) Publication of results in peer-reviewed journals;
(2) Hiring skilled employees, either fresh out of school or perhaps from another company;

(3) Attending and exhibiting at trade shows; and
(4) Sharing of information and open-source software via formal or informal Internet groups.

I'll focus today on one category of technology transfer—the transfer of technology resulting from federally funded research at universities and federal laboratories to the private sector for commercial use and public benefit.

The typical path for technology transfer is as follows:

Federal R&D funds are invested in research programs in fields ranging from agriculture to nanotechnology. In the course of performing research, innovation occurs and inventions are made. The owner of the invention may decide to obtain intellectual property, or IP, protection in the form of a patent, copyright or trademark. The laws pertaining to IP ownership have had a significant impact on the rate of technology transfer. Intellectual property is then licensed, prototyped and ultimately developed into a commercial product. The steps shown above the dashed line on this slide often are carried out within the university or federal laboratory. Upon transferring the technology to industry, the final development and commercialization takes place.

The first step along the technology transfer path is the investment in research. This is a key area of responsibility of the federal government – funding the kind of long-term fundamental research that industry, with understandable focus on the bottom line, simply cannot fund. The federal government's investment in research and development is large.

Pathway from Universities and Federal Laboratories to Market

Research Funding

↓

Research & Development (Innovation)

↓

Intellectual Property Protection
(patents, copyrights, trademarks)

↓

Prototyping & Product Development

↓

Commercialization & Marketing

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In fiscal year 2004 budget, the President has requested $123 billion of your money be directed toward support for research and development. This represents a 7% increase over the 2003 request.

How Much Federal Investment in R&D?

$123,000,000,000

Requested for 2004
by President Bush

A 7% increase over 2003
55% slated for universities, federal laboratories

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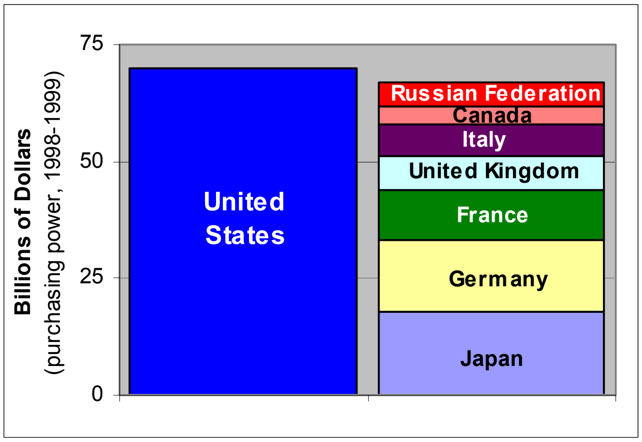
US R&D expenditures exceed those of all other G-8 nations combined.

U.S. Federal Government R&D Exceeds That of G-8 Combined



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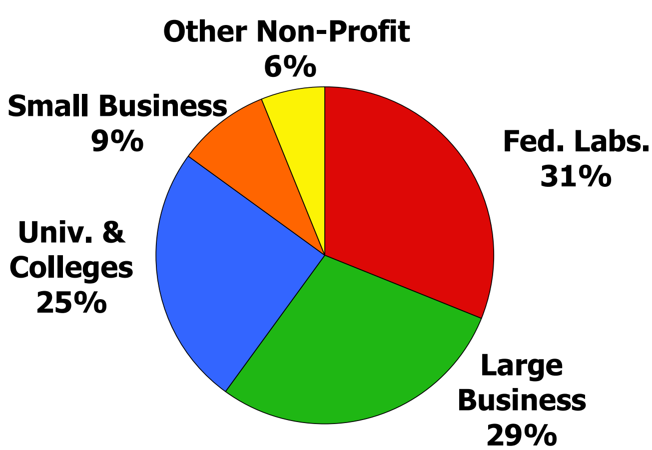
A significant fraction, approximately 55%, of those funds will go to research and development efforts at academic institutions (shown here in blue) and federal laboratories (shown in red), including those operated by the government, such as the National Institute of Standards and Technology, and those operated by contractors, such as Los Alamos National Laboratory.

How are Federal R&D $$ Spent?



Source: RAND, "Technology Transfer of Federally Funded R&D," 2003

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To understand and to appreciate the current technology transfer enterprise, it is interesting to look at its history. The concept of technology transfer is often attributed to a report written in 1945 for the President of the United States by Vannevar Bush, entitled, "Science—The Endless Frontier." Pointing to the success of the Manhattan Project, which depended substantially on the results of basic research at universities, the report emphasized the connection between federal support of basic research and industrial development of technology and the resulting economic benefits.

Vannevar Bush's insights came at the onset of a period of enormous economic growth. His report came at a time when the public not only accepted but also embraced new technologies. It stimulated the formation of organizations dedicated to providing support for basic research, including the National Science Foundation (or NSF) in 1950.

In the 1960's and 1970's, however, it became apparent that the policies regarding ownership of intellectual property created in the course of conducting federally funded R&D were not resulting in the successful transfer of technologies to the private sector for public benefit. Moreover, policies were inconsistent—varying from agency to agency.

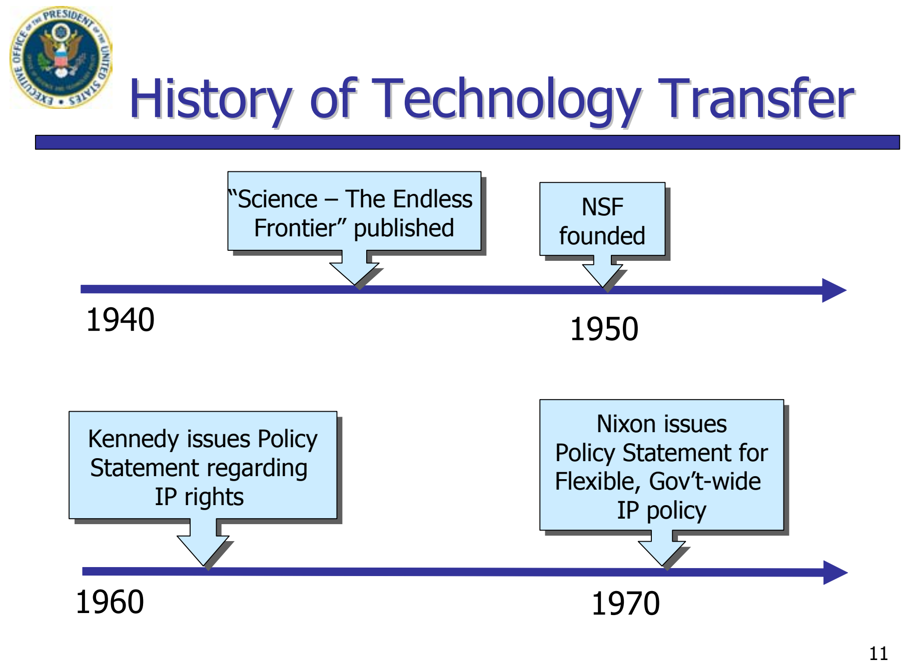
Recognition of the negative impact of current patent policies led President Kennedy to issue a Policy Statement in 1963, establishing Government-wide objectives and criteria for the allocation of rights to inventions made with federal support, which would best serve the overall public interest, yet would encourage their development and utilization.

In 1971, President Nixon issued a revised Statement of Government Patent Policy that further emphasized the need for a flexible, government-wide policy.

Although these efforts led to greater uniformity of patent policies among federal agencies, it did not substantially increase technology transfer.

By the late 1970s, the government held nearly 30,000 patents, yet fewer than 5% had been licensed to companies for commercial use and even fewer were represented in new or improved products or services available to the public.

With this backdrop, beginning in 1980, Congress passed a series of laws to promote partnering between industry and organizations performing federally funded research, including universities and other non-profit organizations, small and large businesses, and federal laboratories.



Perhaps the most familiar of these pieces of legislation is the *University and Small Business Patent Procedures Act of 1980*, more commonly known as the *Bayh-Dole Act*. The provisions of *Bayh-Dole* created a uniform patent policy, permitting universities and small businesses to take title to inventions created with federal funds. The interests of the government and the public were, however, protected. The government retains the right to use the inventions for government purposes. And, if the owner of the intellectual property—the university, non-profit or small business—does not make an effort to commercialize the invention, the government may "march in" and take back title. *Bayh-Dole* also applied to federally funded research laboratories that are operated by contractors, such as the Department of Energy's Lawrence Livermore National Laboratory.

Bayh-Dole did not apply, however, to inventions made by federal employees working at federally operated laboratories. After all, the ownership of federal workers' inventions was not in question. However, Congress wished to encourage the transition of those technologies developed by federal employees into commercial products as well. So, in 1980 (the same year it passed *Bayh-Dole*), Congress passed the *Technology Innovation Act*, also known as the *Stevenson-Wydler Act*. *Stevenson-Wydler* raised the bar by not only *allowing*, but also by *requiring*, federal agencies to take an active role in technology transfer. The *Act* made technology transfer a mission of every R&D agency.

1980 Stevenson-Wydler Act

The Act:

…mandates that federal agencies take active role in technology transfer.

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In 1986, with the passage of the *Federal Technology Transfer Ac of 1986t*, Congress added incentives to the mandates of Stevenson-Wydler. This *Act* allows the federal labs to keep all licensing royalties (which previously had gone to the Treasury's General Fund) and requires that at least 15% of all royalties be shared with the lab employee inventors. This act also enhanced access by private industry to expertise, personnel and facilities resident at government labs when it authorized the federally operated labs (and subsequently in 1989 extended authorization to the contractor-operated labs) to enter into Cooperative R&D Agreements (or CRADAs). Under a CRADA, researchers at a federal lab and at a company, or other non-federal government organization, perform collaborative research of mutual benefit.

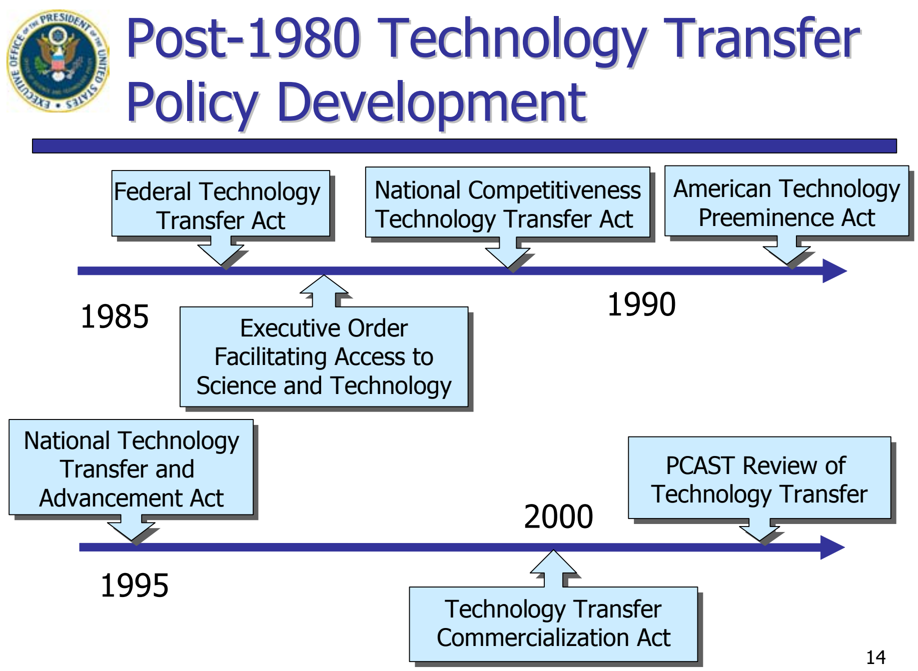
An Executive Order signed in 1987 by President Reagan extended *Bayh-Dole's* provisions to large businesses doing federally funded research and also addressed the circumstances whereby CRADAs and license agreements might be entered into between federal labs and foreign owned companies.

As recently as 2000, Congress passed the *Technology Transfer Commercialization Act*, which attempts to make the transfer of technology from federal labs more streamlined by allowing licensing of relevant background inventions under the terms of a CRADA and by reducing the period for which an agency must advertise its intent to grant an exclusive license from 60 to 15 days. The government's continuing interest in fostering technology transfer, as indicated by the many pieces of legislation enacted over the years, speaks to its ongoing importance.

So, in the two decades since the legislation was passed, have *Bayh-Dole* and *Stevenson-Wydler* affected the transfer of technology from universities and federal laboratories?

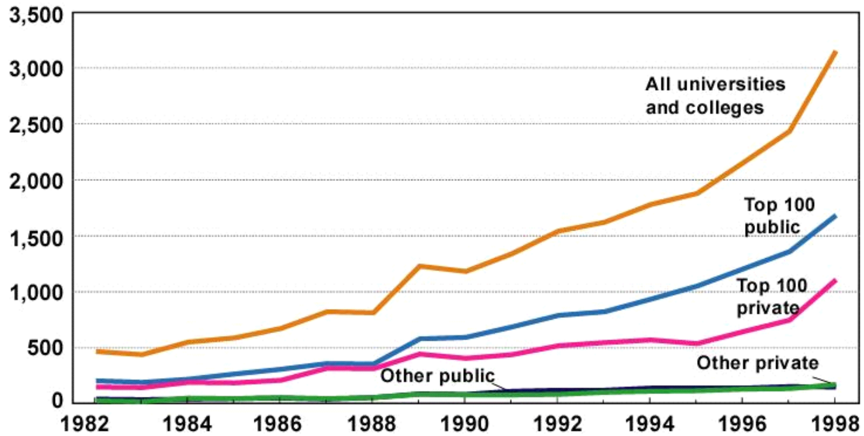
The impact at universities has been loud and clear. Technology transfer offices have been established at campuses across the Nation. Their common mission is to facilitate the transfer of inventions made at their respective universities to the private sector.

In accordance with *Bayh-Dole*, any financial gains made by the university are directed back to the research and educational programs at the institution.



The success of *Bayh-Dole* can be measured in various ways. An immediate effect is apparent in the patenting activity at U.S. universities. The number of patents issued to U.S. universities was approximately 250 per year before the passage of *Bayh-Dole*. As this graph from a National Science Board report shows, in 1998, roughly 3,200 patents were issued. More recently, the Association of University Technology Managers (or AUTM) reported that among the 142 U.S. universities that responded to their survey, just almost 3300 patents were issued. This correlates to an increase in the percentage of all U.S. patents issued to U.S. entities from 1% in 1980 to ~2.5% in each year since 1998. This increase is due to (1) greater numbers of universities filing for and being awarded patents, and (2) individual universities obtaining more patents.

Academic Patents Granted



Source: *Science & Engineering Indicators*, 2000

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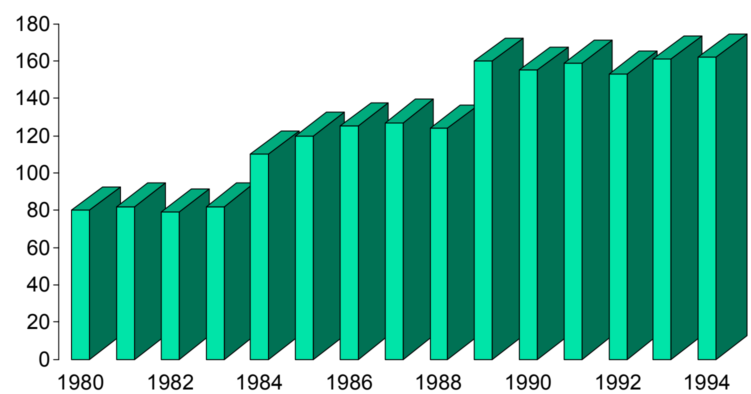
The number of academic institutions receiving patents doubled in the decade following the passage of *Bayh-Dole*. Clearly, more colleges and universities were choosing to participate in technology transfer activities.

Number of Academic Institutions Granted Patents (1980-1994)



Source: *Science & Engineering Indicators*, 1996 & 1998

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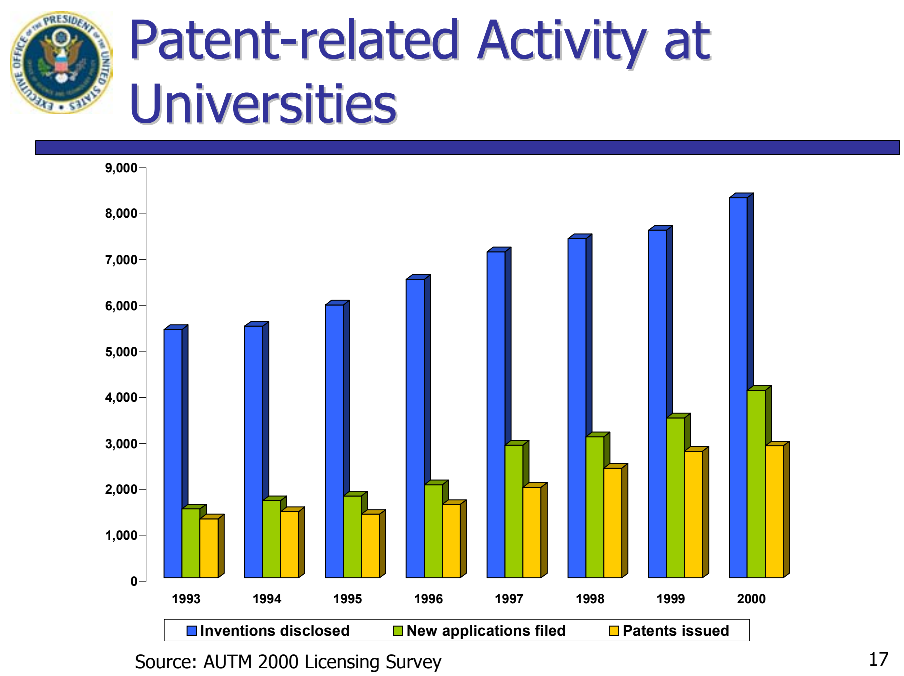
The same trend can be seen in a survey of 66 universities conducted by AUTM from 1993-2000. Note the positive trend in numbers of inventions disclosed, patent applications filed, and patents issued. The increase in patents issued clearly stems from the rising number of disclosures being submitted by researchers at these institutions (not just from universities filing more patent applications on the same number of disclosures). This is a sign that the technology transfer system is continuing to grow from the ground up.

Obtaining patent protection is just one step in the technology transfer process. Are the university technology transfer offices fulfilling their mission to commercialize the inventions of their researchers? Based on responses from 167 U.S. universities and research hospitals to the 2000 AUTM survey, more than 4000 licenses, or options for license, were executed. The institutions reported almost 20,000 active licenses and options, of which approximately half generated revenues totaling $1.24 billion. The respondents reported that roughly 350 new licensed products were made available in 2000 and 388 new companies were formed specifically for the commercialization of university or hospital technology. Over the last twenty years, among the universities participating in the AUTM surveys, a total of nearly 3300 start-up companies were formed as a result of technologies transferred from university R&D.



Respondents to the 2000 AUTM Licensing Survey received an average of roughly $140,000 for each license that generated income. However, the range of royalties received is considerable. Although AUTM does not report royalties for individual licenses, the magazine *Nature* reported the top revenue generating University-owned patents for 1997 and 1998. Note that all but one of these blockbuster patents are pharmaceutical products and the one that is not is the patent for the recombinant DNA process, which impacts not only the drug industry but many other areas of biotechnology as well.

Although pharmaceutical products dominate the top revenue generating university patents, many information technology products trace their origins to academic and federal labs.

While not all of them have directly benefited the universities from which they originated, they have had an impact on the world of IT.

Top University-Owned Patents by Revenue (1997-1998)

	University	Top Product ($)	Revenues ($M)
1	Florida State	Taxol (cancer)	45
2	Stanford	Recombinant DNA	38.5
3	U. of California	Hepatitis B vaccine	30.1
4	Yale	Zerit (HIV)	28.2
5	Michigan State	Cisplatin (cancer)	24.3
6	Columbia	Xalantan (glaucoma)	20
7	U. of Florida	Trusopt (glaucoma)	15.5

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The original web browser, called Mosaic, was developed at the University of Illinois. Mosaic was the basis for Netscape, although the University of Illinois never received any royalties from the transfer.

Lycos was also the product of technology transfer. It was developed by Professor Michael Mauldin at Carnegie Mellon University. In 1995, the university licensed Lycos for a 20% equity stake in the new company. On the day of the company's IPO in 1996, Carnegie Mellon's shares were worth more than $60 million.

I.T. Products Developed at Universities

- **Netscape**
  - 1st graphical web browser (Mosaic) developed at the U. Illinois in '90s
  - U. Illinois received no royalties
- **Lycos**
  - Developed at Carnegie Mellon U.
  - Licensed to start-up for 20% equity

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To give you some sense of the most active technology transfer universities, shown on the left are the top ten programs based on numbers of active licenses and on the right at the top ten in terms of licensing income received. Note that the University of California, which tops both lists, includes the entire UC system of campuses. The universities that appear on the right, but not on the left are those that have a single or a couple "home runs" that is boosting overall revenues. Conversely a number of schools such as Iowa State and NC State provide licenses to their many agricultural technologies at relatively low cost.

Turning now to the federal laboratories: The effect of the enactment of *Stevenson-Wydler* on technology transfer at these institutions was also dramatic.

University Licensing Programs: The Top 10

Active Licenses

Univ. of Cal. (10)	1,253
Stanford	924
Iowa State	871
Columbia	743
MIT	659
Cornell	592
NC State	547
Univ. of Wash.	505
Johns Hopkins	495
Univ. of Wisc.	467

Income in 2000 ($M)

Univ. of Cal. (10)	261.5
Columbia	138.6
Dartmouth	68.4
Florida State	67.5
Stanford	34.6
MIT	30.2
Univ. of Wash.	30.2
Univ. of Penn.	26.5
Univ. of Florida	26.3
Georgetown	26.0

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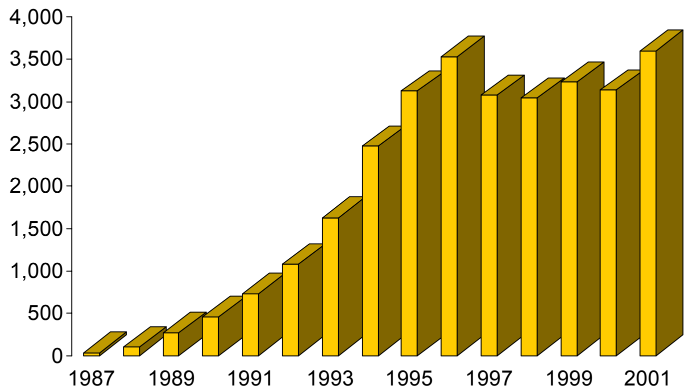
Beginning in 1986, the federal labs took full advantage of the ability to enter into cooperative R&D agreements (or CRADAs). Note that CRADAs are the equivalent of "industrially sponsored research" at universities. A CRADA is one of the few mechanisms by which private industry can pay for collaborative work to be done at a federal lab; however, neither the laboratory nor the individual researcher may make a profit under such agreements. Ten years after CRADAs were created in 1986, the number of active agreements soared to over 3500.

Growth of CRADAs



Source: U.S. Department of Commerce, *Summary Report on Federal Laboratory Technology Transfer*, 2002

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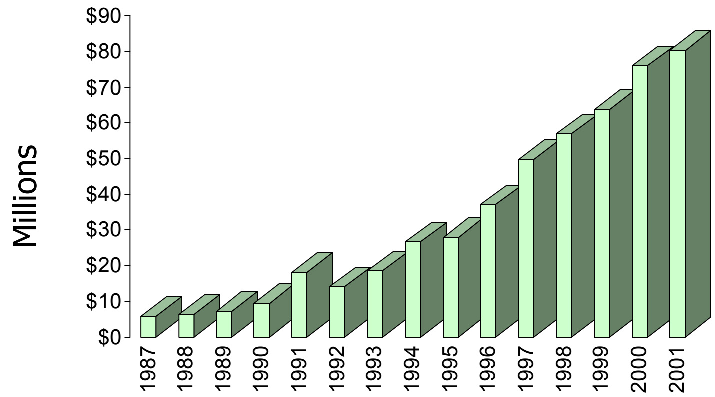
Efforts to promote the commercial utilization (or dual-use) of the technologies being developed for government use at the federal labs were also bearing fruit. In the decade following the amendment of *Stevenson-Wydler*, the number of license agreements that were executed in a given year nearly quadrupled (from 128 in 1987 to 487 in 1997 and reaching 577 in 2001).

Moreover, the amount of income received by the federal labs from their active license agreements increased more than 12-fold from approximately $6 million in 1987 to more than $80 million in 2001.

Clearly, the numbers indicate that technology transfer is happening. But how is it impacting Americans in their day-to-day lives?

I would like to share with you a handful of examples to give you a feel for the range of technologies and their uses.

Federal Lab Income from Licenses



Source: U.S. Department of Commerce, *Summary Report on Federal Laboratory Technology Transfer*, 2002

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I'll begin with the number one revenue-generating patent—Taxol. The Taxol story is a fascinating one that could be the subject of a talk on its own. Briefly, the active compound in Taxol was known to be effective in treating certain cancers. The only natural source was the bark of the slow-growing and relatively rare Pacific yew. The discovery pitted cancer researchers against environmentalists. During the 1980's, many researchers strove to develop an efficient procedure for synthesizing Taxol and in 1989 Dr. Robert Holton and his colleagues at Florida State University patented a method that has been licensed by Bristol-Myers-Squibb. In addition to the synthesis technology developed at Florida State, federally funded researchers at the National Institutes of Health (or NIH) have developed and licensed a more effective method for administering the drug. Sales peaked in 2000 at $1.6 billion for this particular product, after which generic versions of the drug became available.

The Taxol Story

- **Florida State**: Holds patent for the method for Taxol synthesis
- **National Institutes of Health**: Researchers developed, improved method for Taxol administration
- **Bristol-Myers-Squibb**: Licensed both patents and sells Taxol for treating various cancers
- **Massive Sales**: Sales peaked at $1.6B in 2000

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In another example, dry-cleaning may seem like a "mature" industry, however, researchers at the University of North Carolina at Chapel Hill and at North Carolina State University developed a method for dry-cleaning clothes using liquid carbon dioxide. Not only is CO_2 a safer cleaning solution, its use results in less shrinkage and fading of garments and no residual odor. The patents have been licensed to Micell Technology, as start up company that now has 51 Hangers Cleaners franchises in 23 states.

Improved Dry Cleaning Method

- hod of liquid carbon dioxide to dry-clean → less shrinkage, fading, odor
- Micell Tech., a start-up that now has 51 Hangers Cleaners® franchises in 23 states
-
  UNC-Chapel Hill, NC State

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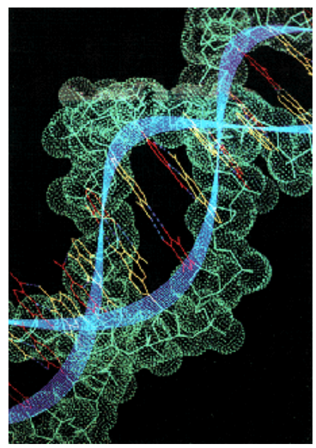
Arguably the most important university patents were the three held by Stanford and the University of California at San Francisco for the recombinant DNA process. The so-called "Cohen Boyer patent" is credited with having started the biotechnology industry. These seminal patents recently expired, but while in force, they were licensed nonexclusively to hundreds of licensees and generated over $100 million in licensing revenues for the universities. This is an excellent example of where nonexclusive licensing to many licensees was determined by the universities to be the best means of ensuring the broadest public benefit and a strong revenue stream for the university.

Recombinant DNA Patents

- **Technology**: Seminal patents underlying biotech industry
- **Utilization**: Hundreds of nonexclusive licenses
- **Developers**: Stanford, UC-San Francisco



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A recently licensed technology that has yet to be fully developed for commercial use is a method that employs electrolysis to prevent the formation of ice on surfaces. The technology, developed at Dartmouth College, has been licensed exclusively, but in several distinct fields of use, including aircraft, ships, automobiles and outdoor surfaces, such as runways and playing fields.

Airplane De-Icing Technology

- **Technology**: Electrolysis to prevent formation of ice
- **Utilization**: Licensed to multiple companies for de-icing aircraft, ships, automobiles, outdoor surfaces
- **Developer**: Dartmouth

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Many technologies developed at the federal labs for government purposes can be adapted to commercial applications. A sensor technology developed by the Navy for biowarfare agent detection has been licensed by LifePoint, Inc. who has developed a non-invasive diagnostic test system for detection of illegal drugs in saliva. In 2002, LifePoint's IMPACT test system was voted first runner-up in *Popular Science* magazine's "Best of What's New Readers' Choice Poll." And in March of this year, it was awarded first place in the "Achievement in Technical Ingenuity Awards for Start-up Companies" sponsored by UCR Connect and IEtechSOURCE.

Although on the surface it may not seem "high tech", agriculture benefits from R&D breakthroughs. It is the subject of research both by government and university investigators. The technologies developed by the U.S. Department of Agriculture Research Service generally are made available freely and without license. More frequently, university research results have led to patents and licensing income.

Dual-Use Technology:
Homeland Security & Workplace Safety

- **Technology**: Flow immunosensor
- **Utilization**:
  - **Homeland**—Detect biowarfare agents
  - **Workplace**—Detect illegal drugs in saliva
- **Developer**: U.S. Navy

LifePoint, Inc.

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For example, the University of California alone has developed and patented 32 varieties of strawberries; a popular grape used in wine production; the Chandler walnut, which accounts for 30% of all walnuts grown in the state; and more recently an improved mandarin orange hybrid. As these examples indicate, federally funded agricultural research is improving our food supply by making varieties of fruits and vegetables that are more disease-resistant, easier to transport, and better tasting.

Agricultural Technologies:
Licensed by the Univ. of California

- 2 types
- edglobe grape used in wine production
- walnut accounts for 30% of walnuts grown in CA
- mproved mandarin orange hybrid recently made available

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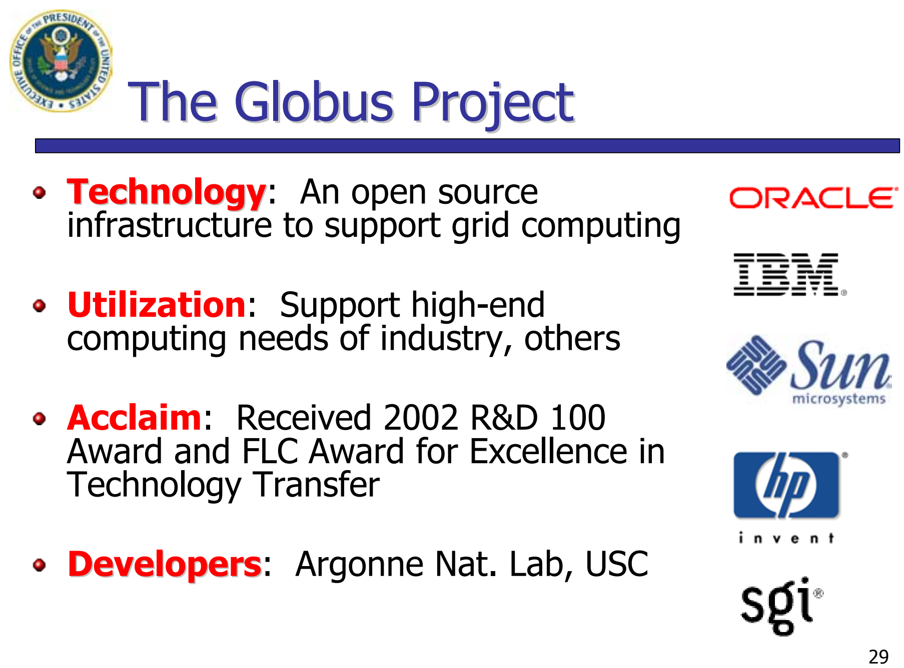
The Human Genome Project is another example where the U.S. government has funded and conducted research, the results of which it has not sought to secure maximum IP protection or to restrict the use only to those who can pay. Last month, in a historic, landmark achievement, the governments of the U.S., U.K., Japan, France, Germany, and China jointly announced that scientists from those nations have completed the essential sequence of three billion base pairs of DNA of the human genome, the so-called molecular instruction book of human life. The results of this joint investment in the Human Genome Project are now freely accessible to the world through the Internet. Widespread access and use of the results of the Project will inevitably lead to progress in biomedical sciences that were previously not possible.



Another example of technology transfer of the results of federally funded research without the need for the protection afforded through licensing is the Globus Project. The Globus Project, based at the Department of Energy's Argonne National Laboratory and the University of Southern California's Information Sciences Institute, led to the development of the Globus Toolkit, an open source infrastructure to support grid computing—the sharing and collaborative use of high-end computers, networks, databases, and scientific instruments by distributed users. The Globus Toolkit includes components for security, information infrastructure, resource & data management, communication, fault detection, and portability. The toolkit is being used by many of today's largest IT companies, including IBM, Hewlett-Packard, Sun Microsystems, Silicon Graphics, and Oracle, in support of their commercial grid computing efforts. For its impact on the IT industry, the Globus Toolkit received a 2002 R&D 100 Award from R&D Magazine, which named it as 2002's "Most Promising New Technology."

Other innovative approaches to enhancing collaboration between industry and academic researchers are coming out of the private sector. For example, Intel Corporation recently opened research centers in close proximity to three university campuses—Carnegie Mellon University in Pittsburgh, the University of Washington in Seattle and the University of California at Berkeley. Each lab will house employees from both Intel and the adjacent university. According to the company, the goal is "not to pull talent out of the university, but to amplify it."

While the transfer of technology has increased over time, we need to continue to improve the process to further enhance the likelihood of the next Lycos or Netscape being recognized and nurtured.

President's Council of Advisors on Science and Technology (PCAST)

John Marburger	White House	Martha Gilliland	U. MO-KC
Floyd Kvamme	Kleiner Perkins	Ralph Gomory	Sloan
Charles Arntzen	Arizona State	Bernadine Healy	Red Cross
Norman Augustine	Lockheed (formerly)	Robert Herbold	Microsoft
Carol Bartz	Autodesk	Bobbie Kilberg	NVTC
Kathleen Behrens	RS	Walter Massey	Morehouse
Erich Bloch	WAG	Gordon Moore	Intel
Stephen Burke	Comcast	Kenneth Nwabueze	SageMetrics
Wayne Clough	Georgia Tech	Steve Papermaster	Powershift
Michael Dell	Dell	Luis Proenza	U. Akron
Raul Fernandez	Dimension Data	George Scalise	SIA
Marye Anne Fox	NC State	Charles Vest	MIT

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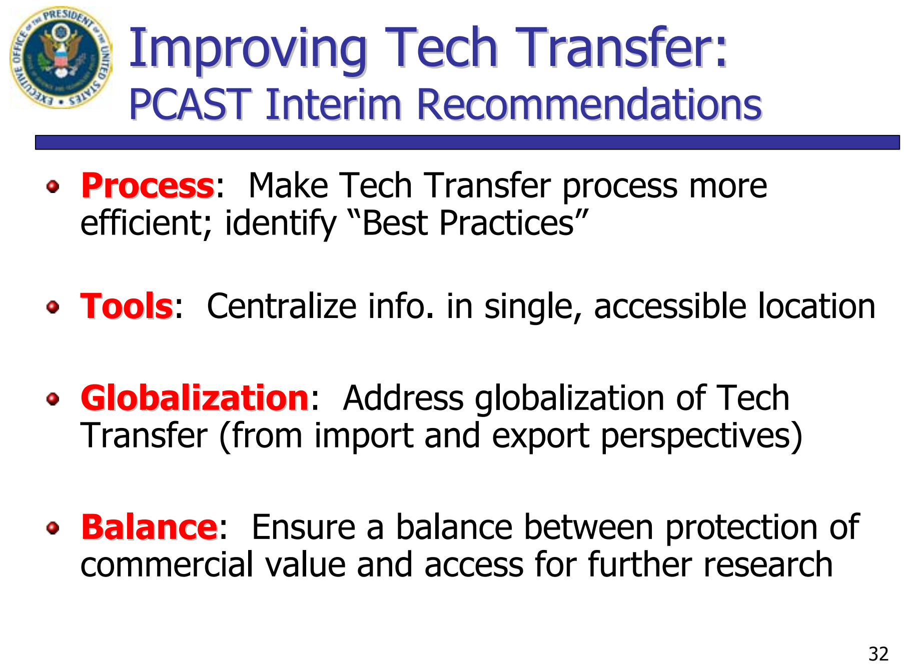
As part of those efforts, last year President Bush asked his Council of Advisors on Science and Technology, or PCAST, to make recommendations for enhancing technology transfer in order to maximize the benefits of federally funded research. PCAST is made up of high-level non-government experts from a range of science and technology disciplines and organizations. As you can see by the list, the membership of PCAST includes some of the most distinguished members of the university community and the IT industry.



The full PCAST review of technology transfer will be available later this year. Although PCAST does not plan to recommend any major changes to the existing legislation, it will recommend that the government work to streamline the technology transfer process and identify "best practices" for universities and federal laboratories, what works and what doesn't. The Council, in a preliminary report, also recommended that the government provide more effective means for industry to identify and locate potentially useful technologies that are coming from the distributed network of federally funded laboratories. These changes are particularly important in areas such as information technology, where product life cycle times are particularly short. Other issues raised by the review are the growing importance of international aspects of technology transfer (both into and out of the U.S.) and the need for balance between providing access to certain biological research tools and allowing adequate protection of commercial value.

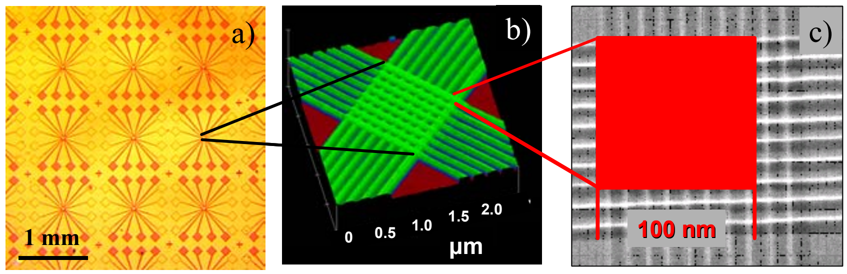
The Department of Commerce (DOC) plays a key role in linking technological development to economic advancement, and directs a number of activities with this aim in mind. For example, DOC's Office of Technology Policy held the Innovation in America roundtable series, designed to bring together leaders in R&D and innovation from U.S. industry, universities and government laboratories to explore the changing innovation landscape and inform R&D policymakers, practitioners and managers. The roundtables helped to identify trends and understand their implications for national R&D and innovation policies and programs.

The Office of Technology Policy also spends a lot of time looking at state and regional business climate policies, trying to better explain the dynamics needed to sustain tech-led economic growth. One of the projects they have under way right now is a review of efforts at 10 federal labs that are partnering effectively with local communities to advance regional economies.

Let me now turn to a specific example of an interagency R&D program that has great potential for technology transfer.

Molecular Electronics:

The Next Wave in Microelectronic Packaging (Collaboration between UCLA and HP)



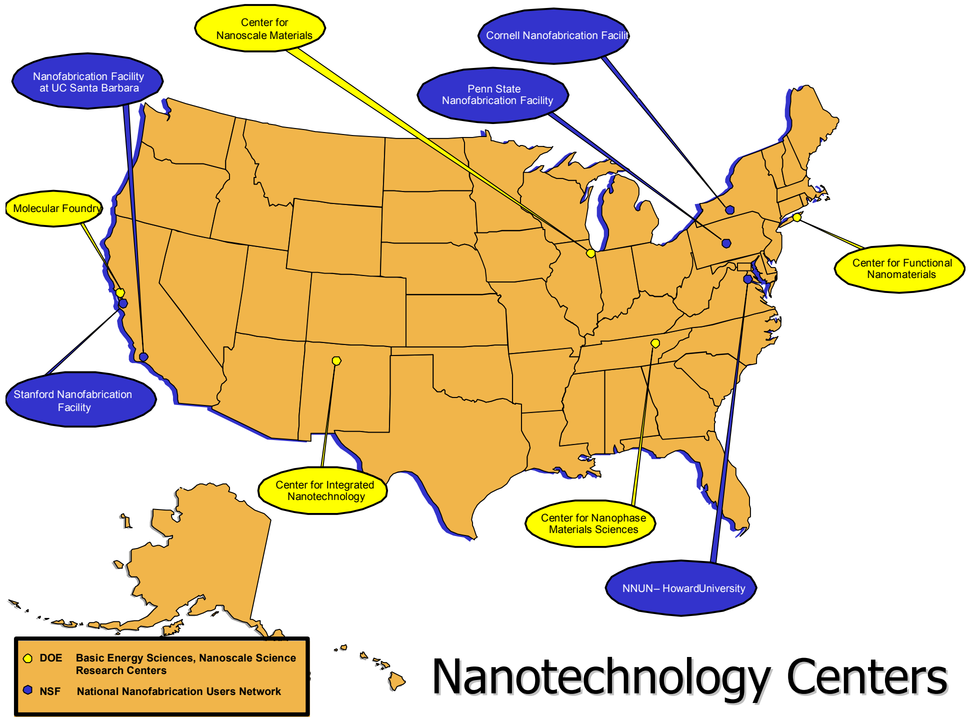
(a) Optical micrograph of an array of 64-bit molecular electronic circuits
(b) Atomic force micrograph revealing a single 64 bit circuit
(c) Electron micrograph of a 100 bit circuit at 5×1011 bits/cm^2

Courtesy J. Heath, Caltech 33

As many of you are aware, the properties of nanoscale materials (materials that are approximately 1/100,000 the diameter of a human hair in size) can vary considerably from those of bulk materials. Entirely new structures, such as carbon nanotubes, are possible. The nanotechnology research of today is anticipated to lead to advances tomorrow in industries ranging from computing to energy. This slide shows one example of current nanotechnology research. To generate the ultra-small circuits shown here, a layer of material one molecule thick is sandwiched between two cross-wise layers of nano-wires. Changes in the electronic state of a single molecule are used to generate a single molecule computer memory scheme. This novel technology was developed by a researcher at UCLA (who is now at Cal Tech) and Hewlett Packard, through joint support from the Federal government and HP.

The Bush administration has identified nanotechnology as a priority, and Federal funding for research aimed at better understanding the behavior of matter at the nanoscale has increased dramatically in the last few years. In his last budget, the President requested $849 million for Federal nanotechnology R&D, an effort that is spread over a number of different agencies throughout the government.

With the field of nanotechnology still in its early stages of development, much of this Federal funding supports basic research aimed at better understanding fundamental questions about the nature of matter at the nanoscale. At the same time, the Administration recognizes that advances in this field are likely to have a profound impact on many sectors of the economy and is actively working to promote technology transfer and commercialization.



For example, in order to facilitate teaming among large groups from academia, government and industry, a number of user centers are being built across the country. The centers are intended to foster interdisciplinary research and to enhance the likelihood that an idea with potential for impact in a commercial application will be identified at an early stage.

Certain of these centers, identified in yellow and brown on this slide, are designed to function as central user facilities for nanotechnology. That is, these user-facilities provide ready access to equipment and expertise for fabricating and characterizing nanoscale materials, structures, and devices.

The centers identified by brown tags are part of the National Science Foundation's National Nanofabrication Users Network (NNUN). These centers serve as central user facilities for academia, national labs, and industry. They enable researchers who do not have access to the necessary infrastructure to enter the nanotechnology arena.

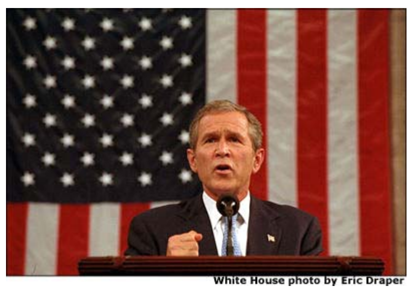
The centers in yellow are part of a new DOE-sponsored network, and are under development. These centers will have central facilities and a network of trained technicians to provide nanoscale expertise, and are co-located with existing DOE user centers to leverage existing capabilities. These facilities are open to use by anyone with a good idea and they are free of charge for those conducting fundamental research. However, there is a fee for doing proprietary work.

Other centers identified on this map include centers of excellence sponsored by NSF (red), NASA (green), and DOD (blue). These centers of excellence encourage the formation of interdisciplinary research teams, but do not serve as central user facilities.

Additionally, the Nanotechnology Initiative is hosting numerous workshops to facilitate industry-university-government communication and collaboration.

The success of technology transfer in the U.S. has not gone unnoticed in other countries, many of which are contemplating similar legislation. Two decades of technology transfer have resulted in the commercialization of numerous inventions made in the course of doing federally funded basic research and the resulting products and services have had major impacts on the quality of life of people in the U.S. and around the world. New companies have been formed and jobs have been created, thereby adding to the strength of the Nation's economy.

The President on Innovation



White House photo by Eric Draper

"The role of government is not to create wealth; the role of our government is to create an environment in which the entrepreneur can flourish, in which minds can expand, in which technologies can reach new frontiers."

--President George W. Bush

July 12, 2002

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The Federal R&D portfolio lays the foundation for innovation and discovery. Science and technology are key to securing the homeland and winning the campaign against terror. President Bush, through his unprecedented support for R&D, is also creating the underlying environment that will promote economic growth. As the President said last year, "The role of government is not to create wealth; the role of our government is to create an environment in which the entrepreneur can flourish, in which minds can expand, in which technologies can reach new frontiers." Technology transfer, through strategic federal R&D policy, will help us to achieve these goals.