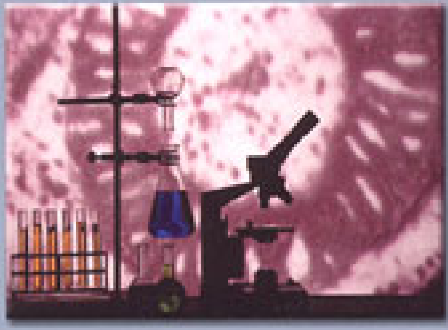
OFFICE OF TECHNOLOGY POLICY

Recent Trends in Federal Lab Technology Transfer: FY1999-2000 Biennial Report

Report to the President and the Congress under the Stevenson-Wydler Act



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Under the Stevenson-Wydler Act

Office of Technology Policy
Technology Administration
U.S. Department of Commerce

May 2002

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FOREWORD

The wealth of nations is changing. While prior centuries were dominated by nations with superior industrial or agricultural capabilities, the innovation age rewards new competencies and strengths. Knowledge – ideas and the people who generate them – is the new coin of the realm. Innovative capacity will be the key driver of future economic prosperity, with emerging technologies such as genomics, bioinformatics and nanotechnology promising even faster change and greater disruption.

Over the past 50 years, the U.S. government has financed more of the world's scientific research and technology development than any other nation, institution or entity. These Federal investments have paid off handsomely and helped position us well for the 21st century. Our economy and technology sector lead the world, thanks in large part to our unique innovative capacity.

America also continues to benefit greatly from its storied Federal lab system and world-class scientists. Our labs offer unique and hard-to-duplicate facilities, longstanding relationships with top innovators, and a Congressional mandate to promote technology transfer –diffusion of knowledge and inventions created with Federal funds. By partnering with industry, Federal labs create new competencies and capabilities to help achieve their missions, ensure their work generates maximum benefit for our nation, and better compete for future resources. Industry gets better access to breakthrough innovations at a time when it is moving more heavily into applied research, use of cutting-edge facilities, and interaction with top talent.

At the same time we face more significant challenges to our innovative capacity and long-term competitiveness than ever before. Many factors are reshaping the way in which technology is developed and commercialized, including the convergence of multiple disciplines, integration of information technologies, emphasis on speed-to-market, shorter product lifecycles, and greater technical complexity. Globalization is profoundly changing trade, technology sourcing, capital flows, and movement of technical talent. Foreign labs are proliferating and becoming more successful in convincing American innovators to move cutting edge research offshore. Other nations are working hard to improve their own innovation infrastructures. In short, U.S. technological leadership is anything but assured in today's global economy – it's very much at stake.

To succeed in the face of these challenges we are going to need extraordinary efforts from industry, educators, and policy makers. And we are going to need our Federal labs to continue in their long tradition of rising to meet our nation's toughest technological challenges. Technology transfer is likely to remain a critical function and contribution of our labs, one that will benefit our nation and the labs themselves, *if executed effectively*.

The purpose of this report is to help with that execution. Congress has tasked the Department of Commerce's Office of Technology Policy to regularly monitor and report on the state of technology transfer by the Federal labs. This Biennial Report, which provides data for all the agencies with Federal lab systems, is part of that process. We hope these reports will inform policy makers and encourage Federal lab tech transfer. We also intend to work with the agencies and labs to be sure we are looking at the right performance metrics – to ensure that we measure what we value and not simply value what we measure. We appreciate the support we have received from the agencies in preparing this report, and we welcome feedback and discussion.

Bruce P. Mehlman
Assistant Secretary for Technology Policy

Chapter 1
Background, Methodology, and Summary of Major Findings

1.1 Background

The Stevenson-Wydler Technology Innovation Act of 1980 was amended in 1986[1] to require a periodic review and report to the President and Congress of federal laboratories'[2] utilization of the technology transfer authorities opened to them by federal law. In response to this requirement, the Department of Commerce's Office of Technology Policy (OTP) has prepared a "Biennial Report" since 1987. The requirement for reporting was intended to facilitate greater use of the considerable scientific and engineering resources of the nation's federal laboratory system, to hasten promising technologies toward commercialization, and to strengthen the competitiveness of U.S. industries.

The present report is the latest in the series of Biennial Reports under the Stevenson-Wydler Act. The prior edition, published by OTP in May 2000, provided an account of federal lab technology transfer activities through FY 1998.[3] This report extends the data coverage through FYs 1999 and 2000.

The present edition is also the last in the Biennial Report series. However, the reporting on federal lab technology transfer activities will continue in a revised form. The Technology Transfer Commercialization Act of 2000 (P.L. 106–404, signed November 1, 2000) instituted some significant changes in the process by which the status of federal lab technology transfer efforts will be reported to the President and Congress.

Under the new law, reporting responsibilities are split: each federal agency which operates or directs federal laboratories (or engages in patenting or licensing of federally owned inventions) is obliged to provide the Office of Management and Budget with an annual report on the agency's technology transfer plans and recent achievements as part of the agency's annual

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1 The Federal Technology Transfer Act of 1986 amended the Stevenson-Wydler Act (P.L. 96–480, 15 U.S.C. Sec. 3701–3714) in several respects, including adding a requirement for the Biennial Report. Appendix 1 of this document provides a discussion of the major pieces of federal technology transfer legislation passed by the Congress since 1980.

2 "Federal labs" refers to government owned or leased/federally staffed facilities for performing research, development, or engineering activities relevant to an agency's missions and interests. The government-owned but contractor-operated facilities with a similar purpose also fall under the "federal lab" title. The U.S. federal lab system presently encompasses more than 700 federal labs and research centers, including the Department of Energy's "national laboratories."

3 *Tech Transfer 2000: Making Partnerships Work*, Office of Technology Policy, Technology Administration, U.S. Department of Commerce, May 2000.

budget submission. Subsequently, the Department of Commerce will prepare an annual overall federal assessment for the President and Congress based on these agency reports.[4] This revised reporting process takes effect in calendar year 2002, in conjunction with the FY 2003 federal budget cycle and requires agencies to report on FY 2001 technology transfer activities.

1.2 Methodology

Ten federal departments include significant federal laboratory operations that have science and technology activities. Each of these departments, together with their agencies and labs, has established programs for transferring technology arising out of lab science and technology activities. This report provides information and analysis about each of these ten federal departments:

- Department of Agriculture (USDA)
- Department of Commerce (DoC)
- Department of Defense (DoD)
- Department of Energy (DoE)
- Environmental Protection Agency (EPA)
- Department of Health and Human Services (HHS)
- Department of the Interior (DoI)
- National Aeronautics and Space Administration (NASA)
- Department of Transportation (DoT)
- Department of Veterans Affairs (VA)

In response to Congressional direction, and consistent with past Biennial Reports, OTP developed and administered a survey to collect data from these departments for this Biennial

[4] See 15 USC Sec. 3710 (f) for a further description of the mandated agency technology transfer reports. The Secretary of Commerce's "Annual Summary Report" is described in 15 USC Sec. 3710 (g)(2)).

Report.[5] Requested information included the incidence of *Cooperate Research and Development Agreements* (CRADAs), and activity levels for frequently cited measures of federal lab management of intellectual property such as *invention disclosure*, *patenting*, and *invention licensing*. The FY 1999 and 2000 data collected by OTP's survey has been added to the data available from previous editions of the Biennial Reports, which for many of the measures provides complete data series from the late 1980s through FY 2001.

This year for the first time, in response to strong Congressional and Administration interest, information also was collected about "downstream outcomes" of federal lab technology transfer activities—such as new products in the commercial marketplace or improved private industry production processes. These outcome cases are intended to illustrate the contributions of federal lab technology transfer to increased national productivity and well-being.

Although the specific focus of this survey was federal lab technology transfer activities in FY 1999 and 2000, this analysis often focuses on historical trends over a longer historical period. This is because annual changes in activity levels may be misleading in characterizing the strength of program performance since many of the activity measures are influenced by complex factors, such as the irregular pace at which R&D yields new knowledge and inventions.

This report also recognizes the considerable differences between departments in the levels of federal budget allocations for laboratory operations. For FY 2000, almost 40% of such allocations were directed toward DoD labs. Federal lab operations at DoE received 18% and lab operations at HHS and NASA, about 15% each in the same year. All other agencies combined had about 12.5% of all federal allocations for laboratory operations. These differences in available resources are particularly important considerations when comparing departmental levels of technology transfer activities and are highlighted by the organization of the report's tables and figures.

A short *summary of the report's key findings* follows. *Chapter 2* describes the trends in federal technology transfer activities within and across departments, in the last several years and since the late 1980s. *Chapter 3* is organized by department. For each department, there is a summary tabulation of technology transfer activity statistics, background on the agency's technology transfer programs, and discussion of the agencies' case examples. *Appendix 1* provides a short historical account of the evolution of federal technology transfer laws and policies of the last two decades. *Appendix 2* provides detailed tabulations of the complete time series (FY 1987–2000) of technology transfer activity statistics collected for this and the previous editions of the Biennial Report.

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[5] The data from OTP's survey are aggregated and reported throughout this document by federal department. In general, however, the information was collected at a more detailed level (e.g., the DoD data reflects inputs from the Army, Navy, and Air Force; that from HHS reflects inputs from the National Institutes of Health, Federal Drug Administration, and Centers for Disease Control).

1.3 Principal Findings

- ***Cooperative Research and Development Agreements.*** For the ten departments with federal labs, there were some 2,900 active CRADAs with industry/non-federal R&D partners in FY 2000. While significantly larger than the hundreds of such agreements in place in the early 1990s, the FY 2000 level represents a decline of nearly 20% since the 1996 peak of 3,688. However, this drop is primarily due to sizable reductions in CRADA utilization at DoE and DoC. Levels of CRADA utilization at the other departments either continued to grow or remained at historically high levels.

- ***Invention disclosure and patenting.*** Four agencies—DoD, DoE, HHS, and NASA—together have accounted for well over 90% of all the federal lab invention disclosure and patenting throughout the 1990s. Of these agencies, DoD and DoE have been by far the most active, accounting for between 68 and 75%. However, the aggregate levels of invention disclosure and patenting have remained relatively flat throughout the 1990s.

- ***Licensing of Inventions.*** Federal labs had just under 3,000 active licenses for inventions in FY 2000, although not all of the departments engage in invention licensing to the same extent. DoE and HHS accounted for the majority (78%) of the federal-wide total in FY 2000. Despite some gaps in data, it appears that invention licensing has increased consistently since the late 1980s.

- ***Income from Invention Licenses.*** Most of the departments derive some annual income from invention licenses and, for most, the level of license income has been growing over the last decade. Aggregate annual income from invention licenses totaled $68.8 million in FY 2000, up from $9.4 million in FY 1990 and $28.0 million in FY 1995. HHS licenses account for much of this (71% of the total in FY 2000), with much the same proportion throughout the prior decade. The Department of Energy accounted for 19% of total invention license income in FY 2000. To date, the income stream from invention licenses have been comparatively small at the other eight federal lab departments.

- ***Downstream outcomes from federal lab technology transfer.*** Nine of the ten federal lab departments provided illustrative case histories to OTP's survey questions about successful outcomes from agency technology transfer activities in either FY 1999 or 2000; seven of the ten responded for both FY 1999 and 2000. Based on this information, it appears that technology transfer mechanisms are helping to move federal lab science and technology beyond the perimeter of the lab and are having useful impacts in the commercial marketplace.

Chapter 2
Overview of Federal Lab Technology Transfer Activities and Outcomes

This chapter analyzes data from the most recent OTP survey and from previous editions of the Biennial Report. It provides insights about trends in technology transfer activities for the federal lab system as a whole, and for individual departments, since the late 1980s. It also examines new time series data collected for agency technology transfer activities in FY 1999 and 2000. The analysis focuses on four activity measures:

- Cooperative Research and Development Agreements (CRADAs)
- Invention disclosures, Patenting (applications and issues)
- Licensing (for lab inventions and other intellectual property)
- Income received from licensing

This chapter also summarizes the departments' reports of downstream outcomes to which agency technology transfer activities have contributed. This is the first time that this type of information has been collected and presented in the Biennial Report. These case studies are included in response to Congressional interest in better information about the benefits resulting from federal lab technology transfer.

The statistics presented throughout this chapter confirm that there are significant differences among the departments in the nature and intensity of technology transfer activities. It is particularly important to recognizes that agencies carry out their technology transfer activities in different contexts due to differences in mission and in financial resources.

Additionally, there are large differences among the departments in the level of budget resources to support federal lab science and technology—which ultimately influences the resources available to support lab technology transfer activities.[6] DoD receives the greatest level of budget support for its federal lab operations (table 2.1). Federal lab operations at DoE, HHS, and NASA also receive sizable budget support, but at levels 40–50% that of DoD. USDA and DoC represent a third of budget support, roughly a tenth of DoD's level. The other four departments receive still smaller levels of budget support.

[6] Across the departments, budget resources for federal lab technology transfer activities are generally not a separate budget line-item. Typically, technology transfer is funded from a lab's overhead account and usually must compete with other demands for these general resource dollars.

Department	FY 2000 Total Budget Authority (million $)	FY 2000 Total Obligations (million $)	FY 2000 Obligations—Federal Labs[2] (million $)
Defense	$39,664	$36,876	$9,826
Energy	6,892	6,306	4,520
HHS	18,051	18,140	3,714
NASA	9,242	9,568	3,614
Agriculture	1,773	1,752	1,134
Commerce	1,110	1,041	753
Interior	645	566	495
Veterans Affairs	618	367	367
Transportation	603	700	217
EPA	559	537	127

(1) All figures include spending for basic research, applied research, development, R&D facilities, and equipment. Budget authority and obligations measure spending in different ways. Budget authority is frequently cited in national statistics on federal R&D, but generally does not distinguish spending on federal lab activities from extramural performers (e.g., universities). Both types of figures are cited here.

(2) "FY 2000 Obligations—Federal Labs" is the sum of spending for federal research by "intramural" performers and Federally Funded Research and Development Centers (FFRDCs). This sum is taken as a measure of federal lab spending and used above to rank the departments.

Source: The actual FY 2000 budget authority figures are from OMB, The President's 2003 Budget, *Research and Development*, Feb. 7, 2002. The figures for obligations (preliminary FY 2000) come from the National Science Foundation, *Federal Funds for Research and Development*, Fiscal Years 1999, 2000, 2001, July 2001.

2.1 Trends in the Level of Federal Lab Technology Transfer Activities

Cooperative Research and Development Agreements

One major thrust of federal technology transfer policy has been to facilitate and encourage federal labs to participate in research, development, and demonstration (R,D&D) partnerships with U.S. industry or other non-federal parties for the purpose of advancing promising technologies toward commercialization. Through much of the 1990s, Cooperative Research and

Development Agreements (CRADAs) were used by many federal labs as one of their principal mechanisms for establishing and conducting these partnerships.[7]

The CRADA authority began to be used by the federal labs in the late 1980s, but rapid expansion was delayed pending implementation of requisite administrative changes needed to enter into CRADA relationships with industry or other outside parties. During the 1990s, the number of active CRADAs across the ten federal lab departments soared—from 460 in 1990, to just over 2,900 in FY 2000 (figure 2.1). However, there has been a sharp reversal of growth in recent years—a decline noted in the previous edition of the Biennial Report.[8] After reaching a peak of 3,688 in FY 1996, the number of federal-wide active CRADAs dropped nearly 20% to 2,926 by FY 2000. The primary reason for this decline is a decrease in the number of active CRADAs at the two agencies that account for the largest share of all CRADAs—DoE and DoC.[9]

Throughout the FY 1990–2000 period, the vast majority (94–97%) of CRADA activity was concentrated in five departments: Defense, Energy, HHS, Agriculture, and Commerce (table 2.2). Of these, CRADA activity has been particularly prominent at DoD and DoE. During FY 1998–2000, DoD accounted for close to half of all active CRADAs; DoE for roughly another quarter; USDA, DoC, and HHS, for roughly a tenth each. The remaining five departments (NASA, DoI, VA, DoT, EPA) accounted for a small portion of the federal-wide total.

The prominence of DoD and DoE in these statistics is largely related to these agencies' historical associations with defense industries, the substantial number of scientists and engineers at these departments' laboratories, and the comparatively large size of these departments' budgets for R&D. HHS' relatively small share of reported CRADAs—despite the large amount of national R&D funding associated with biomedical research—is due to the extramural nature of

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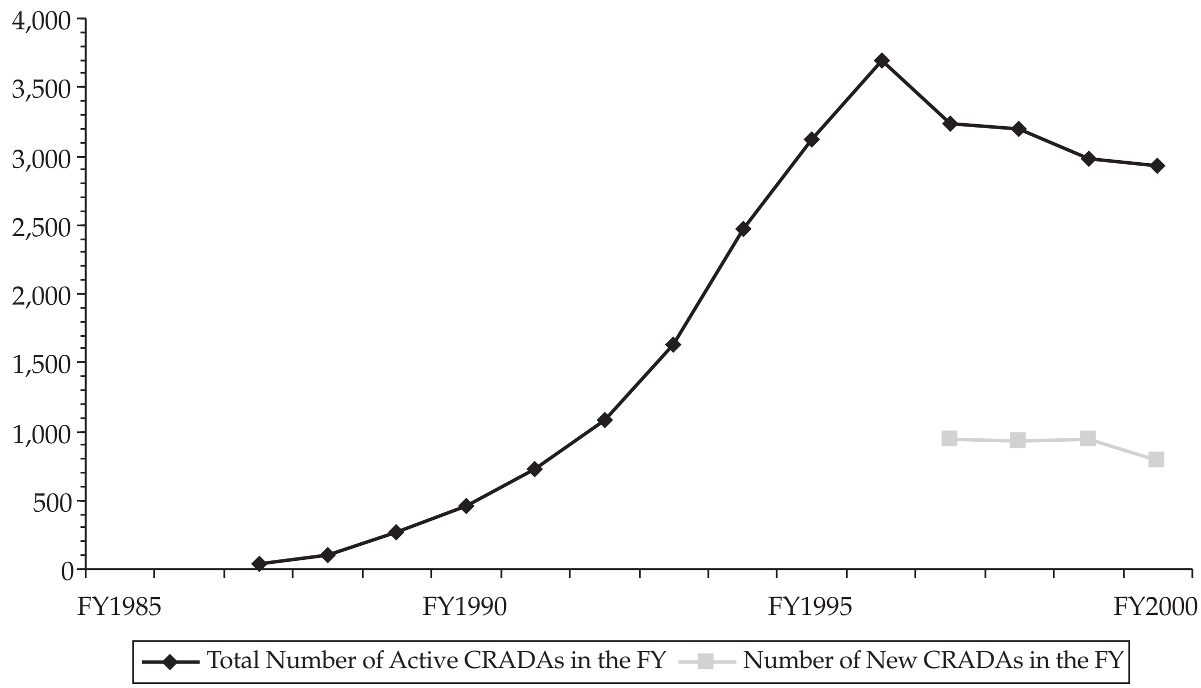
7 CRADA authority was first established by the Federal Technology Transfer Act of 1986. This Act applied only to government-owned/government-operated (GOGO) laboratories. But only a few years later, the National Competitiveness Technology Transfer Act of 1989 enlarged the authority to government-owned/contractor-operated (GOCO) labs (most of which are part of the Department of Energy's laboratory system). The effect of both Acts together was to extend the CRADA option fully throughout the U.S. federal lab system. For further details, see Appendix 1.

8 See *technology transfer 2000: Making Partnerships Work,* Office of Technology Policy, U.S. Department of Commerce, May 2000, pg. 88. The FY 1999 and 2000 data provided by this report, indicate this reversal has continued.

9 In commenting on these figures, DoC indicated the decline related primarily to the experience of the National Institute of Standards and Technology (NIST), where various factors were at play: the expiration of several consortia CRADAs with a large number of members, a refocusing on the lab's core mission that has decreased the need for exclusive relationships with individual companies, and possibly some perceptions among potential partners of logistical/administrative burdens that lowers the appeal of pursuing CRADA relationships. With respect to DoE, a recent report by the Government Accounting Office (GAO) indicated that the department's declining budget could be encouraging the DoE labs to both sign fewer CRADA agreements and to emphasize such relationships that are fully funded by the industry partners. (*Technology Transfer: DoE Has Fewer Partnerships, and They Rely More on Private Funding,* GAO-01-568 July 6, 2001.)

Figure 2.1 All Active CRADAs, FY 1987–2000(1)



(1) Sum of the ten federal departments surveyed for this report.

most HHS research (i.e., non-federal lab entities such as universities, academic health centers, and other non-profit research organizations compete for R&D funding). NASA is unique among federal agencies, in that it typically utilizes other mechanisms for its lab-industry partnerships.[10] As indicated in figures 2 a and b, most departments increased their use of CRADAs. DoE and DoC are the two notable exceptions—each of which had an FY 2000 level of active CRADAs of roughly half the FY 1995 level.

CRADAs are not the only means through which federal labs share scientific knowledge and technical expertise with private industry. Nevertheless, data confirm that they continue to be a widely used tool for technology transfer.

[10] NASA is an exception among the federal labs in its use of CRADAs. NASA continues to rely primarily on transfer authorities granted to it by the Space Act of 1958. This Act gives NASA broad authority to enter into "other agreements" with the private sector and others. These agreements are not regarded as procurements, grants, or cooperative agreements and are not subject to the rules governing such agreements. NASA believes its technology transfer objectives can be achieved with greater flexibility through use of the Space Act.

Table 2.2 - Distribution of Active CRADAs by Department, Selected Years

	FY 1990		FY 1995		FY 2000	
	Number in FY	Share of total	Number in FY	Share of total	Number in FY	Share of total
Defense	113	24.6%	845	27.1%	1,364	46.6%
Energy	1	0.2%	1,392	44.6%	687	23.5%
HHS	110	23.9%	152	4.9%	244	8.3%
NASA	0	0.0%	0	0.0%	1	0.0%
Agriculture	128	27.8%	229	7.3%	257	8.8%
Commerce	82	17.8%	407	13.0%	208	7.1%
Interior	12	2.6%	15	0.5%	40	1.4%
Veterans Affairs	2	0.4%	14	0.4%	2	0.1%
Transportation	1	0.2%	37	1.2%	79	2.7%
EPA	11	2.4%	30	1.0%	44	1.5%
	=====	=====	=====	=====	=====	=====
All ten departments	460	100.0%	3,121	100.0%	2,926	100.0%

Source: Survey of ten federal departments conducted by the U.S. Department of Commerce for this Biennial Report. See Table A2.1 in Appendix 2

Intellectual Property Management

A portion of the Bayh-Dole Act of 1980 provided authority to federal agencies to patent their inventions and to grant licenses.[11] While there are some restrictions on federal labs in applying this authority, Bayh-Dole established significant new tools that the federal labs could use to move promising technology toward commercialization (see Appendix 1).

Federal labs' activities in the areas of invention disclosures, patenting, and licensing are frequently cited as indicators of their active management of created intellectual assets and technical know-how. However, annual comparisons may be misleading as trends in these measures depend significantly on the nature and timing of innovation.

[11] The Bayh-Dole Act is formally titled as the University and Small Business Patent Procedures Act. The same law also extended rights to non-profit institutions such as universities and to small businesses to retain title to inventions arising from federally funded R&D. For further details see the historical discussion in Appendix 1.

Figure 2.2(a) Number of Active CRADAs, by Department, Selected Years

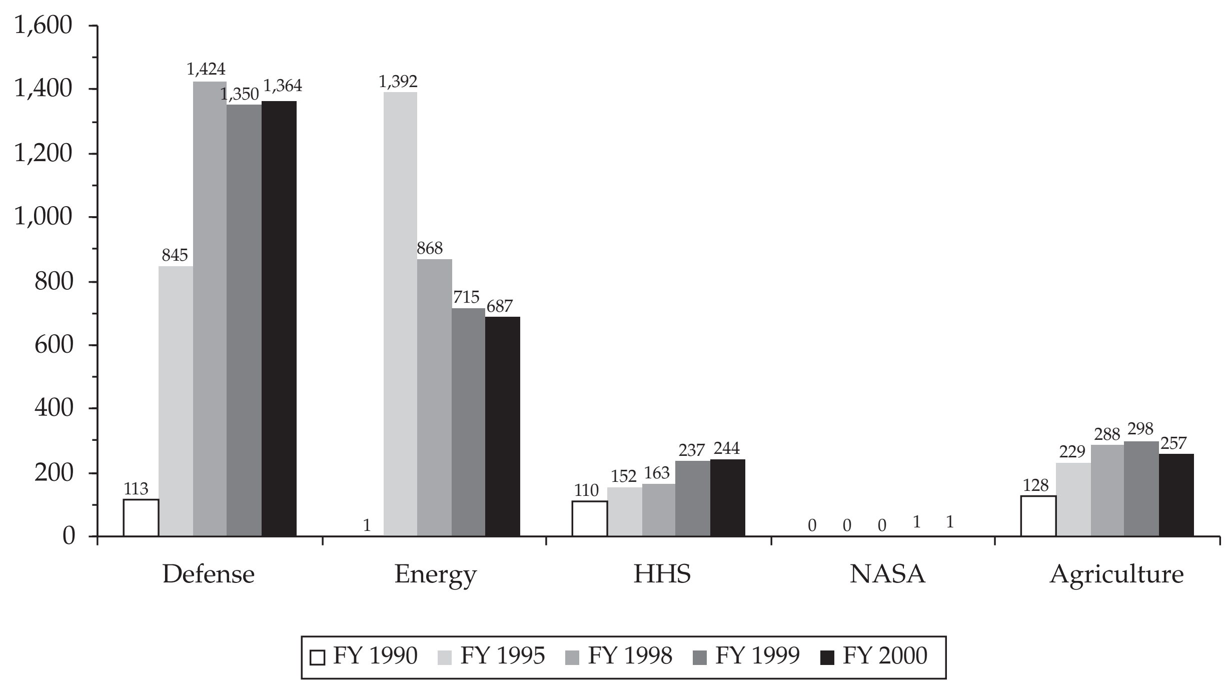
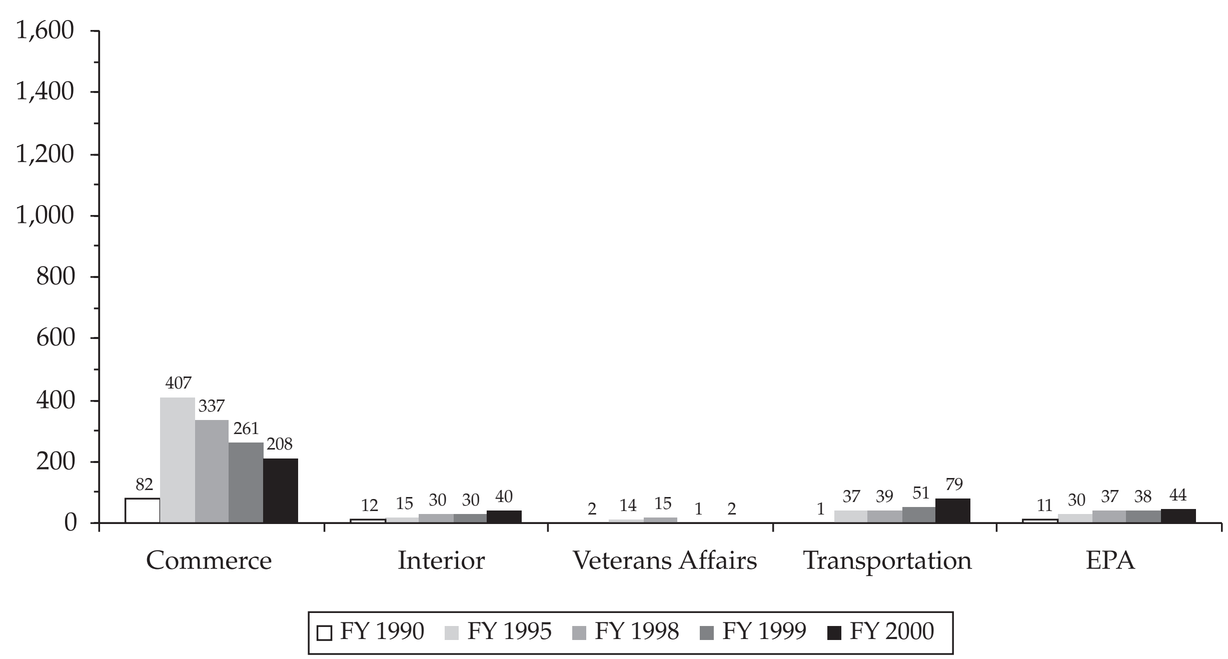


Figure 2.2(b) Number of Active CRADAs, by Department, Selected Years



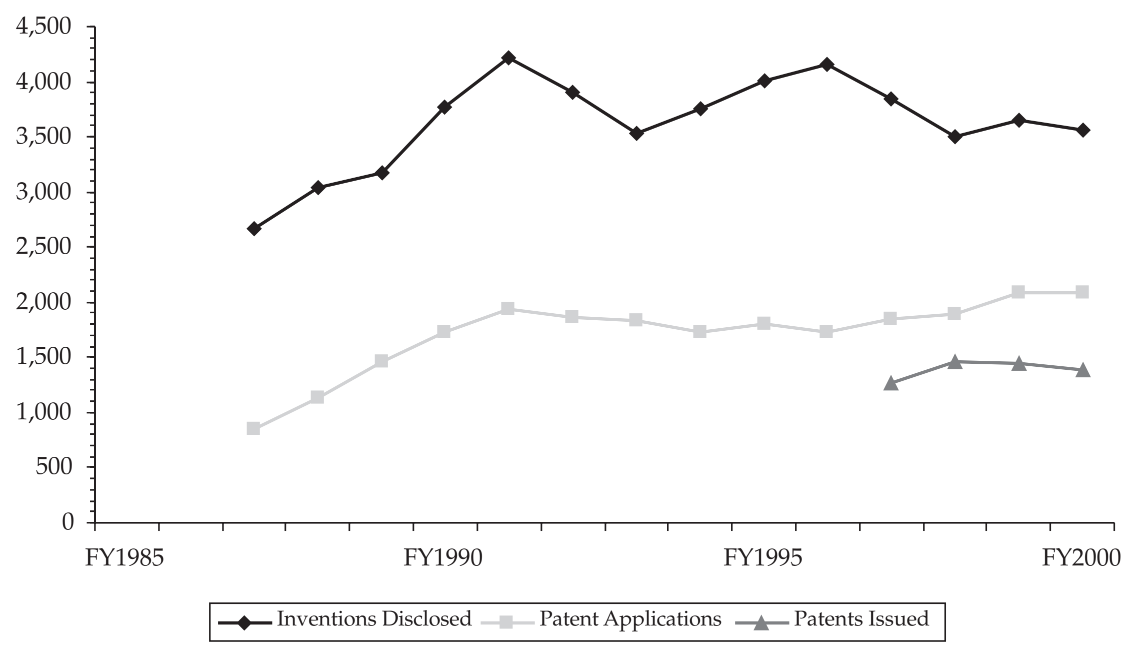
Invention Disclosure and Patenting

Data indicate that invention disclosures and patenting have generally remained constant over the last decade for the ten federal departments as a whole (figure 2.3). By contrast, 1986–90 was a period of significant growth for both these measures.[12]

Throughout the last decade, Defense, Energy, HHS, and NASA have accounted for 92–94% of total invention disclosures and patenting, depending on the measure and year (table 2.3). Of these four, the Departments of Defense and Energy have been the most prolific, accounting for 68–75% of all such activity.

However, these aggregates mask some significant differences in departments' trends during the FY 1995–2000 period (figures 2.4 a–e). Both DoD and DoE exhibited yearly declines in invention disclosures, although, DoD's level of patent applications over the same period was generally stable and DoE's increasing. Invention disclosure at HHS generally rose over the same period, but the annual number of patent applications varied. NASA exhibited a stable level of invention disclosures during the period, but patent applications declined. The trends for the other six federal

Figure 2.3 All Invention Disclosure and Patenting, FY 1987–2000(1)



(1) Sum of the ten federal departments surveyed for this report.

Data on patents issued were not collected from the agencies until FY 1997.

[12] Statistics on patents issued were collected for the Biennial Report for the first time in FY 1997.

Table 2.3 - Distribution of Invention Disclosures and Patenting by Department, Selected Years

	FY 1990		FY 1995		FY 2000	
	Number in FY	Share of total	Number in FY	Share of total	Number in FY	Share of total
INVENTION DISCLOSURES						
Defense	1,383	36.7%	1,168	29.2%	991	27.8%
Energy	1,335	35.4%	1,758	43.9%	1,371	38.5%
HHS	215	5.7%	307	7.7%	375	10.5%
NASA	538	14.3%	517	12.9%	574	16.1%
Agriculture	158	4.2%	133	3.3%	109	3.1%
Commerce	46	1.2%	65	1.6%	32	0.9%
Interior	26	0.7%	2	0.0%	16	0.4%
Veterans Affairs	58	1.5%	36	0.9%	85	2.0%
Transportation	1	0.0%	0	0.0%	0	0.0%
EPA	12	0.3%	15	0.4%	11	0.3%
	=====	=====	=====	=====	=====	=====
All ten departments	3,772	100.0%	4,001	100.0%	3,564	100.0%
PATENT APPLICATIONS						
Defense	807	46.7%	759	42.1%	774	37.2%
Energy	366	21.2%	571	31.7%	788	37.8%
HHS	239	13.8%	166	9.2%	263	12.6%
NASA	181	10.5%	164	9.1%	109	5.2%
Agriculture	76	4.4%	80	4.4%	78	3.7%
Commerce	28	1.6%	35	1.9%	18	0.9%
Interior	15	0.9%	2	0.1%	5	0.2%
Veterans Affairs	8	0.5%	0	0.0%	35	1.7%
Transportation	1	0.1%	2	0.1%	3	0.1%
EPA	6	0.3%	24	1.3%	10	0.5%
	=====	=====	=====	=====	=====	=====
All ten departments	1,727	100.0%	1,740	100.0%	2,160	100.0%
PATENTS RECEIVED(1)						
Defense	—	—	—	—	553	39.8%
Energy	—	—	—	—	515	37.0%
HHS	—	—	—	—	132	9.5%
NASA	—	—	—	—	99	7.1%
Agriculture	—	—	—	—	64	4.6%
Commerce	—	—	—	—	14	1.0%
Interior	—	—	—	—	4	0.3%
Veterans Affairs	—	—	—	—	1	0.1%
Transportation	—	—	—	—	3	0.2%
EPA	—	—	—	—	6	0.4%
	=====	=====	=====	=====	=====	=====
All ten departments	—	—	—	—	1,391	100.0%

Source: Survey of the ten federal departments conducted by the U.S. Department of Commerce for this Biennial Report. See Table A2.2 in Appendix 2

(1) Data for these indicators were not requested from the agencies until FY 1997.

Figure 2.4(a) Invention Disclosure and Patenting, by Department, Selected Years

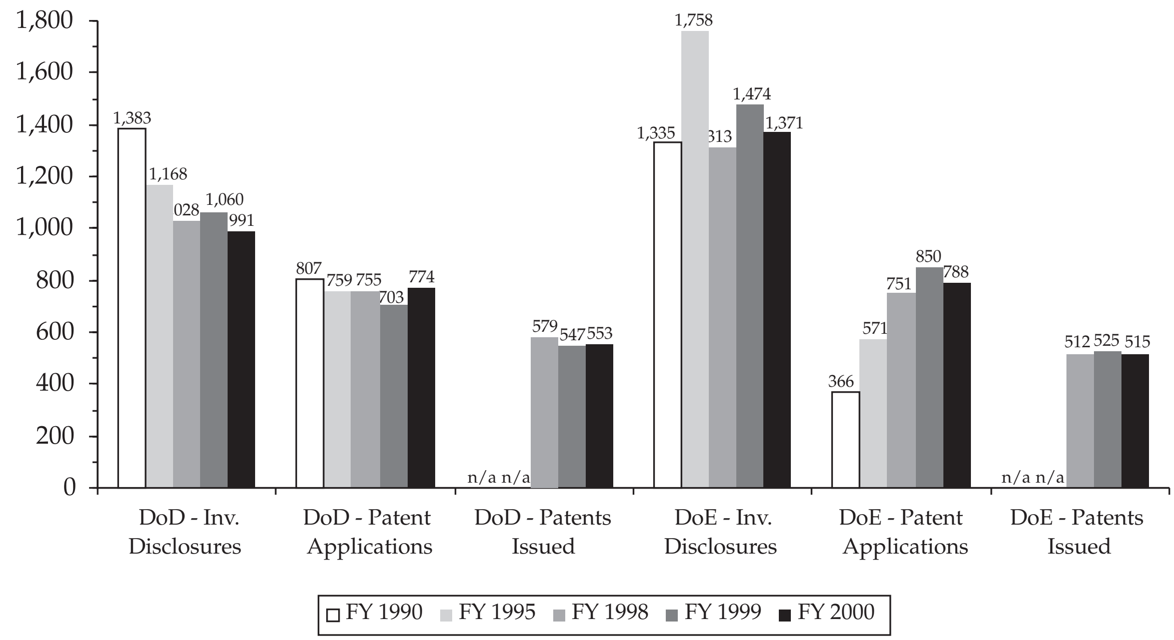


Figure 2.4(b) Invention Disclosure and Patenting, by Department, Selected Years

Figure 2.4(c) Invention Disclosure and Patenting, by Department, Selected Years

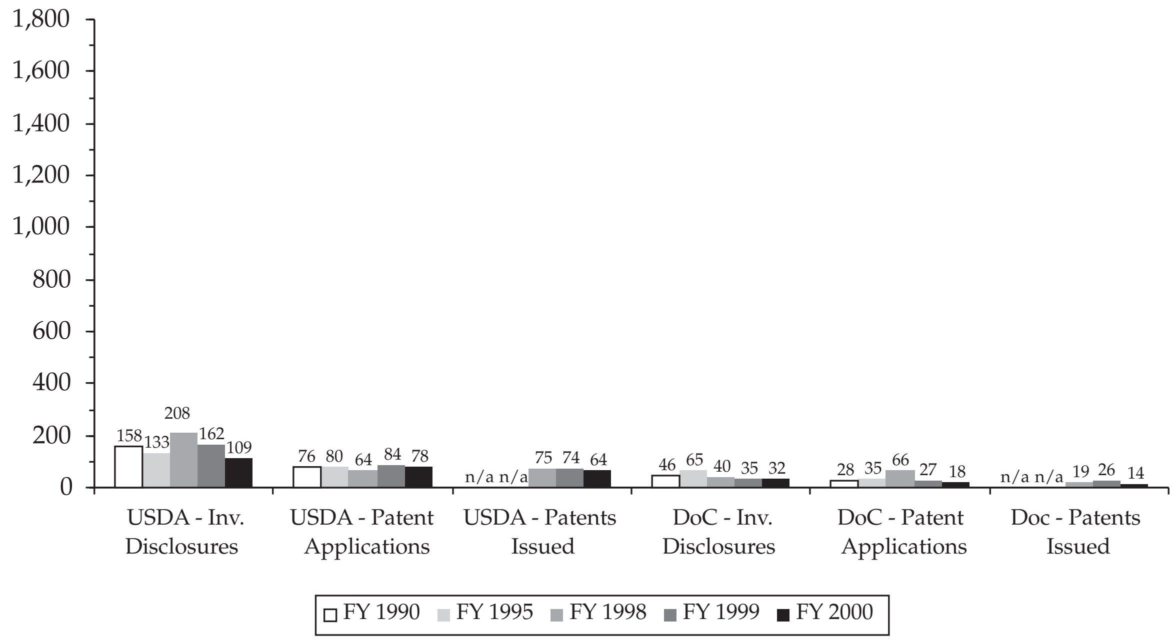


Figure 2.4(d) Invention Disclosure and Patenting, by Department, Selected Years

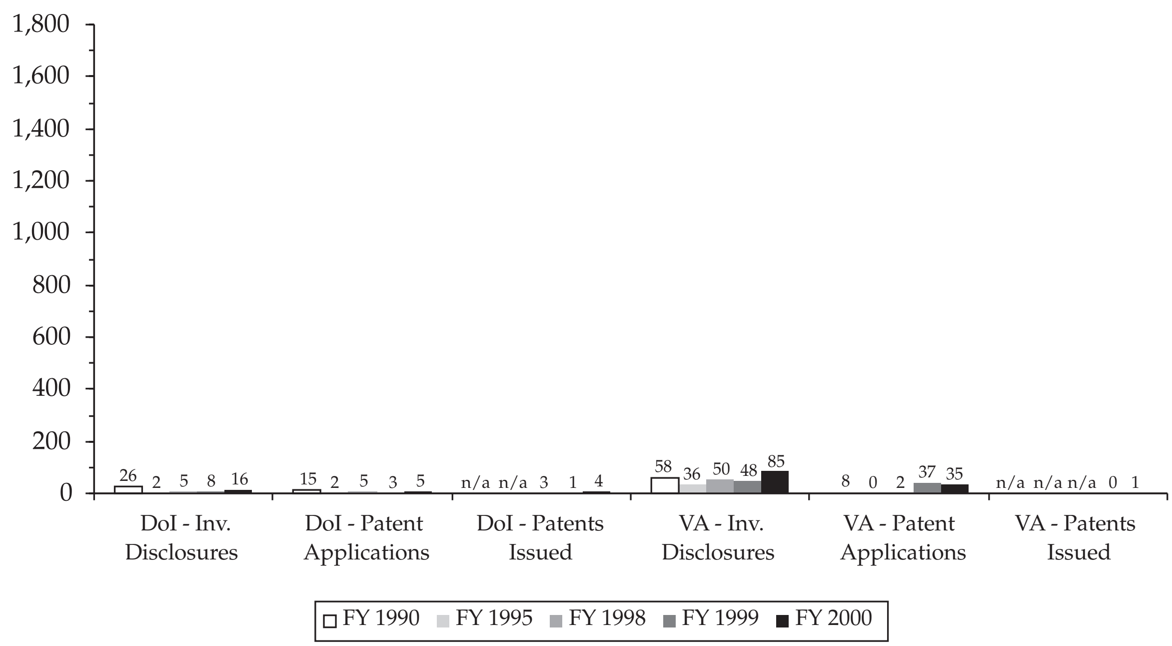
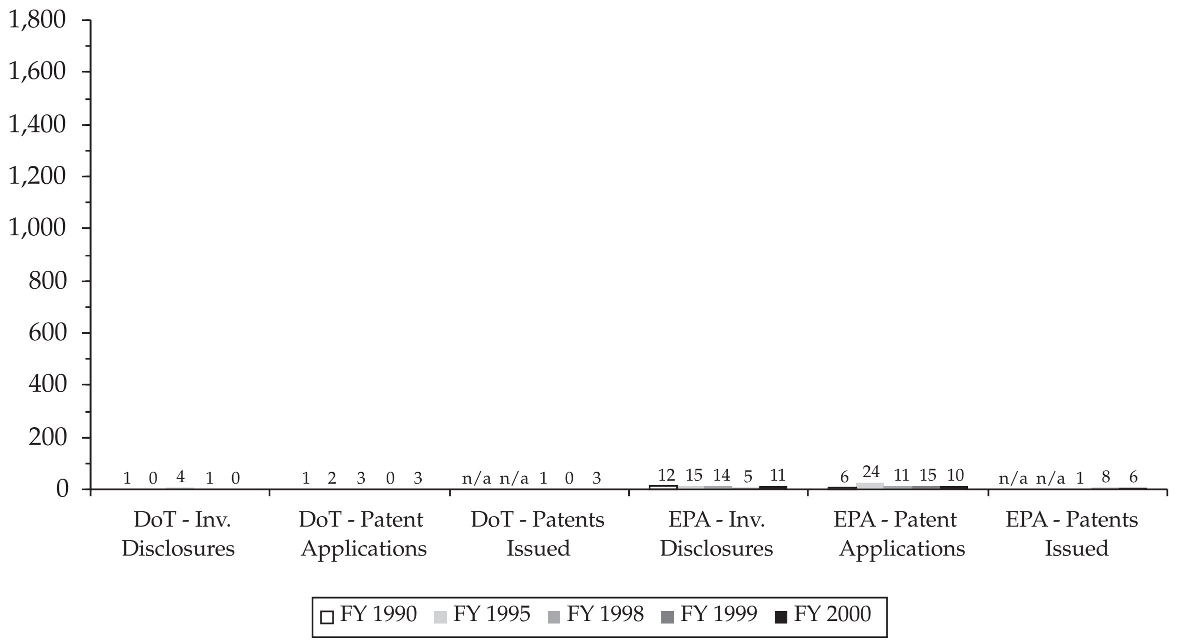


Figure 2.4(e) Invention Disclosure and Patenting, by Department, Selected Years



lab departments also differ widely, but collectively they account for a small portion of federal totals for invention disclosure and patenting.

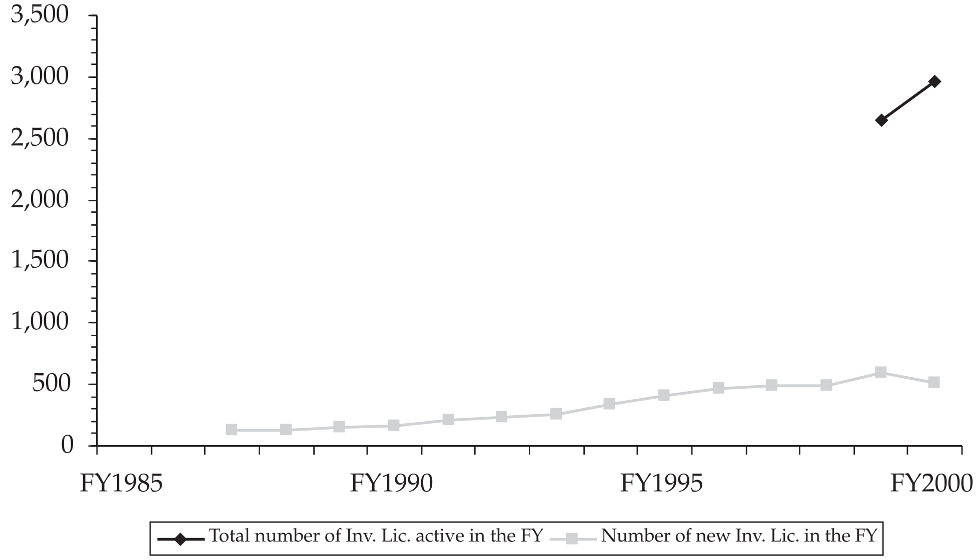
Licensing

Licensing of Inventions. Agencies reported 2,996 active licenses for inventions in FY 2000, a 12% increase over FY 1999 (figure 2.5). HHS and DoE accounted for the majority of this licensing activity—41% and 37%, respectively. Three other agencies contributed about 21%: USDA (8%), DoD (6%), and NASA (6%). The other five departments together accounted for 2% of all active invention licenses in FY 2000.

Collection of data on total active invention licenses began in FY 1999, so the trend for this measure, either across the federal labs or by department, is unknown. However, data on new invention licenses executed in the FY have been collected since 1987. This data suggest that total annual active invention licenses have been consistently growing from a low level in the late 1980s.[13]

[13] Figure 2.5 shows that the total number of new invention licenses executed annually has generally increased since the late 1980s. Corresponding trends for the predominant licensing departments (see Table A2.3 in Appendix 2) indicate substantial and generally continuous growth in the number of new invention licenses executed yearly since the late 1980s. Thus, it is likely that the trend for total active invention licenses over the period prior to FY 1999 is one of substantial upward growth from a low level in FY 1987.

Figure 2.5 All Active Invention Licenses, FY 1987–2000[1]



(1) Sum of the ten federal departments surveyed for this report.

Data on the total number of invention licenses active in the FY were not collected from the agencies until FY 1999.

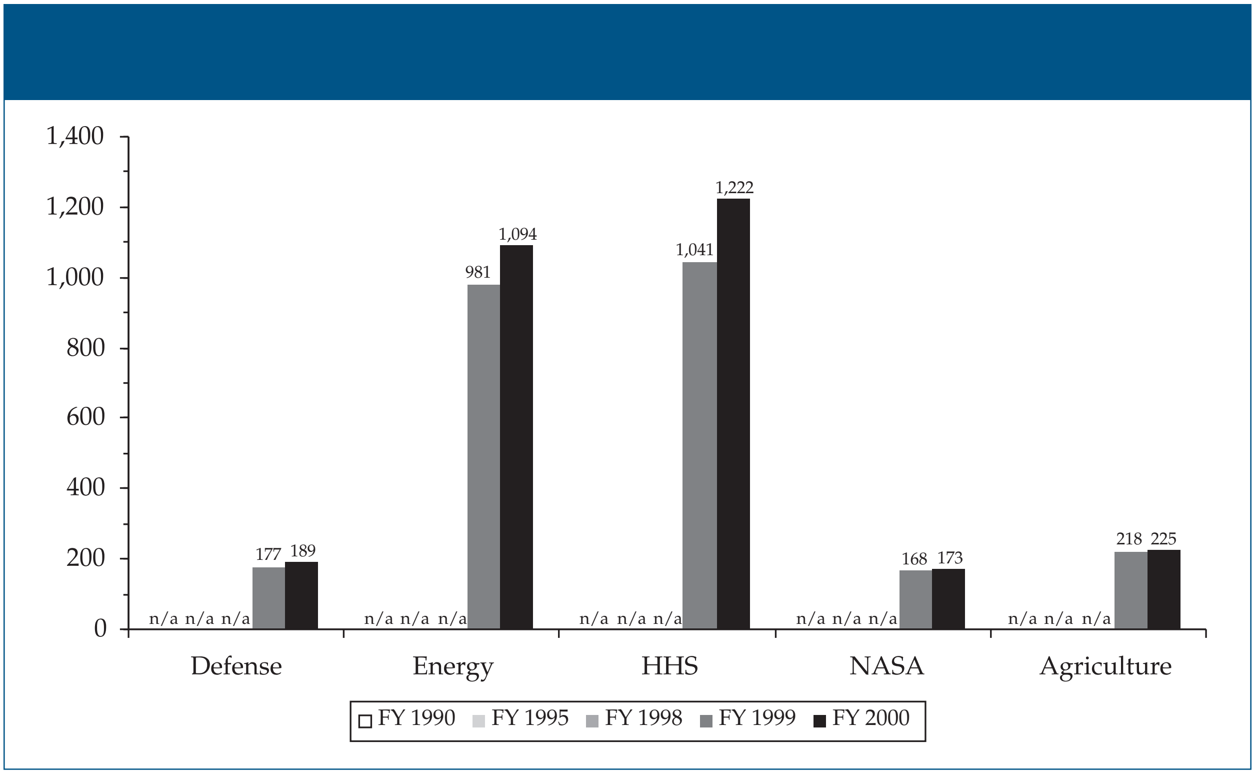
Table 2.4 - Distribution of Active Invention Licenses by Department, Selected Years[1]

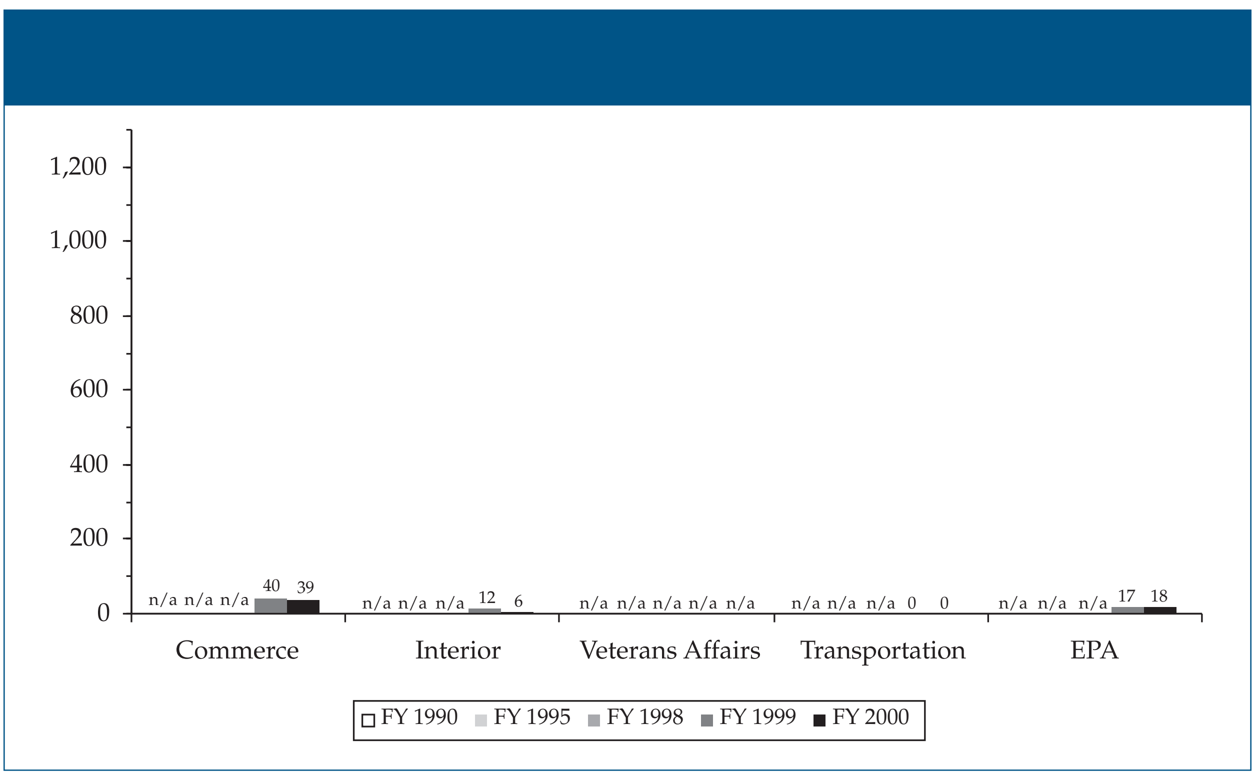
	FY 1990		FY 1995		FY 2000	
	Number in FY	Share of total	Number in FY	Share of total	Number in FY	Share of total
Defense	—	—	—	—	189	6.4%
Energy	—	—	—	—	1,094	36.9%
HHS	—	—	—	—	1,222	41.2%
NASA	—	—	—	—	173	5.8%
Agriculture	—	—	—	—	225	7.6%
Commerce	—	—	—	—	39	1.3%
Interior	—	—	—	—	6	0.2%
Veterans Affairs	—	—	—	—	n/a	—
Transportation	—	—	—	—	0	0.0%
EPA	—	—	—	—	18	0.6%
	=====	=====	=====	=====	=====	=====
All ten departments	—	—	—	—	2,966	100.0%

Source: Survey of the ten federal departments conducted by the U.S. Department of Commerce for this Biennial Report. See Table A2.3 in Appendix 2

(1) Data for these indicators were not requested from the agencies until FY 1997.

OFFICE OF TECHNOLOGY POLICY





Licensing of "Other Intellectual Property." Some of the agencies surveyed also reported licensing of "Other Intellectual Property." Not all the federal agencies license "Other IP" and not all that do were able to provide statistics for this survey. DoC, DoI, DoT, and VA indicated they do not presently license "Other IP." Thus, the FY 2000 figure of 2,189 may understate the total.

In this survey, "Other IP" was classified by the following three categories: *non-patented intellectual property* (tangible research products such as biological materials), *authored works* (e.g., software, engineering drawings, reference data), or *other information deemed commercially valuable by a partner and appropriately protected by the lab* (e.g., know-how used at the lab and applied to solve a specific problem relating to the partner's product).[14]

There were a total of 2,189 active "Other IP" licenses in FY 2000. (By way of comparison, the total of active invention licenses across the ten federal lab departments was 2,966.) Of these, 497 were classified as "non-patented IP"; 1,652 as "authored works"; and 40 as "information deemed commercially valuable by partner and protected." DoE accounted for 80% of the FY 2000 total—1,752 "Other IP" licenses, which were primarily "authored works."[15] HHS accounted for 386, all of which were classified as "non-patented research products." USDA, DoD, and NASA each reported several dozen "Other IP" licenses. (See table A2.3 in Appendix 2 for a full tabulation of the information collected by the survey.)

Income from Licensing

Income from Invention Licenses. For the ten federal departments as a whole, income from invention licensing has grown vigorously over the last several years and, indeed, throughout the 1990s (figure 2.7). The FY 1990 total of $9.4 grew to $68.8 million in FY 2000, inclusive of all forms of income forthcoming from active licenses in the fiscal year, whether from royalties or other kinds of payments. Most departments presently derive some income annually from invention licenses (figures 2.8 a and b), and most departments have experienced a rising level of license income throughout the last decade.

Nevertheless, there are significant differences between departments in the amount of income derived from invention licenses. HHS licenses currently predominate—and have done so throughout the last decade (table 2.5). HHS accounted for about 71% of total invention license income in FY 2000 and DoE for nearly 19%.

[14] The federal technology transfer laws permit federal labs to license intellectual property other than inventions. In view of the increasing importance and recognition of knowledge assets, data were collected on federal lab licensing of "Other IP" for the first time in this edition of the Biennial Report.

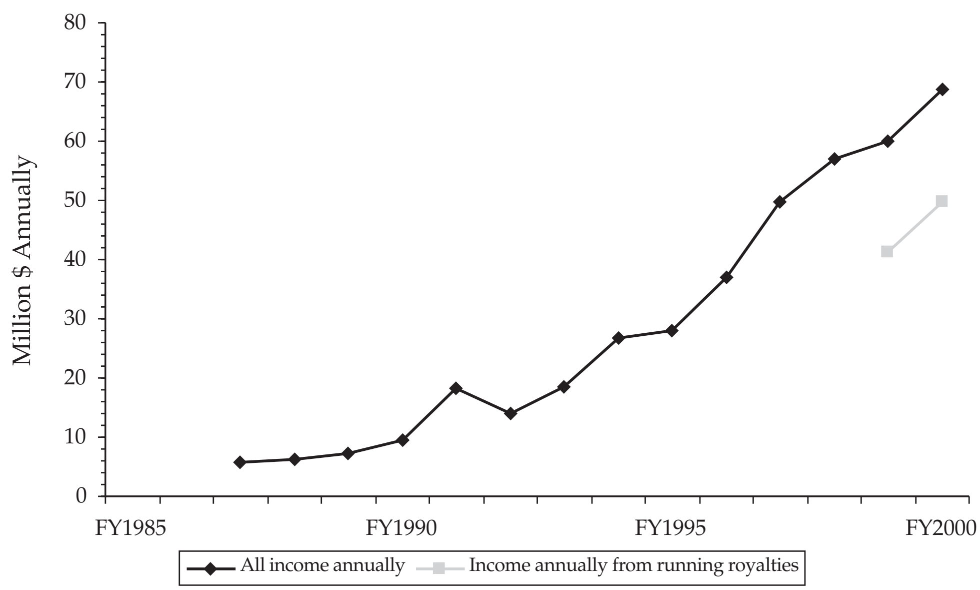
[15] This prevalence is understandable when it is recognized that employees of DoE's contractor operated laboratories are not federal employees. Thus, their works can be copyright protected and licensed.

	FY 1990		FY 1995		FY 2000	
	Million $ in FY	**Share of total**	**Million $ in FY**	**Share of total**	**Million $ in FY**	**Share of total**
Defense	$0.239	2.5%	$0.646	2.3%	$2.213	3.2%
Energy	$2.560	27.2%	$3.455	12.4%	$12.710	18.5%
HHS	$5.839	62.0%	$19.727	70.5%	$48.592	70.6%
NASA	$0.113	1.2%	$0.349	1.2%	$0.762	1.1%
Agriculture	$0.559	5.9%	$1.635	5.8%	$2.555	3.7%
Commerce	$0.052	0.6%	$0.042	0.2%	$0.123	0.2%
Interior	$0.041	0.4%	$2.000	7.2%	$0.850	1.2%
Veterans Affairs	n/a	—	n/a	—	$1.021	1.5%
Transportation	n/a	—	n/a	—	$0.000	0.0%
EPA	$0.003	0.0%	$0.110	0.4%	n/a	—
	=====	=====	=====	=====	=====	=====
All ten departments	$9.406	100.0%	$27.964	100.0%	$68.825	100.0%

Source: Survey of ten federal departments conducted by the U.S. Department of Commerce for this Biennial Report. See Table A2.4 in Appendix 2.

n/a = Data not available from the agency for this report.

Figure 2.7 All Annual Income from Invention Licenses, FY 1987–2000[(1)]



(1) Sum of the ten federal departments surveyed for this report.

Data on running royalty income from licenses was not collected from the agencies until FY 1999.

Figure 2.8(a) Annual Income from Invention Licenses, by Department, Selected Years

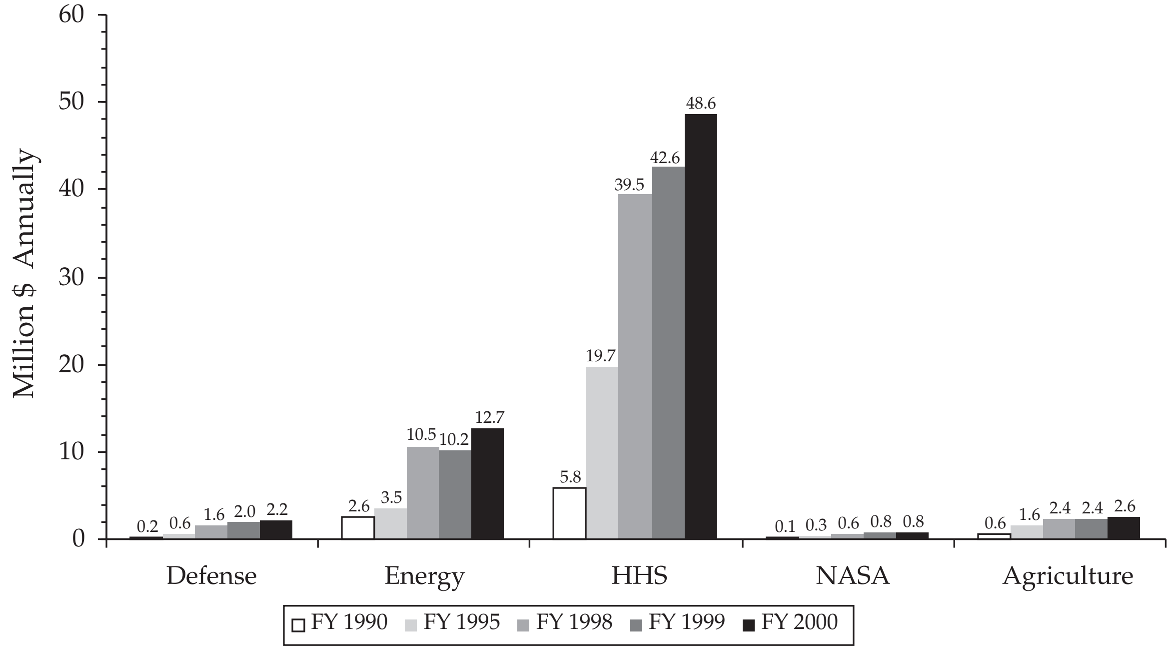
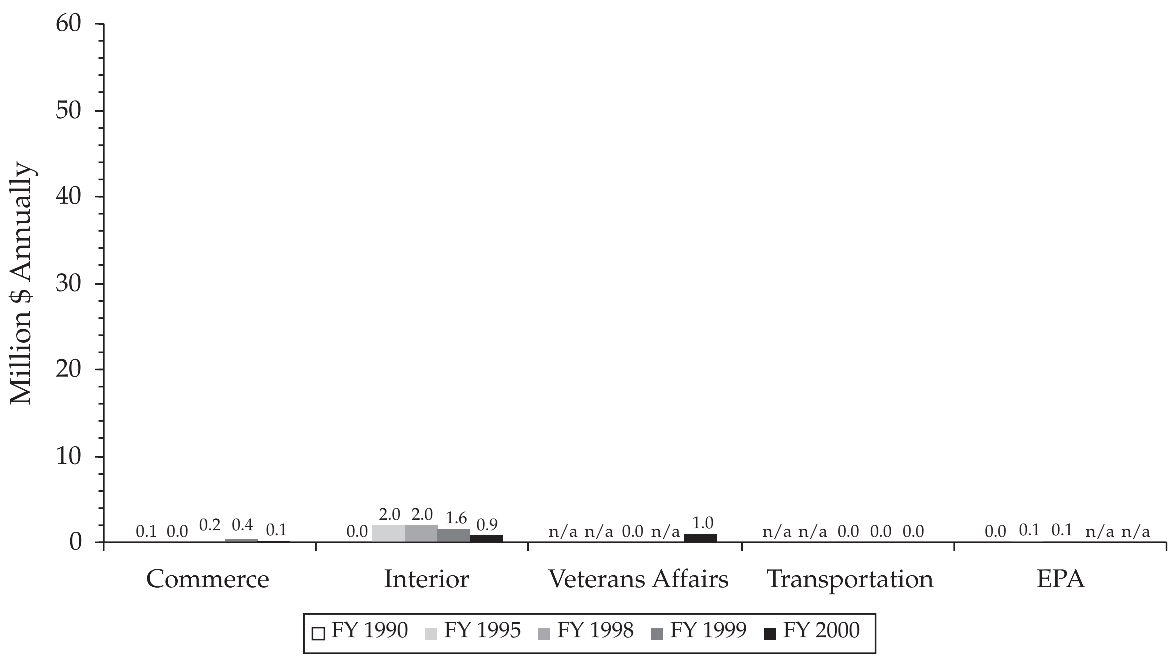


Figure 2.8(b) Annual Income from Invention Licenses, by Department, Selected Years



About 72% ($49.7 million) of the total $68.8 million invention license income in FY 2000 came in the form of running royalties.[16] This statistic is heavily influenced by the large fraction of the income that comes from HHS, where running royalty income predominates (accounting for 90% of all income from invention licenses in FY 2000). But USDA and DoI also receive the predominant fraction of annual income from invention licenses in the form of running royalties (72% and 100%, respectively, in FY 2000). At the other departments, running royalties account for between 18% and 30% of income received from invention licenses.

Income from "Other Intellectual Property" Licenses. Three of the federal lab departments reported receiving income from "Other IP" licenses in FY 2000: HHS ($4.0 million), DoE ($2.8 million), and NASA ($0.2 million). The FY 2000 total for all departments was about $7.0 million. HHS accounted for 57%, DoE for 40%, and NASA for 4%. (See table A2.4 in Appendix 2 for details.)

2.2 Downstream Outcomes from Federal Lab Technology Transfer

The transfer of federal lab know-how and technology to private industry partners can provide benefits to both partners and to society. For example: (1) new technology developed by a federal lab's scientists and engineers (and protected as intellectual property) might be licensed to one or more private industry partners that develop and successfully commercialize new products and processes based on that technology, or (2) new technology or know-how developed as the result of a cooperative R&D partnership between a federal lab and an industrial partner provides new ways for the industrial partner to improve a product line or production processes, or (3) the same kind of cooperative federal lab/industry partnership can also yield new technology and know-how that may improve the federal lab's capabilities for its mission-related work. The realization of such outcomes continues to be a primary motivation for federal technology transfer policy.

However, it is often difficult to analytically demonstrate direct connections between federal lab technology transfer actions and eventual commercial products/processes, because many actors and actions may be involved after transfer from a federal lab. Moreover, the actual development and commercialization of an idea often takes a number of years so that results are not immediately apparent.

[16] "Running royalties" are annual payments made to a lab by the licensee that are based on the sale or use of a licensed laboratory intellectual property. Such payments are earned income from the commercial marketplace, which is taken as a measure of a lab's active management and successful transfer of its intellectual property.

In an effort to better understand what outcomes are being achieved from federal lab technology transfer, the survey for this edition of the Biennial Report requested, for the first time, that agencies respond to the following questions for FY 1999 and 2000:

- Did one or more of your laboratories' technologies transferred under a CRADA become available for consumer (public) or commercial use?
- Did one or more of your industry partnerships under CRADAs produce technologies that will serve to strengthen the capabilities of the laboratory?
- Did one or more of your licensed technologies become available for consumer (public) or commercial use?
- Did one or more of your licensees produce a licensed product or process that will strengthen the capabilities of the laboratory?

Agencies responding affirmatively to these questions were requested to provide examples. Nine of the ten departments provided a "yes" response to one or more of the outcome questions in either FY 1999 or 2000. Seven of the ten departments provided a "yes" response in both FY 1999 and 2000. The agencies' responses are summarized in table 2.6.

Each of the nine departments reporting technology transfer outcomes in FY 1999 or 2000 provided examples and, in a few cases, many examples: Agriculture (4 cases), Commerce (1), Defense (17), Energy (10), EPA (3), HHS (4), Interior (5), NASA (1), Transportation (3). These cases are described in the department-by-department sections of this report's next chapter. The cases vary widely across the departments, and generally confirm the multiplicity of the steps, actors, and results that can be involved as federal lab science and technology works its way into the commercial marketplace or otherwise demonstrates its utility.[17] The detailed cases also confirm that federal science and technology are making their way beyond the confines of the lab and are having significant and useful impacts.

[17] Note that both the nature and number of the cases described were at the discretion of the responding agency. Accordingly, cases provide evidence of concrete success with federal lab technology transfer. But they do not provide—nor are they intended as—a complete, representative picture of the breadth of outcomes of federal lab technology transfer activities.

Department		*Total number of active CRADAs	*Total number of active invention licenses	From CRADAs: One or more transferred technologies became available for consumer or commercial use	From CRADAs: One or more industry partnerships yielded technologies that strengthen the lab's capabilities	From Licensing: One or more licensed technologies became available for consumer or commercial use	From Licensing: One or more licensees produced a licensed product or process that strengthens the lab's capabilities
Agriculture	FY 2000	257	225	Yes	No	Yes	No
	FY 1999	298	218	Yes	No	Yes	No
Commerce	FY 2000	208	39	n/a	n/a	Yes	Yes
	FY 1999	261	40	n/a	n/a	n/a	n/a
Defense	FY 2000	1,364	189	Yes	Yes	Yes	Yes
	FY 1999	1,350	177	Yes	Yes	Yes	Yes
Energy	FY 2000	687	1,094	Yes (57)	Yes (240)	Yes (34)	Yes (18)
	FY 1999	715	981	Yes (75)	Yes (231)	Yes (38)	Yes (8)
EPA	FY 2000	44	18	No	Yes (10)	Yes (1)	Yes (1)
	FY 1999	38	17	Yes (13)	n/a	Yes (2)	Yes (2)
HHS	FY 2000	244	1,222	No	Yes (1)	Yes (30)	Yes (42)
	FY 1999	237	1,041	Yes (1)	Yes (1)	Yes (56)	Yes (50)
Interior	FY 2000	40	6	Yes (2)	Yes (2)	Yes	Yes (1)
	FY 1999	30	12	No	n/a	No	Yes (11)
NASA	FY 2000	1	173	Yes	Yes	Yes	Yes
	FY 1999	1	168	Yes	Yes	Yes	Yes
Transportation	FY 2000	79	0	n/a	n/a	n/a	n/a
	FY 1999	51	0	Yes (1)	Yes (2)	No	n/a
VA	FY 2000	2	n/a	No	No	No	No
	FY 1999	1	n/a	No	No	No	No

* The listed figures for active CRADAs and invention licenses are meant to indicate the relative magnitude of current technology transfer activities by department. Due to the inevitable time lags and activities by outside parties involved, there is normally no relationship between the level of activities in a given FY and the number of “outcomes” that can be itemized.

( ) Figures in parentheses indicate the number of reported technology transfer outcomes identified by the department, although not all agencies systematically track the information and were able to provide such quantitative information.

n/a = Data not available from agency at time of this report.

Chapter 3
Departmental Perspectives

Statistics and other information on agency technology transfer programs, activities, and achievements activities, and achievements are presented for ten federal departments surveyed for this report.[18] Each of the departmental reports includes a description of the downstream technology transfer outcomes submitted in response to the survey questions. The ten departments included in this chapter are:

3.1 Department of Agriculture

3.2 Department of Commerce

3.3 Department of Defense

3.4 Department of Energy

3.5 Environmental Protection Agency

3.6 Department of Health and Human Services

3.7 Department of the Interior

3.8 National Aeronautics and Space Administration

3.9 Department of Transportation

3.10 Department of Veterans Affairs

Data are presented for selected fiscal years 1990, 1995, and the most recent period of 1998–2000. A full set of figures for the FY 1987–2000 period (as they are available) appears in Appendix 2 of this report.

[18] The nature and number of outcome cases provided were at the discretion of the agencies. As noted earlier, information on outcomes was requested from the agencies for the first time for this edition of the Biennial Report.

3.1 Department of Agriculture

		FY 1990	FY 1995	FY 1998	FY 1999	FY 2000
• Total active CRADAs		128	229	288	298	257
- New CRADAs executed in the FY		—	—	102	101	69
• One or more technologies transferred under a CRADA became available for consumer/ commercial use in the FY		—	—	—	Yes	Yes
• One or more industry partnerships yielded technologies that strengthen the lab's capabilities		—	—	—	No	No
• New inventions disclosed		158	133	208	162	109
• Patents applied for		76	80	64	84	78
• Patents issued		—	—	75	74	64
• Total active invention licenses		—	—	—	218	225
- New invention licenses granted in the FY		33	21	23	29	24
• Total active licenses for Other IP**		—	—	—	n/a	n/a
• One or more licensed technologies became available for consumer (public) or commercial use in the FY		—	—	—	Yes	Yes
• One or more licensees produced a licensed product/process that strengthen the lab's capabilities		—	—	—	No	No
• Total income from all licenses	(million $)	—	—	—	$2.377	$2.555
- Income from invention licenses	(million $)	$0.559	$1.635	$2.400	$2.377	$2.555
• Number of licenses earning running royalties		—	—	—	n/a	n/a
- Income from running royalties	(million $)	—	—	—	$1.843	$1.843

*Data covers the following departmental bureaus/divisions/services/offices: Agricultural Research Service (ARS) — whose activities account for the vast majority of technology transfer by the USDA's federal labs and other intramural research facilities.

**"Other IP" is defined to include: non-patented intellectual property (tangible research products such as biological materials), authored works (such as software, engineering drawings, reference data), and information deemed commercially valuable by a partner and appropriately protected by the lab (such as know-how used at the lab and applied to solve a specific problem relating to the partner's product).

"—": Data not requested from agency in previous years' reports.

"n/a": Data not available from agency at time of this report.

A more complete time series of data (FY 1987–2000, as available) appears in Appendix 2 of this report.

Program Background

The Department of Agriculture (USDA) is dedicated to enhancing the quality of life for the American people by supporting the production of agriculture, including ensuring a food supply, caring for the lands, and supporting sound rural development. As a part of that mission, the Department supports agricultural research at both its own laboratories and external research organizations, including universities.

The Department also has a long history of transferring technology to the agricultural community—both in the United States and abroad. Establishment of the land-grant colleges and universities by the Morrill Act of 1862 laid the foundation for agricultural productivity, with its emphasis on teaching, research, and extension services. During the rest of the nineteenth century and through much of the twentieth, agriculture was the principal focus for federal research and development programs. Agriculture remains an important science and technology based sector of our national economy.

The Department's overall budget authority in FY 2000 was $17.1 billion. Of this, authority for all R&D across the department totaled $1.776 billion.[19] Most of this amount is composed of the R&D activities of the Agricultural Research Service (ARS, $906 million); the Cooperative State Research, Education, and Extension Service (CSREES, $538 million); and the Forest Service ($211 million). The small remainder (around $0.1 million) reflects the R&D activities of some seven other bureaus, particularly the Economic Research Service and the Animal and Plant Health Inspection Service.

ARS is charged with extending scientific knowledge across a broad range of programs. The research work presently focuses on three categories: animal production, natural resources, and crop production. These are national research programs, developed in consultation with the agricultural community and are largely carried out in the ARS intramural research facilities.

CSREES works with the land grant institutions in each state and other educational institutions to link the Department's research and education programs. It seeks to advance research, extension services, and education in food and agricultural sciences, working through partnerships with public and private sector organizations. As a part of this work, CSREES sponsors research on agricultural product development, plant and animal genomes, integrated pest management, and other topics of concern to the agricultural community. One principal effort is the National Research Initiative Competitive Grants Program, which is charged with funding research on key problems in biological, environmental, physical, and social sciences on a peer-reviewed competitive basis.

[19] This figure includes basic and applied research, development, R&D facilities, and equipment. Source: Documents from the Office of Management and Budget (OMB) and the American Association for the Advancement of Science.

OFFICE OF TECHNOLOGY POLICY

The Forest Service conducts research—chiefly at the agency's intramural research facilities—concerning new technologies that can help sustain the health, productivity and diversity of the nation's forest and range lands. This new knowledge is intended to benefit private landowners in managing their lands, as well as to serve the needs of public land managers.

The Department's long history of technology transfer in support of agriculture has given it an opportunity to develop and refine an approach that suits its mission and the social and economic context in which it operates. The Department recognizes that in many circumstances, the results of its research are best disseminated through publication. As such, the Department provides nearly 9,000 publications per year to the world's knowledge base. In some cases, patent protection is sought for the innovations produced in its research programs. The Department decides whether to pursue patenting or other legal protection for its inventions by determining whether transfer to the private sector for development is necessary "as an intermediate step in getting the benefits to the ultimate users, farmers and consumers."[20]

In implementing the Stevenson-Wydler and Bayh-Dole Acts, the Department has created separate technology transfer offices for its two principal intramural research organizations: the Agricultural Research Service and the Forest Service.

Researchers at ARS are served by its Office of Technology Transfer (OTT), headquartered in Washington. Authority on behalf of ARS to enter into CRADAs and to license its patents has been delegated to OTT. The staff includes technology transfer coordinators located in six geographical areas across the country. As a historical note, ARS was the first federal laboratory to sign a CRADA.

In the Forest Service, authority to enter into CRADAs has been delegated to the Director of the Forest Products Laboratory and, as well, to the directors of various field operations and experimental stations maintained by the Forest Service. License agreements are negotiated and administered by the Office of the Forest Service Patent Advisor at the Forest Products Laboratory in Madison, Wisconsin.

Selected Examples of Downstream Outcomes from Agency Technology Transfer

- **AquaVac-ESC™** became the world's first approved, licensed, and manufactured live fish vaccine in FY 1999. This new vaccine will help the catfish industry solve a key problem and provides producers with a more cost-effective way to raise healthy fish for consumers. The vaccine is expected to provide lifelong protection against enteric septicemia (ESC) of catfish.

  Previously, producers had to dispense antibiotics in feed to control the disease—an impractical approach, since sick fish do not eat. Additionally, over time, the ESC bacterium develops resistance to the antibiotics. The vaccine can be used in fish as young as 7 days

[20] Agricultural Research Service, Technology Transfer in ARS, p. 1.

and up to 31 days after hatching. (Seven days is the youngest age at which catfish have been vaccinated to prevent infection.) The vaccine can also be given by bath immersion on the truck that takes the young fry to the pond, or in tanks at the hatchery.

The technology resulted from an agreement executed in 1998 between the USDA's Agricultural Research Service (ARS), the Aquatic Animal Health Research Laboratory (Auburn, AL) and Intervet, Inc. (Millsboro, DE). The objective was to conduct biosafety and field efficacy trials at channel catfish farms in the Mid-South area, for ARS' patented, modified live vaccine to prevent enteric septicemia of catfish caused by *Edwardsiella ictaluri*. The vaccine master seed was transferred to Intervet in 1998, where the vaccine was manufactured and licensed by USDA's Animal and Plant Health Inspection Service (APHIS) for use in 7 to 14 day old channel catfish fry to prevent ESC. Between 1998 and 2000, ARS and Intervet conducted field and biosafety trials, to further develop the vaccine for commercial use. ARS was awarded a U.S. patent for the ESC vaccine in 2000.

Intervet launched the ESC vaccine as AquaVac-ESC™ in 2001, and subsequently sold about 300 million doses to catfish farmers in the Mid-South area. AquaVac-ESC™ was successfully received by farmers and greatly or completely reduced the losses in fish due to ESC in the farms where the fish were immunized. By 2002, the CRADA agreement between ARS and Intervet also is expected to lead to the manufacture and licensing of a modified live vaccine to prevent columnaris disease or fin rot in channel catfish caused by *Flavobacter columnare*. Columnaris disease is the second most important disease problem in catfish after ESC.

- **Dragonfly™** is a new kind of insect trap that effectively attracts and kills mosquitoes and biting flies. The technology represents an environmentally friendly alternative to chemical pesticides for mosquito control and broadly supports the increasing public interest in least-toxic pest management practices.

  Dragonfly™ contains a mosquito lure, which blends carbon dioxide, heat, and octenol—the same chemical cues that naturally attract mosquitoes and other biting insects. The trap mimics the human or animal blood system, which helps lure mosquitoes to the trap. When mosquitoes home in on the target and stop to dine, they are killed with an electronic pulse and fall into a removable tray. This is a big advantage over traditional electrical, "bug zapping" types of traps, which widely splatter the insect's remains.

  The technology for the trap was developed through cooperative research (via a CRADA) between the USDA's Center for Medical, Agricultural, and Veterinary Entomology, Mosquito and Fly Research Unit (Gainesville, FL) and the James Nolen & Company (Warwick, RI). (Nolen & Company later became the BioSensory Insect Control Corporation, with headquarters in Willimantic, Connecticut.) The purpose of this CRADA was to develop technologies (for residential, commercial, and scientific applications) to monitor and/or control mosquitoes and biting flies without using chemical insecticides. ARS scientists provided entomological expertise; Nolen & Company provided engineering expertise. At the time the CRADA was initiated, traps for mosquito control were being marketed, but were ineffective in managing the pests and killed large numbers of harmless and beneficial insects.

Other companies have sublicensed the technology from BioSensory to develop similar versions of the trap, to meet specific needs—for example, a version that uses propane to generate the heat and carbon dioxide.

- **CIDETRAK®CRW** is an environmentally friendly insecticide spray additive that helps protect corn crops from corn rootworms—a major pest in the Corn Belt and Texas.

CIDETRAK®CRW improves the selectivity of insecticides that target rootworm beetles. When combined with any of several insecticides, only one-tenth the normal application rate is necessary to achieve control. And the combination works better than conventional sprays. Additionally, by rotating use among insecticides, farmers can help prevent insecticide-resistant corn rootworm strains from quickly developing in their fields.

CIDETRAK®CRW also helps to address two problems that arise with spray-applied chemical control agents: being washed away by rainfall and the death of beneficial insects from insecticide exposure. The spray formulation includes a sticky wheat gluten, so when spray droplets dry on leaves, they stick like glue. The gluten also acts to shield the insecticide from beneficial insects, reducing their potential for exposure to the toxin. Rootworm beetles are enticed to feed specifically on the spray residue and effectively eat a lethal dose of poison.

The technology was developed through a CRADA between the USDA's National Center for Agricultural Utilization (Peoria, IL) and Trécé, Inc. (Salinas, CA). The CRADA resulted from discussions in 1999 in the course of a USDA sponsored Areawide Program for Corn Rootworm Management. State and federal scientists attending this meeting recognized the potential for the development of insecticide resistance by the pest and voiced concern at the development of an area-wide management program based on a single insecticide chemistry. Trécé was already underway with a project to develop improved traps for monitoring the incidence of beetles in the field. The company recognized a market opportunity to use existing USDA technologies to create a useful spray additive and fill a market niche. A license to use gluten for a formulation ingredient was obtained through the Biotechnology Development and Research Corporation. Through the CRADA, the optimal formulation of CIDETRAK®CRW was developed and tested by USDA researchers.

In a broader perspective, the CIDETRAK®CRW technology is part of a national Integrated Pest Management (IPM) program to help reduce reliance on agricultural chemicals. The technology helps provide safer, more effective methods for controlling agricultural pests. It has also led to new developments in bioassay protocols and field evaluation techniques.

- **Surround®WP crop protectant** is a particle film that works as an environmentally friendly insect repellant to control pear psylla—an insect that damages pear crops and can result in major crop losses. Surround®WP crop protectant became commercially available in 2000.

  This particle film technology provides a means to replace chemicals that kill insects with particles that repel insects. The films are made from kaolin, which is a non-toxic, reflective mineral. This reflectiveness works to reduce both damage and heat stress.

  Scientists at the USDA/ARS's Appalachian Research Station (Kearneysville, WV) conducted the initial experiments with particle coatings on apples and pears. The success of this early work was limited, but, nonetheless, revealed sufficient promise. Soon after (in September 1996), the Appalachian Research Station entered into a CRADA with the Englehard Corporation (Iselin, NJ) to both determine the commercial potential of hydrophobic particles for arthropod control and to advance beyond the ARS' achievement in reducing disease and heat damage to plants. The agreement combined USDA's agricultural knowledge and research capabilities with Engelhard's expertise in particle formulations and processing. The shared goal was to develop an insect control approach that is environmentally benign but as effective as conventional pesticides.

  This technology enlarges on the set of approaches and products available for alternative pest control. It also works to increase grower interest in environmentally friendly alternatives to chemical pesticides.

3.2 Department of Commerce

		FY 1990	FY 1995	FY 1998	FY 1999	FY 2000
•Total active CRADAs		82	407	337	261	208
- New CRADAs executed in the FY		—	—	77	62	40
• One or more technologies transferred under a CRADA became available for consumer/commercial use in the FY		—	—	—	n/a	n/a
• One or more industry partnerships yielded technologies that strengthen the lab's capabilities		—	—	—	n/a	n/a
• New inventions disclosed		46	65	40	35	32
• Patents applied for		28	35	66	27	18
• Patents issued		—	—	19	26	14
• Total active invention licenses		—	—	—	40	39
- New invention licenses granted in the FY		0	4	17	7	3
• Total active licenses for Other IP**		—	—	—	0	0
• One or more licensed technologies became available for consumer (public) or commercial use in the FY		—	—	—	n/a	Yes
• One or more licensees produced a licensed product/process that strengthen the lab's capabilities		—	—	—	n/a	Yes
• Total income from all licenses	(million $)	—	—	—	$0.394	$0.123
- Income from invention licenses	(million $)	$0.052	$0.042	$0.241	$0.394	$0.123
• Number of licenses earning running royalties		—	—	—	n/a	n/a
- Income from running royalties	(million $)	—	—	—	n/a	n/a

*Data covers the following departmental bureaus/divisions/services/offices: National Institute of Standards and Technology (NIST). (Does not include statistics from the National Oceanic and Atmospheric Administration and the National Telecommunications and Information Administration—but which have exhibited considerably smaller levels of technology transfer activities, compared to NIST.)

**"Other IP" is defined to include: non-patented intellectual property (tangible research products such as biological materials), authored works (such as software, engineering drawings, reference data), and information deemed commercially valuable by a partner and appropriately protected by the lab (such as know-how used at the lab and applied to solve specific problem relating to the partner's product).

"—": Data not requested from the agency in previous years' reports.

"n/a": Data not available from the agency at time of this report.

A more complete time series of data (FY 1987–2000, as available) appears in Appendix 2 of this report.

OFFICE OF TECHNOLOGY POLICY

Program Background

The Department of Commerce (DoC) works in partnership with business, universities, communities, and workers to promote U.S. competitiveness. It does this by strengthening economic infrastructure, facilitating the development of cutting-edge science and technology, providing an information base, and by managing national resources.

The Department's overall budget authority in FY 2000 was $8.7 billion. Of this, authority for all R&D across the department totaled $1.174 billion.[21] The vast majority of the R&D budget comprises activities of the National Oceanic and Atmospheric Administration (NOAA, $643 million) and the National Institute of Standards and Technology (NIST, $455 million). The remainder (about $60 million) largely reflects the R&D activities of the National Telecommunications and Information Administration (NTIA) and the Bureau of the Census, along with very small amounts for the Technology Administration (Office of the Undersecretary/Office of Technology Policy) and Economic Development Administration (EDA).

NOAA conducts research and development to support its two-fold mission of environmental assessment and prediction and environmental stewardship. NOAA's research programs are carried out by five major divisions and a number of special program units. The divisions include the National Weather Service, the Office of Oceanic and Atmospheric Research, the National Environmental Satellite, Data and Information Service, the National Ocean Service, and the National Marine Fisheries Service. NOAA's broad responsibilities are supported by a program of research conducted primarily at agency laboratories, but with additional research at universities throughout the country. This research presently focuses on three main areas: tracking and warning of dangerous weather systems; helping to guide the nation's use and protection of ocean and coastal resources; and improving our understanding of the oceans and atmosphere that sustain life on the planet.

NIST develops and disseminates measurement techniques, reference data, test methods, standards, and other infrastructural technologies and services that support U.S. industry, scientific research, and the activities of many federal agencies. In addition to the core measurement, testing, and standards functions carried out by its laboratory programs, NIST also conducts several extramural programs, including: the Advanced Technology Program, to stimulate the development of high-risk, broad-impact technologies by U.S. firms; the Manufacturing Extension Partnership, to help smaller firms adopt new manufacturing and management technologies; and the Baldrige National Quality Program, to help U.S. businesses and other organizations improve the performance and quality of their operations by providing clear standards and benchmarks of quality.

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[21] This figure includes basic and applied research, development, R&D facilities, and equipment. Source: Documents from the Office of Management and Budget (OMB) and the American Association for the Advancement of Science.

OFFICE OF TECHNOLOGY POLICY

NTIA is a principal adviser on telecommunications policies affecting economic and technological advancement and telecommunications regulation. NTIA's Institute for Telecommunication Sciences (ITS), the principal federal laboratory for telecommunications science and engineering, conducts research in support of this mission. ITS also provides specific telecommunications planning and evaluation for federal agencies and U.S. industry.

The Bureau of the Census conducts survey research, chiefly for the executive branch. This includes the decennial census of the nation's population. The Bureau also conducts business surveys, which provide the basis for the economic indicators the Department periodically issues.

Technology transfer from the Department's research labs and agencies derives chiefly from the activities of NIST, NOAA, and NTIA. The Department has delegated authority to negotiate and execute CRADAs and licenses to each of the organizations conducting research.

NIST delegates this authority to each of its laboratories, while maintaining a central Office of Technology Partnerships (OTP) at its principal facility in Gaithersburg, MD. Patent licensing at NIST is handled by this central OTP.

NIST's mission is to develop and promote measurement, standards, and technology to enhance productivity, facilitate trade, and improve the quality of life. In carrying out this mission, NIST works directly with industry partners, universities, associations, and other government agencies. NIST accounts for most of the Department's industry/laboratory partnerships, and many of these partnerships are with consortia of companies in specific sectors seeking to explore an issue of common interest. Generally, the emphasis of NIST's technology transfer work is on *the broad dissemination of research results within a sector*, rather than on the creation of intellectual property and associated licenses.

NOAA, which has laboratories throughout the United States, also delegates authority to enter into CRADAs to its individual laboratories, while maintaining a primary ORTA in Silver Spring, Maryland. This ORTA handles patent licensing for NOAA, along with the Department's Office of General Counsel.

ITS (the NTIA laboratory) has been delegated authority to enter into CRADAs and patent licenses. ITS has an ORTA, but also coordinates with a common ORTA in Boulder, Colorado, where NIST and NOAA both have research facilities.

Selected Examples of Downstream Outcomes from Agency Technology Transfer

National Institute of Standards and Technology (NIST) —

As discussed above, NIST utilizes CRADAs, licenses, and other technology transfer mechanisms to collaborate with industry and to ensure that the resulting knowledge and technologies are broadly disseminated. NIST does not focus on the creation of intellectual property and the generation of associated licenses—although, these mechanisms are used, where appropriate, as tools to accomplish NIST's mission. While there are instances of technologies developed through NIST CRADAs or licensing arrangements that have become available for commercial use, NIST does not systematically collect data about such downstream developments and, thus, cannot provide an exact count of the number of commercially valuable technologies generated as a result of collaborative ventures. Nonetheless, examples can be provided on an anecdotal basis:

- **NIST helps semiconductor manufacturers identify defects in materials.** As the semiconductor industry continues to miniaturize its products, the detection of contamination in the chip-production process becomes more difficult. Inspection systems on fabrication lines evaluate the quality of wafers during various stages of production, but the typically used optical-based techniques have difficulty detecting the smallest particles that may cause defects in materials used to manufacture computer chips.

  NIST scientists investigated how light scatters when contacting these surfaces, and as a result of this research, designed an instrument that eliminates background interference and allows semiconductor manufacturers to measure surface contaminants on a microscopic level. After receiving a patent for this invention, NIST licensed the technology to ADE Corporation (Westwood, MA) in FY 2000 to further develop and market the product.

  Because of NIST's research, ADE Corporation has enhanced the sensitivity of their instruments to detect micro-contaminants found on material surfaces. As a result, a technical challenge for the semiconductor industry has been addressed, allowing manufacturers to continue to miniaturize their products and enabling faster, smaller, and more efficient computers.

3.3 Department of Defense

		FY 1990	FY 1995	FY 1998	FY 1999	FY 2000
• Total active CRADAs		113	845	1,424	1,350	1,364
- New CRADAs executed in the FY		—	—	399	449	425
• One or more technologies transferred under a CRADA became available for consumer/ commercial use in the FY		—	—	—	Yes	Yes
• One or more industry partnerships yielded technologies that strengthen the lab's capabilities		—	—	—	Yes	Yes
• New inventions disclosed		1,383	1,168	1,028	1,060	991
• Patents applied for		807	759	755	703	774
• Patents issued		—	—	579	547	553
• Total active invention licenses		—	—	—	177	189
- New invention licenses granted in the FY		15	34	34	61	67
• Total active licenses for Other IP**		—	—	—	n/a	n/a
• One or more licensed technologies became available for consumer (public) or commercial use in the FY		—	—	—	Yes	Yes
• One or more licensees produced a licensed product/process that strengthen the lab's capabilities		—	—	—	Yes	Yes
• Total income from all licenses	(million $)	—	—	—	$2.005	$2.213
- Income from invention licenses	(million $)	$0.239	$0.646	$1.560	$2.005	$2.213
• Number of licenses earning running royalties		—	—	—	42	29
- Income from running royalties	(million $)	—	—	—	$0.865	$0.672

*Data covers the following departmental bureaus/divisions/services/offices: Army, Navy, Air Force.

**"Other IP" is defined to include: non-patented intellectual property (tangible research products such as biological materials), authored works (such as software, engineering drawings, reference data), and information deemed commercially valuable by a partner and appropriately protected by the lab (such as know-how used at the lab and applied to solve specific problem relating to the partner's product).

"—": Data not requested from agency in previous years' reports.

"n/a": Data not available from agency at time of this report.

A more complete time series of data (FY 1987–2000, as available) appears in Appendix 2 of this report.

OFFICE OF TECHNOLOGY POLICY

Program Background

The Department of Defense's (DoD) total budget authority in FY 2000 was $287.3 billion. Of this, authority for all R&D across the department totaled $39.96 billion.[22] Split by major services and offices, the Army's R&D activities totaled about $5.2 billion; that of the Navy, $9 billion; the Air Force, $14.5 billion; and various other defense agencies (e.g., Defense Advanced Research Projects Agency, Ballistic Missile Defense Organization), $9.4 billion overall.

DoD's budget for R&D is the largest of all the federal agencies. However, it should be noted that "R&D" at DoD includes funding (typically extensive) for testing, evaluation, prototype development, and other activities that precede actual production. In this respect, "science & technology" R&D at DoD—the so called 6.1–6.3 R&D activities, plus medical research in defense health programs—accounted for only $8.832 billion of the Department's nearly $40 billion budget authority for R&D in FY 2000.

A new paradigm for technology partnering with the private sector is emerging at DoD as a result of current budgetary and technological trends. The Department recognizes that the huge increases in private sector research expenditures, both in the U.S. and around the globe, have made it extremely difficult to stay on the cutting edge of all the technologies of importance. Accordingly, the new paradigm puts emphasis on partnering with the private sector, other agencies, and academia to leverage the Department's position in militarily critical technologies.

As a result, DoD has committed itself to technology transfer of several kinds. The Department's technology transfer programs include cost sharing of research with the private sector (dual use technologies), integrating advanced commercial technologies into its work (spin-on technologies), and making existing technologies more affordable through spin-offs to the private sector. These approaches have been adopted as a basic feature of DoD policy and are being implemented throughout the DoD research system.[23]

DoD's technology transfer program is decentralized, with more than 100 ORTAs and other focal points for technology transfer across the Department's large and complex laboratory system. The Department also recognizes a need to coordinate these and related activities and has, toward this end, created the Office of Technology Transition in the Office of the Secretary of Defense, pursuant to 10 USC § 2515. The office provides leadership within DoD on technology transfer programs under the Stevenson-Wydler and Bayh-Dole Acts. It also manages related technology partnership programs, such as the Dual Use Science and Technology Program, the SBIR program, the Manufacturing Technology Program (ManTech), portions of the information collection and dissemination activities of the Defense Technical Information Center, the Independent Research and Development

[22] Source: Documents from the Office of Management and Budget (OMB) and the American Association for the Advancement of Science.

[23] DoD, Directive 5535.8 (DoD Technology Transfer (T2) Program), May 14, 1999; DoD, Directive 5535.3 (DoD Domestic Technology Transfer (T2) Program), May 21, 1999.

program, the Title III program under the Defense Production Act, and the Commercial Operations and Support Savings Initiative.

The three DoD service branches—the Army, Navy, and Air Force—maintain laboratories with a wide range of state-of-the-art human and physical resources. Included are expertise in a number of technical areas, as well as world-class facilities and equipment, many of which are unique. Also, DoD differs from all of the other federal agencies in that its mission-related responsibilities are particularly extensive—such as, space missions, medical research, land management, health care, telecommunications, weaponry, national security, transportation, environmental management, and training.

The Army has delegated authority to enter into CRADAs and patent license agreements to the commanders and directors of its laboratories, R&D centers, test and evaluation centers, and medical institutes. Each of these organizations has an ORTA that is the point of contact for potential users of a laboratory's technology infrastructure. The Army's Domestic Technology Transfer Program is intended to work through the decentralized, coordinated efforts of these ORTAs.

At the Navy, signature authority for standard CRADAs and licenses has been delegated to all major Navy facilities where R&D is performed. Nevertheless, only slightly more than half of those facilities have formally established ORTAs. For management and control purposes, the collection of licensing fees and the distribution of royalties are performed at the Office of Naval Research headquarters.

The Air Force has authorized commanders and directors of each of its research, development, test, and evaluation centers to enter into CRADAs and licensing agreements. The Air Force maintains fourteen ORTA offices, one at each of its six laboratory sites and the remaining eight located at other research organizations.

DoD continues its traditional involvement with local governments and the communities in which the department's many bases and laboratories are located. DoD laboratories also partners with universities through CRADAs.

Finally, in looking at data on the Department's technology transfer activities, it is important to recognize that DoD and its laboratories (like NASA and DoE) have a long history of obtaining "defensive" patent protection to ensure that patents obtained by others cannot block its access to militarily important technologies. As a result, the quantitative metrics presented earlier in this report show a disproportionately large number of patents in relation to the number of licenses that the services grant each year.

Selected Examples of Downstream Outcomes from Agency Technology Transfer

Army —

- **LASFORM[SM] laser forming system**. This is a new rapid prototyping technology, which confers production and cost advantages in the manufacture of traditionally cast and forged components.

  This technology is a flexible, one-step process by which a precursor material (usually a powdered metal introduced into a laser beam) is deposited as molten droplets onto a metallic substrate located beneath the focused beam. Through computer instructions, a multi-axis positioning system drives the substrate in motions reproducing a horizontal layer (or slice) of the part as described by a computer aided design (CAD) model. After the initial layer has been deposited and fused to the substrate, the beam and power delivery subsystem are indexed in the vertical direction by an amount equal to the layer thickness. A layer-upon-layer deposition sequence is then repeated until the desired density is achieved. While other rapid prototyping processes are available, none has the size capability of LASFORM, and the properties of their prototyped parts do not have sufficient strength or toughness to be used in the field.

  LASFORM was developed by the Army Research Laboratory (ARL). The technology is being further developed and commercialized through an FY 2000 CRADA between ARL and AeroMet (a subsidiary of MTS Systems Corp, in Eden Prairie, Minnesota). AeroMet was founded in 1997 with the sole purpose of commercializing LASFORM and also capitalizing on ARL's vision and direction in rapid prototyping.

  AeroMet has installed and is now operating a large-scale laser forming system at its facility. It is also now working with Boeing (and the Navy) to demonstrate the viability of the LASFORM process in producing and repairing hard to get titanium spare parts for aircraft and ship applications. A number of companies are now evaluating the technology for reducing the cost of traditionally cast and forged components. Partnerships have also been formed with several companies to share data and reduce the cost of implementing new manufacturing processes. Based on LASFORM capability, AeroMet can now produce traditionally high-cost parts for commercial and DoD aerospace applications.

- **iScreen—a digital technology for improved and automated refractive eye screening.** Based on advanced imaging and signal processing, this technology is a major improvement over standard refractive photography and provides a greatly improved process for screening children and adults for various eye diseases. The digital iScreen device is significantly smaller and lighter than standard 35 millimeter photographic systems; it also provides real-time feedback and increases the accuracy of diagnoses.

  Refractive photography has been used for many years to diagnose eye diseases. The problem with this process, however, is that the quality of a picture is uncertain until the film is developed (which may require subsequent patient visits). Also, a full cycle of photography and analysis can take several weeks.

The iScreen technology result from a CRADA between the U.S. Army Aviation and Missile Command's Missile Research, Development, and Engineering Center (MRDEC) and Vision Partners, a private company (Memphis, TN). The CRADA arose from a Vision Partners inquiry to MRDEC in 1997, seeking to investigate prospects for automating and improving the refractive process through advanced imaging and signal processing. This partnership produced the iScreen device, which was capable of screening both children and adults in a matter of seconds for a range of eye diseases such as amblyopia, strabismus, and cataracts and refractive problems such as myopia, hyperopia, and astigmatism. Design of the unit and construction of a first set was provided by MRDEC staff. However, this construction was subsequently transitioned to another private company (SPARTA Inc., Huntsville, AL). A patent for the unit was expected in FY 2000. Testing and demonstration is proceeding in doctor's offices and schools.

- **Sudden Infant Death Syndrome Monitor and Stimulator.** SIDSMAS is an acoustic physiological monitoring sensor, with the potential to save many lives. It employs a fluid-filled bladder with a hydrophone inside that matches the acoustic impedance of an infant in contact with the pad. As presently marketed, the unit also provides heat, soothing sounds, and vibrations to help the child fall asleep and, with transmitter/alert functions, can be useful in nurseries, hospitals, day-care centers, and homes.

A single acoustic sensor can collect information concerning heart, lungs, and digestive tract functions, or detect changes in voice or sleep patterns, motor activity, and mobility. The primary beneficiaries of the technology presently are infants, adults suffering from sleep apnea, and those who monitor their bodily processes during exercise. But future applications will likely be far wider, including the infirm, hospital patients, and the elderly.

The SIDSMAS technology was invented and developed by a single Army Research Laboratory (ARL) scientist—who has received three U.S. patents for the technology and has three foreign applications pending. The data collected by this inventor for the technology has been recognized by surgeons and research physiologists as outstanding and is regarded by many to be the basis for the next generation stethoscopes and long-term health monitoring.

The SIDSMAS technology has been licensed to the Vestaguard Corporation, which plans to develop and market a SIDS and apnea monitor for infants and adults who suffer from sleep disorders. Vestaguard is also working with ARL, through a CRADA, to continue development of the technology. The technology has also been licensed to Personal Electronics Devices Inc., which will be marketing SIDSMAS for purposes of ambulatory monitoring for people engaged in exercise.

- **Shelf-stable, ready-to-eat military rations.** These are several types of pocket sandwiches that are shelf-stable at room temperature for up to three years and which continue to look freshly prepared. These ration items are based on an innovative adaptation of intermediate moisture food (IMF) technology. They were developed to support Army mobilization requirements for the 21st century.

  IMF technology involves the careful balancing of moisture, pH, and water binding that gives foods soft, moist qualities but which does not promote microbiological growth. This simplifies shipping, distribution, and handling and increases soldier acceptance, mobility, and consumption.

  This adaptation of IMF technology is the result of work reaching fruition in FY 1999 by the Mobility Enhancing Ration Components team, of the U.S. Army Soldier Systems Command (SSCOM), at the Army's Natick RD&E Center (NRDEC). An SSCOM CRADA with Sara Lee Bakery produced extended shelf-life bakery items that do not require refrigeration. Another SSCOM CRADA with GoodMark Foods, Inc. provided further development of the meat-filled sandwich components.

  The new rations were commercialized through Sara Lee Bakery. GoodMark Foods, Inc. is commercializing the meat-filled sandwich components. There have been several additional requests from major food industrial organizations to collaborate on commercializing similar food products.

Navy —

- **Technique to centrifugally cast metal matrix composites.** A pair of researchers at the Naval Surface Warfare Center Carderock Division invented a new technique for centrifugal casting of metal matrix composites. This technology is now being transferred to private companies for development of commercial applications.

  With careful selection of an alloy for the matrix material and a very hard powder for desired wear characteristics, metal matrix composites can be used to create a wide variety of parts, including tubes, brakes, clutches, and gears that have different desirable material properties. Typical examples of metal matrix composites are silicon carbide, boron carbide, and titanium carbide in aluminum, magnesium, and bronze matrices, respectively. These composites incorporate short fibers and whiskers and particles in metallic matrices. When ingots of these composites are cast in a rotating mold, it is possible to produce large and small, intricate and simple, symmetrical components. Depending upon the respective densities (or specific gravities) of the metal matrix and the particles, it is possible to produce tailor made composites with reinforced wear surfaces on the outer or inner part as desired.

  The NSWC scientists invented a technique to centrifugally cast such composites and opened a way to fabricate a wide variety of parts with different material properties in differing sections of the part. For example, this technique has been used to produce a longer lasting, more efficient, cost effective brake pad for the U.S. Navy, which complied with environmental regulations for alternatives to asbestos material.

The Navy inventors received a patent for this technology in 1991. To provide a second procurement source, a CRADA was signed in 1997 with U.S. Bronze Foundry and Machine Inc. (a supplier of bronze friction drums for Navy standard hauling winches). In 1999, NSWC licensed the technology (on partially exclusive basis) to MSE Technology Applications Inc. (Butte, MT) to develop the technology to a wide variety of automotive and aerospace applications (such as disk brake rotors and clutch plates for land, air, and space vehicles). In 2000, a CRADA was signed with John Crane Marine U.S.A., a company interested in applying the technology to large diameter seal rings.

- **Security system for local area computer networks.** A computer network security system based on Market Central Inc.'s SecureSwitch™ Information Security System (SSISS) and Radionics Inc.'s Readykey® Information Security System for Computers™ (RISSC) has been developed for local area computer network security that is superior to existing techniques. The combined SSISS/RISSC system provides a maximally secure computer network for processing highly sensitive data.

In 1996, an employee of the Naval Air Warfare Center Weapons Division (NAWCWD) invented and patented a basic shielded computer network switch for safely isolating and connecting local networks to external networks. The technology was further refined and moved toward commercialization through a CRADA that NAWCWD signed in 1997 with Market Central Inc., to produce the switches, and with Radionics Inc., to access its control technology and market distribution system. The RISSC system combines Radionics' Readykey® Access Control System with patented secure network switches developed by the Naval Air Warfare Center Weapons Division and Market Central, to provide high level password protection, authentication, discretionary access control, audit trail, and network configuration management. The SSISS system follows a similar approach.

With the SSISS/RISSC system, basic security features no longer reside on each individual network computer platform. The secure computer network system uses network architecture consisting of units of the basic shielded switch, a data relay switch, and a computer power on/off relay switch. The computer security requirements of password protection, authentication, discretionary access control, audit trail, and network configuration management are directly tied to each computer system's power supply and external network connections which are monitored and controlled by a system administrator. The system uses hardware and software to determine when and where a user may enter the system.

This is the only network switch to be approved by the Department of Defense as meeting the National Communication Security Memorandum (NACSIM) 5203 security requirements. The National Security Agency tested, validated, and accepted the original system for its own use.

The annual U.S. market for the SSISS/RISSC computer security systems is projected to be in excess of one million workstations in 2002. The Navy's secure switch technology was transferred and is licensed to Market Central—which now sells the switches as a commercial product line. Market Central is in the process of obtaining foreign patents in order to conduct international sales.

- **Spill Sentry, an automated oil spill sensing technology.** This technology was developed by the Space and Naval Warfare (SPAWAR) Center to improve response to accidental oil discharges by providing an early notification of a petroleum spill on water. Oil spill detection methods currently practiced at marine facilities worldwide rely solely upon the use of human observation to visually identify the presence of a spill, which is often very unreliable, especially during foul weather, darkness, or in locations difficult to monitor.

  An array of fluorescence-based sensors operates from just below the water surface, continuously testing for an increased petroleum hydrocarbon (POL) contaminant concentration, which is indicative of a spill. Data from each of the sensors is transmitted via a secure radio receiver to a central base station computer for analysis, display, logging, and alarming. The primary intended use of the system is to protect marine facilities from accidental petroleum discharges by providing responding authorities with immediate notification of the occurrence of a leak or spill.

  This detection technology has been licensed to Applied Microsystems Ltd. (Sidney, British Columbia), which is currently manufacturing and marketing a commercial version (named *Spill Sentry*) of the Navy sensor. This transfer was achieved through a patent license agreement in January 2000. After initial test marketing, Applied Microsystems projects sales of more than 1000 units/year. The Navy benefits from the commercial availability of a cost-effective oil spill sensor system and from patent royalties on all sales (national and international). The public benefits from a cleaner aquatic environment as spills and their resulting ecological damage are minimized.

  Several related spin-off products are being developed from the transferred technology including an oil content monitor for shipboard bilge systems, an aquatic bioluminescence detection system, and an aquatic toxic algae sensor.

- **Commercial applications of omni-directional vehicle drive technology.** The Naval Sea Systems Command (NAVSEA) entered into a two-year CRADA in January 1996 with Air Tracks Inc. (New Jersey) to transfer NAVSEA's omni-directional vehicle (ODV) technology. Air Tracks was incorporated to commercialize innovative technology for the production of omni-directional vehicles.

  ODV technology enables vehicle movement in any direction, which is especially advantageous for operations in confined or hazardous spaces. This technology is mechanically simpler and easier to fabricate, maintain, and operate than standard all-wheel steer (AWS) vehicles.

The ODV drive consists of four identical drive units, omni wheels, suspension system, a battery, and an electronic control system with each wheel having its own motor. The technology provides a method to overcome the limitations of conventionally steered vehicles in demanding environments, a reliable and controllable drive system adaptable to support autonomous and robotic systems, an ability to move in any direction and reposition a load precisely, and a system design that is scalable to support vehicle load capacity. For example, unlike a standard forklift, an ODV can overcome factory floor surface obstacles and difficult surfaces while operating in a small or irregular space.

Air Tracks—now doing business under the name AIRTRAX Corp.—markets and sells forklifts and a ground-handling machine based on ODV technology. The company plans to use ODV concepts for a wheelchair design. AIRTRAX has been awarded a Navy Phase II Small Business Innovation Research program award (SBIR) to develop a materials handling device for NAVSEA using omni-wheel technology.

- **Head contact microphone, based on a surface laminated piezoelectric film transducer.** Vocalizations made by a wearer are transferred through physical contact of the transducer with the human cranium, usually the forehead. With external noise eliminated in this way, this microphone technology allows the user to communicate in high noise environments.

The transducer is used as a head contact microphone (with dimensions of approximately one inch by one inch by one-eighth inch, with electrical leads attached). The transducer is placed into contact with the cranium by several means—the most common one being mounted in the headband of a hat or helmet. A constriction band in the hat or helmet provides for a firm fitting and tight contact with the forehead. The primary advantage of this assembly is its ability to reject ambient high intensity acoustic sources, which enables effective communication in a wide range of high noise environments, such as aircraft operations, hazardous materials suits, fire and police communications, manufacturing plants, and underwater communication systems such as scuba gear.

The basic technology was developed and patented in 1989 by a civilian employee of the Naval Sea Systems Command (NAVSEA). It was further developed by NAVSEA in subsequent years.

In 1996, the Pittsburgh Fire Department in conjunction with NASA's Mid-Atlantic Technology Applications Center, expressed interest in the possible use of the technology in fire fighting equipment such as helmets. NAVSEA initiated a relationship with Sensory Systems, Inc. (a Pittsburgh, PA, small business) to develop the technology. Sensory Systems received a non-exclusive license in 1999 to manufacture a head contact microphone assembly kit that could be placed in fire fighting helmets or other similar applications. The first products were delivered in early 2000. Sensory Systems is targeting the fire fighting community in the U.S. as the initial market and is considering foreign countries in the future.

Other companies have submitted applications, and negotiations for additional non-exclusive licenses are in progress. Due to the publicity of this technology, other branches of the military and other government agencies have expressed interest. Other applications under consideration include hazardous materials garments, manufacturing facilities, heavy equipment operation, man-machine interfacing, and assistive technology.

- **Single molecule biosensors.** A new class of biosensors has been developed that provide a means to detect a wide variety of biomolecules, including proteins, viruses, and bacteria. This new technology enables production of small, inexpensive, and highly sensitive sensors with widespread applications in consumer, medical, automotive, aerospace, and robotics markets.

  These biosensors use principles of atomic force microscopy (AFM) to measure the strength of single DNA-DNA and antibody-antigen bonds—in effect, detecting and characterizing single molecules of DNA or antigen. In brief, magnetic microbeads are set to pull on these bonds with a known force; the bond strengths are tested by observing whether the beads detach. This force-assay approach provides a common sensor platform from which various kinds of physical, chemical, and biological measurements can be made with high sensitivity, cost effectiveness, accelerated data management, integration, and reliability. This technology is likely to impact standard sensing measurements, biological diagnostics, and drug discovery.

  The technology was created by the Naval Research Laboratory, under programs sponsored by the Army, Navy, and the Defense Advanced Research Projects Agency (DARPA), to develop highly sensitive sensors for chemical and biological weapons applications.

  Three such sensors—a micromechanical sensor, an optical microscope, and a magnetoresistive sensor—were licensed to Graviton, Inc. (La Jolla, CA), a start-up company, formed to develop and market the sensor technology. The licenses were intended to facilitate applications in the areas of pharmaceutical drug discovery; clinical and non-clinical diagnostics; and chemical sensors for passive environmental monitoring, active process monitoring, and portable gas monitoring.

  Graviton introduced its first gas-monitoring product in 2000. It has also taken on a new corporate partner, a biotechnology company, that will further the technology and develop products in the fields of pharmaceutical drug discovery, clinical diagnostics, and non-clinical diagnostics under a sublicense.

- **Quantitative Mobility Spectrum Analysis (QMSA) for evaluating semiconductor electronics materials.** This technology provides a fully automated process for characterizing the fundamental electrical properties of layered semiconductor structures. QMSA is a valuable new tool for R&D, diagnostics, and quality control in semiconductor manufacture and research.

QMSA provides a fully automated analysis of magneto-transport data for a variety of complex semiconductor materials. It allows for accurate and simultaneous characterization of the density and mobility of multiple charge carriers in semiconductor materials. The analytical method for characterization, developed and optimized in the 1980s and 1990s, was combined with software to implement the method. In 1995, the methodology was further refined and transformed into an algorithmic approach. By using QMSA to monitor materials in near real-time, manufacturers can increase product quality and decrease the number of wafers that fail to meet specifications, resulting in an overall cost reduction.

Naval Research Laboratory (NRL) scientists developed and patented QMSA. In 1996, NRL both licensed this patent to and established a CRADA with Lake Shore Cryotronics Inc. (Westerville, Ohio). LSCI is an international supplier and developer of instrumentation systems with computer automated operations that characterize the magnetic properties of a variety of materials, including superconductors, permanent magnets, thin film magnetic media, and ultrathin multilayer films. LSCI has incorporated QMSA into two new computer controlled systems for Hall effects analysis. Under the CRADA, NRL scientists have worked collaboratively with LSCI to transfer electrical characterization expertise, refine the QMSA algorithm, provide advice on product development, and assist in responding to LSCI customer questions. QMSA is also available as a stand-alone software product.

NRL is continuing to improve the QMSA product and increase its capabilities, both in collaboration with LSCI under the CRADA and through ongoing government-sponsored programs. LSCI anticipates expansion into other industrial markets, such as bipolar transistor and infrared detector manufacturers. As LSCI expands its product sales and customer feedback is analyzed, enhancements to the system will be developed and new applications examined.

- **Temporally Ordered Routing Algorithm (TORA) for mobile wireless networks.** TORA is a novel approach to routing—i.e., finding paths for forwarding information through a network—that better fits the needs of dynamic, bandwidth constrained, wireless networks. TORA supports the extension of Internet-type information and services to users on the move or in remote locations.

  TORA establishes a multi-path routing structure to improve robustness and reduce the frequency of protocol reactions to network dynamics. The protocol is designed to be highly adaptive, efficient, robust, and scalable to reduce communication overhead, thus preserving limited bandwidth and resources of wireless systems. The range of potential applications for this technology and the communities it may benefit are extremely large, including disaster mobilization, emergency connectivity, fleet management, data acquisition/monitoring in remote or high-risk environments, forward-deployed military operations, and factory automation.

TORA was invented and patented by a Department of the Navy employee and his University of Maryland advisor during the course of his graduate thesis research. The Naval Research Laboratory (NRL) and the University of Maryland granted a non-exclusive license to Nova Engineering Inc. (Cincinnati, OH) in August 2000 to develop and market the technology.

Nova Engineering has developed a wireless router product based on the TORA technology. This product will allow the rapid deployment of mobile networks capable of supporting Internet-type services with little or no pre-existing infrastructure. Potential applications include home networking (such as all home appliances being part of a wireless network), distributed sensor networks, and wearable computing. The inventor is also actively pursuing TORA standardization efforts through the Internet Engineering Task Force.

- **LaserNet Fines** (LNF) is an online optical system for monitoring the mechanical wear of equipment. This near real-time methodology provides on-site imaging, diagnostics, and categorization of wear debris particles that allows early identification of the potential for failure due to wear. This system provides these functions through the combination of online optical imaging, computerized identification, and assessment.

LNF utilizes a pulse laser diode to form images of debris particles in a flowing fluid system and computer image analysis and classification algorithms based on neural networks and fuzzy logic to determine the size and concentration of particles and identification of the mechanical wear processes associated with the particles from their shape characteristics. This fully automated system can determine the type, severity, and rate of progression of mechanical faults and can make recommendations for appropriate remedial actions. The technology is applicable to a wide range of machinery types, including engines, gearboxes, drive trains, and hydraulic systems. It is applicable for fault analysis in aircraft, helicopters, surface ships, submarines, heavy land vehicles, construction and off-road equipment, railroad equipment, oil drilling equipment, and almost any other mechanical system with rotating, reciprocating, or articulating parts.

The underlying LNF technology was developed by Naval Research Laboratory (NRL) scientists, for which a patent was issued in 1996. Following NRL's construction of a laboratory prototype in 1995, Lockheed Martin Naval Electronics and Surveillance Systems Division was selected to produce a field deployable instrument for the Navy. Lockheed Martin delivered first prototypes in 1998. Presently, a first generation Lockheed Martin product is available on an off-the-shelf basis and is on board ships to improve Navy maintenance programs. A smaller and less expensive, second-generation instrument is being completed.

With successful completion of the first instrument for the Navy, Lockheed Martin recognized there would be commercial potential. And on this basis, NRL licensed the technology to Lockheed Martin to facilitate commercial applications. Presently, Lockheed Martin has entered into an agreement with another private company (Spectro, Inc.) for marketing and distribution within the oil analysis community.

Air Force —

- **Composite forearm crutch (for medical therapy).** Joint development activities between the Air Force Research Laboratory Materials and Manufacturing Directorate and Ergonomics, Inc. have yielded a carbon fiber reinforced forearm crutch which is 56% lighter yet stronger than traditional aluminum forearm crutches. In addition, the crutch is quiet (in contrast to aluminum, which is noisy) and aesthetically pleasing.

  The probably greatest benefit of this new technology is to patients using forearm crutches for an extended or lifetime period, such as post-polio, spinal injury, etc. Use of this new crutch allows the user reduced muscle fatigue and accompanying secondary shoulder and joint fatigue. The fact that the crutch is quiet to use, as well as aesthestically pleasing, provides additional self-esteem to the user.

  The Air Force's partner in this venture, Ergonomics Inc., is a start-up company directed at developing ambulatory assist devices such as crutches, walkers, and canes.

- **EMCORE Photovoltaics.** Formed only recently in 1998, the Pholtovoltaics Division of the EMCORE Corp. has established a state-of-the-art manufacturing facility in the Sandia Research Park (New Mexico) and has become the recognized leading supplier worldwide of space solar cells.

  Collaborative work by an Air Force Research Laboratory (AFRL) scientist/manager and a Sandia National Laboratories scientist in 1997–98 yielded an idea and approach for utilizing a novel material, InGaASN, for quadruple junction solar, with a potentially high conversion efficiency. (The theoretical limit conversion efficiency of this quadruple junction technology is 42.5%. By comparison the conversion level available from the best triple junction technology in 2000 was around 26%.) This concept sparked considerable interest among researchers and industry. This invention lead EMCORE to form a Photovoltaics Division in 1998, in close proximity to AFRL and Sandia. Soon after, EMCORE licensed the intellectual property for the quadruple junction solar cell developed by the Air Force. AFRL has also awarded EMCORE a contract under the Dual Use Science and Technology Program to develop the >35% efficiency solar cell technology.

- **New technology to aid in shoreline restorations.** The Air Force's Air Armament Center is working (via a CRADA) with the Benedict Engineering Company, Inc. (Tallahassee, FL) to demonstrate a new approach to the groyne system that appears to be effective in accreting sand on shore to extend and re-nourish beaches which are eroding.

It is generally accepted by the coastal engineering community that porous groynes work, notwithstanding that this classical piling system is usually both expensive and permanent in its installation. By contrast, Benedict Engineering's new groyne system—which it developed and has patented—involves a netting material that is porous and allows water to flow through while trapping or allowing sediment to settle. Also, unlike the previous approach, this new system is removable.

If the demonstration proves successful, the porous (net) groynes system will be established as an effective, economical means to meet a critical need for controlling shoreline erosion in many areas.

- **KnowledgeKinetics, a collaborative framework.** This is a first commercial version of software that leverages information and simulation technology to enhance decision support by linking information and tools together to get critical information to decision-makers when and where they need it. This software was developed and released in FY 2000 by the Ball Aerospace and Technologies Corporation, as one part of the Air Force's ongoing Collaborative Enterprise Environment (CEE) program.

  The Information Directorate of the Air Force Research Laboratory has initiated a major effort to implement a "collaborative enterprise environment" (CEE) to provide the framework and development methodology required for affordable and timely technology for the 21st century warfighter. Collaborative Environments are an enabling technology which will allow the entire research or design team to simultaneously solve problems using a common set of models, simulations, databases, and tools. The CEE concept is a major cultural change in the research and development process that involves applying state-of-the-art simulation and information sharing technology to the way business is done.

  Ball Aerospace worked with the Air Force on a cooperative (non-CRADA) basis to develop the KnowledgeKinetics software.

3.4 Department of Energy

		FY 1990	FY 1995	FY 1998	FY 1999	FY 2000
• Total active CRADAs		1	1,392	868	715	687
- New CRADAs executed in the FY		—	—	266	240	151
• One or more technologies transferred under a CRADA became available for consumer/ commercial use in the FY		—	—	—	Yes (75)	Yes (57)
• One or more industry partnerships yielded technologies that strengthen the lab's capabilities		—	—	—	Yes (231)	Yes (240)
• New inventions disclosed		1,335	1,758	1,313	1,474	1,371
• Patents applied for		366	571	751	850	788
• Patents issued		—	—	512	525	515
• Total active invention licenses		—	—	—	981	1,094
- New invention licenses granted in the FY		62	140	162	202	169
• Total active licenses for Other IP**		—	—	—	1,403	1,752
• One or more licensed technologies became available for consumer (public) or commercial use in the FY		—	—	—	Yes (38)	Yes (34)
• One or more licensees produced a licensed product/process that strengthen the lab's capabilities		—	—	—	Yes (8)	Yes (18)
• Total income from all licenses	(million $)	—	—	—	$11.764	$15.840
- Income from invention licenses	(million $)	$2.560	$3.455	$10.536	$10.199	$12.710
• Number of licenses earning running royalties		—	—	—	193	220
- Income from running royalties	(million $)	—	—	—	$1.975	$2.228

*Data covers the following departmental bureaus/agencies/services/offices: Comprehensive of DoE's federal laboratories (GOGO and GOCO).

**"Other IP" is defined to include: non-patented intellectual property (tangible research products such as biological materials), authored works (such as software, engineering drawings, reference data), and information deemed commercially valuable by a partner and appropriately protected by the lab (such as know-how used at the lab and applied to solve specific problem relating to the partner's product).

"—": Data not requested from agency in previous years' reports.

A more complete time series of data (FY 1987–2000, as available) appears in Appendix 2 of this report.

OFFICE OF TECHNOLOGY POLICY

Program Background

The Department of Energy (DoE) is the science and technology agency whose research supports our nation's energy security, national security, and environmental quality and contributes to a better quality of life.

DoE traces its origins to the Manhattan Project and the national effort to develop an atomic bomb during World War II. Following the war, Congress passed the Atomic Energy Act of 1954, which created the Atomic Energy Commission (AEC) to take over the scientific and industrial complex related to work with nuclear energy. The AEC initially focused on national security-related uses of atomic energy but the Atomic Energy Act gave birth to a commercial nuclear power industry and gave the AEC regulatory authority over it. In 1974, the AEC was abolished and two new agencies created: the Nuclear Regulatory Agency to regulate the commercial nuclear power industry and the Energy Research and Development Administration to manage the national security related programs.

DoE was created to provide a unified federal approach to energy issues and in response to the challenges presented by the energy crisis of the 1970s. The new department undertook responsibility for long-term, high-risk R&D in energy technology, federal power marketing, energy conservation, nuclear weapons, and energy regulation. During the 1970s, the Department emphasized energy development and regulation. In the 1980s, the emphasis shifted to nuclear weapons research, development, and production. In the period since the end of the Cold War, the Department has focused on environmental clean up of the nuclear weapons complex, nonproliferation and stewardship of the nuclear stockpile, energy efficiency and conservation, and technology transfer and industrial competitiveness.

DoE's overall budget authority in FY 2000 was $17.8 billion. Of this, authority for all R&D across the department totaled $6.956 billion.[24] Funding for R&D in energy and science programs totaled $3.755 billion. Funding for the National Nuclear Security Administration and other defense related programs totaled $3.201 billion.

DoE engages in a wide range of technology partnerships with others as a part of its mission. Many of these partnerships are integral parts of DoE programs. For example, the Office of Industrial Technologies (OIT), one of the components of the Office of Energy Efficiency and Renewable Energy, creates partnerships among industry, trade groups, government agencies, and other organizations to research, develop, and deliver advanced energy efficiency, renewable energy, and pollution prevention technologies for industrial customers. Through its "Industries of the Future" program, OIT creates partnerships between industry, government, and supporting laboratories and institutions to accelerate technology research, development, and deployment.

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[24] This figure includes basic and applied research, development, R&D facilities, and equipment. Source: Documents from the Office of Management and Budget (OMB) and the American Association for the Advancement of Science.

Similarly, the Office of Building Technology, State and Community Programs (BTS) is facilitating an industry-led initiative to develop technology roadmaps focusing on various aspects of the building industry. Roadmapping provides a framework both for cooperative technology development efforts and for market transformation activities that will help to accelerate the adoption of new technologies and approaches in the marketplace. It also assists in aligning government R&D resources with the high-priority needs identified by industry.

The Office of Environmental Management (EM) within the Department manages the largest environmental management program in the country—the clean-up of legacy wastes from nuclear weapons manufacturing. EM provides science and technology, ranging from basic research to technology development and demonstration, including deployment of innovative remediation technologies. Technical assistance is provided to successfully deploy innovative scientific and technological solutions to clean up the sites, while addressing long-term environmental stewardship needs.

In addition to these kinds of programmatic partnerships, the Department supports technology transfer partnerships with the private sector, built on the capabilities and expertise of its laboratories and facilities. These technology transfer partnerships use a variety of mechanisms, including CRADAs and the licensing of intellectual property.[25]

DoE has unique statutory authority under which it conducts these technology transfer activities. Under the Atomic Energy Act of 1954, the Department of Energy was granted authority to take title to all inventions made in the United States that are useful solely in the utilization of special nuclear material or atomic energy in an atomic weapon. DoE may also take title to all inventions useful in the production or utilization of special nuclear material or atomic energy, made or conceived under contractors or arrangements entered into for the benefit of DoE, whether or not funds are expended.[26] At the same time, under that Act, DoE was directed to establish a program for the dissemination of scientific and technical information produced at its laboratories for the advancement of science and industry. Thus the agency and its laboratories have had dual roles: identifying and protecting sensitive or classified information for the security of the nation, while sharing its other information with the public.

[25] The Department has identified the following mechanisms for achieving technology transfer in this manner: (1) Cooperative Agreements (generally cost-shared with industry, universities or others); (2) Cost-Shared Contracts/Subcontracts (procurement-based collaborations for mutual benefit); (3) Personnel Exchange Programs (allowing government or laboratory staff to work in industry facilities or industry personnel to work in government labs); (4) R&D Consortia (arrangements involving multiple federal and nonfederal parties working for a common R&D objective); (5) Technical Assistance to Small Business (undertaken in response to an inquiry from an individual or organization seeking to further knowledge, solve a specific problem, or improve a process or product). DoE R&D Council Technology Transfer Working Group, Partnering for Success: A Review of DoE Technology Transfer Policies and Procedures (June, 1999), App. A, available at http://www.er.doe.gov/production/octr/aeptr/ttwg.htm.

[26] 42 USC §§ 2168, 2181–2183.

Unlike other federal agencies, DoE carries out most of its mission activities through a system of federal laboratories at government-owned, contractor-operated (GOCO) facilities. These laboratories, referred to as "national laboratories," are typically operated under five-year management and operating contracts by universities, not-for-profit organizations, and large businesses. This operating structure dates back to the 1940's, when the decision was made to keep the nuclear weapon laboratories separate from the Defense Department and to retain a workforce of non-federal employees.

The unique statutory authorities and the use of GOCO laboratories introduce added legal complexities into the Department's technology transfer efforts. DoE has, through its management and operating contracts, waived intellectual property rights to the inventions of its contractor-operators under terms that parallel those found in the Bayh-Dole and Stevenson-Wydler Acts. Since laboratory employees are not federal employees, the GOCO operators may, with prior DoE approval, assert their rights in both copyrightable works and patentable inventions, for purposes of licensing for commercialization. In addition, under the National Competitiveness Technology Transfer Act of 1990, Congress granted DoE the authority to delegate to its laboratories the authority to enter into CRADAs.

As a result of their advanced national security work, the DoE national laboratories and associated production facilities have developed unique competencies and capabilities that often exceed those found either in the private sector or in other federal laboratories. For example, as a part of their nuclear weapons work, the national laboratories pushed the domestic industry to develop ever faster, more powerful computers and compatible information storage and telecommunications systems.

Generally, DoE's approach to managing its intellectual resources varies widely across the breadth of the Department's laboratory system. Its weapons laboratories and production facilities have a history of conducting R&D and protecting the results for mission purposes. However, the DoE laboratories performing research in environmental quality and energy efficiency and conservation have a strong charge to share the results of the work with the public. These differences in mission can lead to differences in approach to the use of patenting, CRADAs, and patent licenses.

Management of the technology transfer process for DoE has been delegated to the Department's field offices, which now have authority to approve most CRADAs. The Department has delegated CRADA authority to its two GOGO fossil fuel laboratories and each of its GOCO laboratories. Licensing practices at the DoE contractor-operated laboratories are similar to those followed by universities under the Bayh-Dole Act.

Selected Examples of Downstream Outcomes from Agency Technology Transfer

- **Variable frequency microwave** (VFM) is a technology for processing advanced materials used in semiconductors, electronics packaging, and optical electronics. The process allows for selective and rapid curing of electronic polymers, which confers savings of manufacturing cost and allows for freedom of material selection.

Significant funding was focused in the late 1980s and early 1990s on the application of microwave energy for processing advanced materials (e.g., advanced ceramics, composites, high performance polymers). Favorable results were produced in the laboratory, with benefits including significantly reduced processing time and enhanced material properties. Nonetheless, the prospect of scale-up to commercial size and manufacturing reliability was restricted due to problems of uniformity and reproducibility related to then conventional microwave technology.

Researchers at DoE's Oak Ridge National Laboratory (ORNL) conceptualized the VFM process as a way around these challenges. VFM relies on microwave energy that is electronically swept through a broad range of frequencies. This new approach eliminated the hot-spots and non-uniformity of the curing process that resulted from conventional, fixed-frequency microwave ovens.

Initial efforts by ORNL established proof-of-principle for VFM, and yield an ORNL patent for the process. Subsequently, ORNL entered into a CRADA with Microwave Laboratories, Inc., a manufacturer of broadband microwave tubes, to investigate initial applications and packaging options for the technology in R&D applications.

In 1994, Lambda Technologies (Morrisville, NC) was formed with the sole purpose of commercializing the VFM technology. Lambda received an exclusive licensing agreement from ORNL late that year, for the base VFM patents. An ORNL-Lambda CRADA was also established to pursue the best areas for VFM applications. The strength of this relationship enabled Lambda to obtain venture capital funding to begin product definition and marketing. Lambda's first product line, the VariWave®1500, won an *R&D 100 Award* in 1997. Since that start-up and first product two additional CRADAs and four new license agreements have been executed between ORNL and Lambda. There are now a total of 16 patents issued to ORNL and/or Lambda Technologies based on the fundamental use of VFM.

In 1998, Lambda launched two new VFM products for polymer processing in the electronics industry: the MicroCure®2100, a batch processing system, and the MicroCure®5100, an inline, automated production system. To date, more than 50 VFM systems have been installed for processing advanced polymer adhesives and encapsulants used in semiconductor and opto-electronic applications.

At present, Lambda focuses primarily on the semiconductor and photonics market. However, university and industrial users of the original VariWave® VFM products are conducting research into additional industrial applications. ORNL is collaborating on research seeking to apply VFM to biomedical applications.

- **Regenerable desulfurization sorbent** (RSV-1). This is a material, formed into pea-sized pellets, that can function as a very efficient sponge to remove sulfur from gasified coal used to power turbines for electricity generation. RSV-1 can withstand the high temperatures of the gasification process, can be used over and over again, and has significant cost advantages over other coal cleaning alternatives.

RSV-1 was invented by a pair of staff researchers at DoE's National Energy Technology Lab. The material has been some 20 years in development, but in the end provides a simple solution to a very complex and long-standing problem in advanced coal-based power generation. The technology is regarded as a leapfrog advancement in state-of-the-art coal and fuel gas cleaning. The inventors recently received an award for the material from *R&D Magazine*, calling it one of the 100 most significant technology developments in the year 2000.

Exclusive rights to produce RSV-1 has been licensed to Süd Chemie (formerly, United Catalysts Inc.) of Louisville, KY.

In addition, the U.S. Navy is presently exploring the use of RSV-1 to facilitate the use of fuel cells as shipboard power sources. Fuel cells are electrochemical devices that convert hydrogen to electricity. In shipboard application, the hydrogen stream will come from diesel fuel and removal of sulfur from this gas steam will be critical. Due to RSV-1's high reactivity and effectiveness and ability to be regenerated over multiple cycles—all of which will allow a large reduction in the size and weight of the fuel cell power system—the Navy's customary shipboard use of diesel fuel will provide virtually pollution free operation.

- **Multi-junction solar cells.** Solar cell technology licensed from DoE's National Renewable Energy Laboratory (NREL) provided a basis (in part) for the Emcore Corporation (headquartered in New Jersey) to form a Photovoltaic Division (located in Albuquerque, New Mexico) in early 1998, with the purpose of producing cutting edge multi-junction solar cells.

  By the fall of 1999, Emcore Photovoltaics had delivered initial samples of cells to a few customers for evaluation. By January 2000, 23% efficient dual-junction solar cells were being manufactured in quantity for a spacecraft program. Development of an advanced design commenced soon after with the objectives of providing higher efficiency and less radiation damage in orbit. And in September 2000, a triple-junction cell with 26% efficiency and better radiation performance was in production.

  Original members of Emcore Photovoltaics had previously worked at DoE's Sandia National Laboratory, on related technology. Licensing and technical support from NREL (in addition to Emcore's own intellectual property) provided key assistance during the company's development phase. In 2001, Emcore Photovoltaics underwent substantial expansion, due to growing demand for its solar cell products.

- **Waste Inspection Tomography (WIT) to non-invasively characterize nuclear waste drums.** WIT is a non-invasive and non-destructive waste-drum inspection technology that allows for safe and accurate inspections of nuclear waste drums, and provides a cost-effective minimization of the need for potentially hazardous glovebox inspections. WIT utilizes computer tomography (CT), a technology that served to revolutionize medical diagnostic imaging in the 1980s.

  DoE has over 600,000 drums of nuclear waste stored at 30 sites across the United States. Contents of the drums must be characterized and designated as high-level, low-level, or transuranic waste prior to being assigned to a permanent storage location.

  Bio-Imaging Research, Inc. (Lincolnshire, IL), a company with prior expertise in medical diagnostic imaging, developed WIT as a means to non-destructively examine nuclear waste stored in drums. Bio-Imaging's development and demonstration of the technology was supported through a Small Business Innovative Research (SBIR) grant provided by DoE's Office of Environmental Management. Bio-Imaging adapted its existing medical X-ray CT technology to inspect drums containing nuclear waste. Bio-Imaging's device also included CT gamma ray assay techniques by Lawrence Livermore National Laboratory (LLNL)—which Bio-Imaging licensed from LLNL. (LLNL had earlier developed active and passive CT as a non-destructive waste assay method for low-level, transuranic, and mixed waste drums.) Both Bio-Imaging and LLNL received a *R&D 100 Award* for WIT in 2000.

  Through the Rapid Commercialization Initiative (a federal-state government partnership), the WIT technology received regulatory approvals in state and federal jurisdictions. Five different state regulatory agencies and the federal EPA have jointly verified the performance of the WIT technology.

- **Sandia Octahedral Molecular Sieves** (SOMS) provide a new way to effectively capture radioactive Strontium 90 contaminants. SOMS are new microporous materials, which can act as tiny sponges that can suck up and capture divalent cations into their microscopic pores—a process called ion exchange. Pore size and chemistry of the framework can be fine-tuned on the nano scale, so that SOMS materials capture cations on the bulk scale selectively and efficiently, in all types of environments.

  SOMS have proved to be extremely selective in capturing Strontium 90 ions. Accordingly, it is anticipated that SOMS can play a significant role in remediation of the legacy of nuclear fuel reprocessing by providing a way to efficiently separate and facilitate the disposal of radioactive Strontium 90.

  Once radioactive material has been absorbed, the SOMS can be heated to 500 degrees Centigrade, at which point the SOMS collapses into a dense glass-like material, trapping the radioactive cations tightly into its crystalline structure. Bricks made from these densified SOMS are impervious to leaching and stable against high pH, radiation, and heat, making them ready for a waste repository or landfill, after only minimal processing.

The SOMS technology should also be well suited for disposal applications in numerous other industries where selective removal of industrial metals from solutions is needed.

The SOMS technology was developed by DoE's Sandia National Laboratory (SNL), in collaboration with researchers at the University of California at Davis, DoE's Pacific Northwest National Laboratory (PNNL), the University of Michigan, the State University of New York at Stony Brook, and DoE's Lawrence Livermore National Laboratory (LNNL). Sandia plans to continue research on the SOMS technology for several more years, but is interested in pursuing partnerships with industry to further development, scale-up, and commercialization.

- **Inorganic membrane technology.** The Inorganic Membrane Technology Laboratory (IMTL) at DoE's Oak Ridge National Laboratory (ORNL) has been working to develop and deploy unclassified spin-off products from DoE's inorganic membrane technology, which arises from gaseous diffusion barrier separations technology and related inorganic membrane manufacturing processes.

  In contrast to organic membranes, inorganic membranes can be deployed for high temperature and aggressive chemical applications. This is important because separations processes can often be significantly improved by operating at the extreme temperature and pressure ranges that only inorganic membranes can withstand.

  IMTL is using CRADAs, licensing, and facility/equipment leasing to advance commercialization opportunities. Since 1996, some fifteen CRADAs have been completed with two partners: the Pall Corporation and the Coors Technical Ceramics Company. To date, both companies have received licenses from DoE for portions of the background inorganic membrane technology and CRADA-developed technology. Facility and equipment leases are in place with Pall, and Pall has established a membrane manufacturing facility, Pall Industrial Membranes (PIM), at DoE's East Tennessee Technology Park (Oak Ridge, TN).

  Pall's AccuSep™ inorganic membranes is a first success story from this overall effort. Products embodying this membrane material are currently being developed and marketed, and reflect technology that was matured in the course of Pall's CRADAs with IMTL. PIM was established for the purpose of manufacturing DoE-approved inorganic membrane products. PIM uses elements of DoE's classified manufacturing processes married with standard industrial membrane manufacturing processes to produce unclassified products.

- **Computer model to predict ceramic powder compaction behavior and improve ceramic component manufacturing processes.** DoE's Sandia National Laboratory (SNL), five ceramics manufacturers (which organized into a consortium for this R&D effort), and DoE's Los Alamos National Laboratory (LANL) are working together to identify ways to more efficiently design and manufacture ceramic powder compacts through powder pressing. Ceramic powder compacts play important roles in household appliances, automobiles, computers, medical equipment, and in the neutron generators that are part of the mechanisms of nuclear weapons.

  SNL's interest in this aspect of ceramics dates from 1995. SNL initiated the partnership in 1996 to address these issues. One research goal for the joint effort has been to develop a computer model to predict ceramic powder compaction behavior, such that manufacturing problems could be anticipated and avoided before they occurred. A second research goal has been to better understand the properties of ceramic powders, such that components can be pressed more reliably.

  The desired modeling software—running on a laptop personal computer—was developed, tested, and validated. SNL scientists developed the computer code; industry consortium members tested the software, drawing on their resident manufacturing equipment and expertise. Industry members concluded that the software provided several important benefits: an improved basis for tool and die design, a way to diagnose problems and assess solutions, and a resource that provided a competitive edge to the consortium's members. Previously, die design and powder compaction were more art than science, with little systematic understanding of why defects in ceramic components occurred.

  SNL and DoE have subsequently used this new knowledge in the production of lead zirconate titanate (PZT), which is used for voltage bars in neutron generators. PZT powder has multiple commercial benefits, ranging from high-technology sports equipment to specialty components in advanced analytical equipment and satellites.

- **Peregrine technology for improving radiation treatments in cancer therapy.** Peregrine is a computer-based system for more precisely directing radiation at tumors, with minimal damage to surrounding healthy tissue. The technology was developed through advances resulting from nuclear weapons research and with the multidisciplinary scientific expertise of DoE's Lawrence Livermore National Laboratory (LLNL).

  Peregrine has been under development at LLNL since 1994, in collaboration with researchers at the University of California at San Francisco and other academic institutions. Peregrine calculates, in three dimensions, where radiation goes in the body and how much of it will strike tissue, bone, or empty cavities. This capability will allow doctors to more accurately target tumors with radiation, permitting increased dosages to destroy tumors without increasing damage to healthy surrounding tissue. Peregrine uses individual patient CT (computer tomography) scans to tailor precise radiation dose calculations for each patient, based on each patient's distinct anatomy and disease.

The FDA recently granted clearance of the Peregrine system for medical applications. Peregrine will be initially deployed by the NOMOS Corporation (Sewickley, PA), a global leading supplier of planning and delivery technology for intensity modulated radiation therapy (IMRT), an approach it introduced to oncology in 1992.

- **Improved tools for analyzing highway concrete.** DoE's Kansas City Plant—a part of the department's established facilities for manufacturing—is working jointly with the Missouri Department of Transportation, through a CRADA, to develop an automated system for evaluating hardened Portland concrete. This new process will save time and enhance evaluation capabilities.

  The new technology will involve an automated video imaging system to determine the microscopic properties of hardened Portland concrete. Image processing software is being designed to analyze the image and calculate up to 16 standardized measurements for grading the quality/density of the concrete. Air voids, a common problem in poured concrete, can be detected at sizes up to 2 microns and discriminated from aggregate, sand crystals, and cracks. This process will eliminate manual concrete evaluations and allow for consistency in the evaluation process.

  The project will utilize the Kansas City Plant's expertise in image processing, pattern recognition, and system integration and Missouri DOT's knowledge and experience in concrete analysis.

  DoE also anticipates that the technology developed through the CRADA will improve its ability to perform core surveillance of the nation's weapons stockpile.

- **DRIVER MAX, a microprocessor control unit for fleet transportation (such as city buses) operations that helps to reduce emissions and improve fuel economy.** Tighter environmental standards are driving fleet transportation operators to look for unique solutions for reducing emissions from their buses.

  DoE's Kansas City Plant worked with Fosseen Manufacturing and Development, Inc. on a retrofit fuel injection system that provides for timely injection of ethanol and water into the air stream of a diesel engine, which then promotes more complete combustion. This engineering yields significant reductions in particulate emissions (up to 50%), along with improved fuel economy (up to 20%).

  The Kansas City Plant developed a microprocessor-controlled system that continuously analyzes real-time vehicle operating parameters and determines the optimal injection rate for the ethanol/water alternate fuel.

  DRIVER MAX has been purchased by two city bus systems in Iowa. Transit authorities in Missouri, Illinois, and Kentucky are studying the technology for use on their fleets.

3.5 Environmental Protection Agency

		FY 1990	FY 1995	FY 1998	FY 1999	FY 2000
• Total active CRADAs		11	30	37	38	4
- New CRADAs executed in the FY		—	—	12	13	10
• One or more technologies transferred under a CRADA became available for consumer/ commercial use in the FY		—	—	—	Yes (13)	No
• One or more industry partnerships yielded technologies that strengthen the lab's capabilities		—	—	—	n/a	Yes (10)
• New inventions disclosed		12	15	14	5	11
• Patents applied for		6	24	11	15	10
• Patents issued		—	—	1	8	6
• Total active invention licenses		—	—	—	17	18
- New invention licenses granted in the FY		1	1	0	2	3
• Total active licenses for Other IP**		—	—	—	n/a	n/a
• One or more licensed technologies became available for consumer (public) or commercial use in the FY		—	—	—	Yes (2)	Yes (1)
• One or more licensees produced a licensed product/process that strengthen the lab's capabilities		—	—	—	Yes (2)	Yes (1)
• Total income from all licenses	(million $)	—	—	—	n/a	n/a
- Income from invention licenses	(million $)	$0.003	$0.110	$0.100	n/a	n/a
• Number of licenses earning running royalties		—	—	—	n/a	n/a
- Income from running royalties	(million $)	—	—	—	n/a	n/a

*Data covers the following departmental bureaus/divisions/services/offices: Office of Research and Development (ORD).

**"Other IP" is defined to include: non-patented intellectual property (tangible research products such as biological materials), authored works (such as software, engineering drawings, reference data), and information deemed commercially valuable by a partner and appropriately protected by the lab (such as know-how used at the lab and applied to solve specific problem relating to the partner's product).

"—": Data not requested from agency in previous year's reports.

"n/a": Data not available from agency at time of this report.

A more complete time series of data (FY 1987–2000, as available) appears in Appendix 2 of this report.

Program Background

The Environmental Protection Agency (EPA) is the principal federal agency responsible for monitoring and regulating environmental quality. Its mission is to protect human health and to safeguard the natural environment, air, water, and land, upon which life depends.

To support this broad mission and related regulatory authority, EPA conducts research and development in relevant areas of science and technology through its own system of laboratories and through the sponsoring of external research by industry, universities, and other research performers. Environmental research is critical for developing the scientific understanding and the technological tools to allow the nation to enhance environmental quality for current and future generations. This investment provides a scientific basis for developing cost-effective environmental policies, creating the knowledge base for citizens to make wise environmental decisions, and enabling new and better approaches to environmental protection.

The agency's overall budget authority in FY 2000 was $ 7.6 billion. Of this, authority for all R&D across the department totaled $0.558 billion.[27]

EPA's Office of Research and Development (ORD) maintains a number of research facilities around the country, including the National Center for Environmental Assessment, the National Exposure Research Laboratory, the National Health & Environmental Effects Research Laboratory, and the National Risk Management Research Laboratory. In addition to ORD activities, research is also conducted by the Office of Air and Radiation, the Office of Water, the Office of Prevention, Pesticides, and Toxic Substances, and the Office of Solid Waste and Emergency Response. This work is performed pursuant to a series of research strategies and plans covering important environmental issues. At present, the strategies relate to ecological research, environmental monitoring and assessment, global change, particulate matter, pollution prevention, and waste research.

EPA's research programs cover a wide spectrum of environmental sciences and engineering disciplines consistent with its broad regulatory authority. EPA has a strong commitment to share that research with industry and the public to improve human health and the environment. With the authority granted in the Federal Technology Transfer Act, EPA actively shares its expertise and knowledge through several technology transfer mechanisms including Cooperative Research and Development Agreements (CRADAs), collegial interchanges, and the licensing of intellectual property.

Through an innovative cooperative agreement with the Battelle Memorial Institute, EPA established the Environmental Technology Commercialization Center (ETC^2) to facilitate the transfer of EPA technologies and capabilities to industry, particularly small business. ETC^2 is a network

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[27] This figure includes basic and applied research, development, R&D facilities, and equipment. Source: Documents from the Office of Management and Budget (OMB) and the American Association for the Advancement of Science.

of technology professionals dedicated to interact with EPA researchers to facilitate technology transfer initiatives, and foster interaction with state agencies, industry associations, and other stakeholders. The Coordinator of the Federal Technology Transfer Act for EPA, located at the ORD research facility in Cincinnati, Ohio, is responsible for this initiative along with the other technology transfer mechanisms.

Selected Examples of Downstream Outcomes from Agency Technology Transfer

- **Rapid fungal detection system.** This new detection system provides consistently accurate, quantitative measurements of fungal contamination at a significantly lower cost per sample, taking subjective bias out of typical microbial identification. This system was introduced commercially to the indoor air quality marketplace in FY 2000.

  This detection system utilizes a key technique of contemporary molecular biology (the polymerase chain reaction—PCR) to detect and quantify more than 50 species or groups of species of problematic fungi.

  The technology was developed by EPA's National Exposure Research Laboratory and a private sector CRADA partner, Aerotech Kalmar Laboratories (a small business, offering a wide variety of analytical services to the indoor air quality industry). Aerotech Kalmar currently holds a license to the technology and is marketing the detection system commercially.

- **Improved method for treating lead contaminated soils and sediments.** This is a method for in-situ immobilization of lead in contaminated solids, wastes, and sediments. The approach is based on EPA-patented technologies. It uses solid calcium phosphate materials.

  EPA's National Risk Management Research Laboratory has licensed the technology to a small computer service company. Several contaminated sites were successfully remediated utilizing this technology in FY 1999.

- **New remediation process for destroying halogenated organic compounds.** This new approach relies on base catalyzed decomposition to remediate hazardous wastes containing halogenated organics. The process provides improved removal efficiency at greater cost effectiveness.

  EPA developed and commercialized this technology through a CRADA and then a subsequent license to an environmental research and remediation firm. In FY 1999, several sites were effectively remediated with this process.

3.6 Department of Health and Human Services

Table 3.6 - Technology Transfer Activities and Outcomes at the Department's Federal Labs and Research Centers*

		FY 1990	FY 1995	FY 1998	FY 1999	FY 2000
• Total active CRADAs		110	152	163	237	244
- New CRADAs executed in the FY		—	—	43	65	50
• One or more technologies transferred under a CRADA became available for consumer/ commercial use in the FY		—	—	—	Yes (1)	No
• One or more industry partnerships yielded technologies that strengthen the lab's capabilities		—	—	—	Yes (1)	Yes (1)
• New inventions disclosed		215	307	287	328	375
• Patents applied for		239	166	132	241	263
• Patents issued		—	—	171	180	132
• Total active invention licenses		—	—	—	1,041	1,222
- New invention licenses granted in the FY		47	176	215	208	192
• Total active licenses for Other IP**		—	—	—	323	386
• One or more licensed technologies became available for consumer (public) or commercial use in the FY		—	—	—	Yes (56)	Yes (30)
• One or more licensees produced a licensed product/process that strengthen the lab's capabilities		—	—	—	Yes (50)	Yes (42)
• Total income from all licenses	million $	—	—	—	$44.821	$52.547
- Income from invention licenses	million $	$5.839	$19.727	$39.500	$42.599	$48.592
• Number of licenses earning running royalties		—	—	—	223	230
- Income from running royalties	million $	—	—	—	$34.599	$43.892

*Data covers the following departmental bureaus/divisions/services/offices: Centers for Disease Control (CDC), Food and Drug Administration (FDA), National Institutes of Health (NIH).

**"Other IP" is defined to include: non-patented intellectual property (tangible research products such as biological materials), authored works (such as software, engineering drawings, reference data), and information deemed commercially valuable by a partner and appropriately protected by the lab (such as know-how used at the lab and applied to solve specific problem relating to the partner's product).

"—": Data not requested from agency in previous years' reports.

A more complete time series of data (FY 1987–2000, as available) appears in Appendix 2 of this report.

Program Background

The Department of Health and Human Services (HHS) is the principal agency for protecting the health of Americans and providing essential human services. HHS carries out this mission through more than 300 programs in such areas as medical and social science research, preventing the outbreak of infectious disease, ensuring food and drug safety, managing the Medicare and Medicaid health insurance programs, running the Head Start program, and managing many other programs for low income families, children, and older Americans. Many of its programs are delivered through state and local government agencies and private sector grantees. HHS is also the federal government's largest grant-making agency and operates the nation's largest health insurance program.

The Department's overall budget authority in FY 2000 was $45.5 billion. Of this, authority for all R&D across the department totaled $18.182 billion.[28] Funding for biomedical research by the National Institutes of Health (NIH) accounted for the vast majority of the Department's R&D budget authority: $17.234 billion in FY 2000. The small remainder was spread among a number of other HHS agencies, but most notably the Centers for Disease Control (CDC, $477 million), the Food and Drug Administration (FDA, $135 million), and the Agency for Healthcare Research and Quality (AHRQ, $168 million).

NIH is one of the world's foremost medical research centers, currently comprising 27 separate Institutes and Centers (such as the National Cancer Institute, National Institute for Allergies and Infectious Diseases, National Institute on Aging, National Human Genome Research Institute, National Library of Medicine). NIH annually conducts around 2,000 projects at its own (intramural) laboratories and funds some 35,000 research grants to non-federal scientists in universities, medical schools, hospitals, and other research institutions throughout the country and abroad.

CDC provides a system of health surveillance to monitor and prevent the outbreak of diseases, maintains national health statistics, provides for immunization services, and guards against international disease transmission. FDA promotes and protects the public health by helping safe and effective products reach the market in a timely way and by monitoring products for continued safety after they are in use. AHRQ supports cross-cutting research on health care systems, quality, and cost.

A key aspect of the Department's overall mission is to protect and improve public health. This frequently requires availability of new and more powerful therapeutic drugs, vaccines, therapies, diagnostic tools, and medical devices brought to the commercial marketplace by private sector companies. These new products and services often depend directly on research work supported by HHS and on subsequent transfers of technologies from these agencies to the private sector for further development and commercialization. Research conducted by the

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[28] This figure includes basic and applied research, development, R&D facilities, and equipment. Source: Documents from the Office of Management and Budget (OMB) and the American Association for the Advancement of Science.

Public Health Service (PHS) components of HHS—notably NIH, FDA, CDC—generally has the greatest potential for yielding new technologies.

In the Public Health Service setting, transfers of technology can take various forms: including, a biological sample provided under a Material Transfer Agreement, a license to an invention made by an HHS researcher, a CRADA in an area of mutual interest, or authoring a technical paper for publication.

PHS agencies have articulated their approach to technology transfer in several policy documents, which describe the agencies' approach to patenting of new technologies emerging from their research, to the licensing of those technologies, and to the establishment of CRADAs.[29]

In explaining the circumstances in which a patent will be sought, PHS policy states:

> The PHS generally seeks to patent and license biomedical technologies when a patent will facilitate and attract investment by commercial partners for further research and commercial development of the technology. This is critical where the utility of the patentable subject matter is as a potential preventive, diagnostic, or therapeutic product. However, it also could occur when a patent is necessary to encourage a commercial partner to keep important materials or products available for research use.[30]

The policy notes that in many circumstances patent protection will not be sought:

> Patent protection is generally not sought by PHS where further research and development is not necessary to realize the technology's primary use and future therapeutic, diagnostic, or preventive uses are not reasonably anticipated. For example, PHS will generally not seek patent protection for research tools, such as transgenic mice, receptors, or cell lines. For research tools, the public interest is served primarily by ensuring that the tool is widely available to both academic and commercial scientists to advance further scientific discovery. Secondarily, a financial return to the public is obtained through royalties on the research tool that has significant commercial value.
>
> In addition, when commercialization and technology transfer can best be accomplished without patent protection, such protection will not be sought. For example, some technologies may be transferred to the private sector most expeditiously through publication. For such technologies, patenting and licensing are unnecessary and could inhibit broad

[29] US Public Health Service, Technology Transfer Manual, Ch. 200, PHS Patent Policy; Ch. 300, PHS Licensing Policy; Ch. 400, PHS CRADA Policy, found at http://www.nih.gov/od/ott.

[30] US Public Health Service, Technology Transfer Manual, Ch. 200, PHS Patent Policy, found at http://www.nih.gov/od/ott.

dissemination and application of the technology. Methods of performing surgical procedures, for example, could fall within this category.

There is also a PHS policy that explains the principles governing the licensing of patented technologies. PHS licenses, rather than assigns, its patents because it allows the agencies to "ensure the broadest and most expeditious development of new products." The agencies' preference for non-exclusive licenses is also explained:

> The agencies prefer to negotiate non-exclusive or co-exclusive licenses whenever possible. This allows more than one company to develop products using a particular technology, products that may ultimately compete with each other in the marketplace. PHS recognizes that companies typically need an exclusive market position to offset the risk, time, and expense of developing biomedical diagnostic or therapeutic products; however, companies do not necessarily need to achieve that position by exclusively licensing a government technology used to develop that product. Instead, they frequently are able to add their own proprietary technologies to the technology licensed from the government to ultimately achieve some level of uniqueness and exclusivity for the product.[31]

Additionally, there is a PHS policy that addresses the appropriate use of the CRADA mechanism in PHS labs. One of the primary concerns expressed relates to the possible effect of the CRADA on the freedom of researchers to discuss and share their ideas. The policy states, "[A] proposed CRADA would not be appropriate if the fundamental mission of the PHS is compromised by creating, either explicitly or indirectly, more than minimal constraints on research freedom and communication." The policy also cautions against excessive reliance on CRADA funding by the laboratories, stating that CRADAs are "not intended to be a general funding mechanism to support directed research" at the laboratories. The policy also discusses concerns relating to the dissemination of research results, the requirement of an intellectual contribution from the collaborator, the avoidance of conflicts of interest, and the ensuring of fair access to CRADA opportunities.

NIH serves as the lead agency for HHS in the formulation of technology transfer policy; it also provides patent and licensing services for NIH, FDA, and other PHS entities through a centralized Office of Technology Transfer. Additionally, several Institutes within NIH have created ORTA offices to support the scientists in their organization and to negotiate individual CRADAs.

Authority for entering into CRADAs has been delegated to the heads of NIH, CDC, and FDA. At NIH, Institute and Center Directors have signatory authority to enter into CRADAs—although, all proposed CRADAs must undergo review by the NIH Director. At FDA, all

[31] US Public Health Service, Technology Transfer Manual, Ch. 300, PHS Licensing Policy, found at http://www.nih.gov/od/ott.

proposed CRADAs undergo review by the CRADA Review Board and by the Commissioner of the agency. CDC provides a full range of technology transfer services to its own laboratories.

Selected Example of Downstream Outcomes from Agency Technology Transfer

Centers for Disease Control (CDC) —

CDC indicated there were "no" reportable commercial outcomes or benefits to agency lab capabilities or technologies in FYs 1999 and 2000 that resulted from past/current CRADAs or licenses. Accordingly, the agency did not submit case example materials for this edition of the Biennial Report.

Food and Drug Administration (FDA) —

- **Quality Indicator Device for testing the quality of frozen food.** This invention indicates the quality of frozen food by colorimetrically detecting decomposition.

  FDA has licensed this invention to Cox Technologies, Inc., which is making the device available commercially. In the future, the technology may have applications in addition to food freshness.

National Institutes of Health (NIH) —

- **Estrogen receptor knock-out mouse model.** Animal models have often been extremely beneficial in aiding the progress in the health sciences. This has been especially so for the genetically modified, in-bred mice that are capable of targeting important genes. These animals have enabled the study of diseases with unimaginable precision—which has resulted in many important medical advances.

  The last twenty years have witnessed a huge proliferation in the development of genetically modified mouse models, which as a valuable research resource must be shared widely with the biomedical sciences community. NIH scientists have developed a number of these useful animal models, and many have been made available commercially through licensing to corporate partners.

  The Estrogen Receptor knock-out mouse model is a good example. NIH licensed this technology to Taconic Transgenics, which in turn made it commercially available to the research community.

  This mouse—also known as the ERKOα mouse—contains a targeted disruption of the α estrogen receptor gene. Homozygous ERKOα mice are healthy but sterile, while heterozygous mice remain fertile. This mouse provides a model for mechanisms of estrogen-dependent cellular proliferation, differentiation, and metabolism in both reproductive and non-productive tissues.

- **Alfaxalone**, a veterinary product, whose main application is for anesthesia in the cat and other animal species. This is a safe and effective ready-to-use formulation of the anesthetic agent, alfaxalone, using patented cyclodextrin technology and a novel buffered formulation.

  This product is currently being made available commercially by Jurox Private Limited, an Australian company.

- **A new laboratory reagent kit to test for AIB1**, a cancer marker. AIB1 is a steroid receptor and a co-activator associated with breast cancer.

  A test kit for this marker has recently been introduced by Vysis for the research marketplace. Vysis also hopes to develop an FDA-approved diagnostic test that could be part of a breast cancer panel or a stand-alone test kit.

- **Diagnostic test for Familial Mediterranean Fever (FMF), a rare genetic disorder.** This is now being made available commercially by Specialty Laboratories.

  FMF occurs most commonly in people of non-Ashkenzi Jewish, Armenian, Arab, and Turkish backgrounds, living in the United States and abroad. People with FMF suffer from recurring bouts of fever, most commonly with severe abdominal pain due to inflammation of the abdominal cavity. Some patients develop amyloidosis, a potentially deadly buildup of protein in vital organs such as the kidneys. The only treatment for FMF is a drug called colchicine, which a patient must take every day for the rest of his/her life and which also causes side effects such as diarrhea and abdominal cramps. Many patients choose to stop taking colchicine for various reasons, including the drug's side effects.

  If doctors could identify in advance those people at high risk for developing amyloidosis, the potentially fatal complication of FMF, they could act to ensure that those patients stayed on their medication and could in many cases prevent the development of amyloidosis.

3.7 Department of the Interior

		FY 1990	FY 1995	FY 1998	FY 1999	FY 2000
• Total active CRADAs		12	15	30	30	40
- New CRADAs executed in the FY		—	—	7	10	8
• One or more technologies transferred under a CRADA became available for consumer/ commercialuse in the FY		—	—	—	No	Yes (2)
• One or more industry partnerships yielded technologies that strengthen the lab's capabilities		—	—	—	n/a	Yes (2)
• New inventions disclosed		26	2	5	8	16
• Patents applied for		15	2	5	3	5
• Patents issued		—	—	3	1	4
• Total active invention licenses		—	—	—	12	6
- New invention licenses granted in the FY		0	3	0	0	2
• Total active licenses for Other IP**		—	—	—	0	0
• One or more licensed technologies became available for consumer (public) or commercial use in the FY		—	—	—	No	Yes
• One or more licensees produced a licensed product/process that strengthen the lab's capabilities		—	—	—	Yes (11)	Yes (1)
• Total income from all licenses	(million $)	—	—	—	$1.640	$0.850
- Income from invention licenses	(million $)	$0.041	$2.000	$2.000	$1.640	$0.850
• Number of licenses earning running royalties		—	—	—	11	
- Income from running royalties	(million $)	—	—	—	$1.640	$0.850

*Data covers the following departmental bureaus/divisions/services/offices: U.S. Geological Survey (USGS).

**"Other IP" is defined to include: non-patented intellectual property (tangible research products such as biological materials), authored works (such as software, engineering drawings, reference data), and information deemed commercially valuable by a partner and appropriately protected by the lab (such as know-how used at the lab and applied to solve specific problem relating to the partner's product).

"—": Data not requested from agency in previous years' reports.

"n/a": Data not available from agency at time of this report.

A more complete time series of data (FY 1987–2000, as available) appears in Appendix 2 of this report.

OFFICE OF TECHNOLOGY POLICY

Program Background

The Department of Interior's (DOI) mission is to protect and provide access to the nation's natural and cultural heritage and to honor the nation's trust responsibilities to American Indian Tribes. The Department's activities include the management of public lands and mineral resources on the outer continental shelf, to conserve and protect fish and wildlife, to preserve the National Park System, and to provide reliable, impartial information concerning the earth.

The Department's overall budget authority in FY 2000 was $8.5 billion. Of this, authority for all R&D across the department totaled $0.618 billion.[32] Much of this R&D budget comprises activities of the U.S. Geological Survey (USGS)—just over $500 million in FY 2000. The small remainder is spread among five other Department bureaus, most notably the National Park Service (about $30 million) and the Minerals Management Service (also about $30 million). (The other three bureaus are the Bureau of Reclamation and the Bureau of Land Management and Fish & Wildlife Service.)

USGS is responsible for monitoring ground and surface water quality. It also provides scientific information related to the environment, natural hazards, mineral, energy, water, and biological resources, as well as serving as the principal civilian mapping agency. The National Park Service's mission is the promotion, regulation, and preservation of the national park system. The Fish & Wildlife Service focuses on protecting and enhancing fish, wildlife, plants, and their habitats. The Minerals Management Service has responsibility for mineral resources on the U.S. outer continental shelf. The Bureau of Reclamation and Bureau of Land Management have natural resource management missions for water in the western states as well as more than 260 million acres of public lands.

Historically, all the DOI Bureaus have worked closely with universities, states and regional resources, private industry, and other federal departments to carry out their respective research mission. In any given year the DOI Bureaus have several thousand scientific cooperative projects and volunteer programs underway across the nation.

For purposes of the Stevenson-Wydler Act the USGS is deemed one laboratory, with its ORTA in Reston, Virginia. The ORTA coordinates technology transfer at 35 major USGS laboratories and several hundred field offices across the country. Several other DOI agencies have delegated authority directly to their laboratories to enter into CRADAs. The Bureau of Reclamation has conferred this authority on the Research and Laboratory Services Division in Denver, Colorado. In the Fish and Wildlife Service, CRADA authority has been given to the thirteen Research and Development Centers. Within the National Park Service, individual parks and the scientific support Centers have authority to enter into CRADAs. The CRADA and licensing activities of all bureaus are coordinated with the DOI Solicitor's Office.

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[32] This figure includes basic and applied research, development, R&D facilities, and equipment. Source: Documents from the Office of Management and Budget (OMB) and the American Association for the Advancement of Science.

Selected Examples of Downstream Outcomes from Agency Technology Transfer

- **Pulsed-limestone acid mine drainage technology.** Acid mine drainage (AMD) is a serious water quality issue in 26 U.S. states. In the Appalachian coal region, AMD has degraded more than 8,000 miles of streams and has left many aquatic habitats virtually lifeless. The U.S. Environmental Protection Agency estimates that $1 million a day is being spent in Appalachia alone for chemical treatment of the problem. New, cost-effective technologies that can revitalize the water and return wildlife offer new economic development opportunities for large segments of these former mining states.

  In FY 1999, the U.S. Geological Survey received two patents for new AMD restoration technology. In the same year, it established a CRADA with the Freshwater Institute (a division of the Conservation Fund) to improve engineering design and solve energy source issues.

  During FY 2000, a 100-gallon-per-minute facility (including a building, holding ponds, and drainage system) was installed at a National Park Service site in Pennsylvania. In the same year, a funding grant was sought and received for a Maryland community to install a commercial scale AMD facility and operate it for three years. (The funding came from state and federal programs designed to help communities cost-share pollution remediation efforts.) The plant will be on line by the summer of 2002.

- **Hoverprobe—environmental evaluation is critical to land management.** In FY 2000, the USGS worked with with two small companies to design and patent the Hoverprobe, a floating meta-drill system, mounted on a watercraft which uses air stream technology to propel itself across land and water. The three-party invention incorporates hovercraft technology developed by Hovertechnics Corporation (located in Benton Harbor, Michigan), a meta-drill soft core system developed by MPI Drilling, Inc. (Ontario, Canada), and engineering and design components developed by the U.S. Geological Survey. The current design allows the driller to obtain core sediment samples up to 40 meters in length without the use of fluids that potentially could contaminate the samples.

  The system takes samples in shallow water, mud flats, marshes, beaches, and on firm ground. The technology has been used, for example, to study nutrient and sediment cycling in Chesapeake Bay and Lake Michigan. Conventional drills mounted on trucks, ships, and boats cannot access shallow places such as those found in estuaries. Additionally, many locations will not allow drill rigs into an area due to the permanent damage that can result to the ecosystem. This new technology enables coring operations in shallow intertidal areas, where drilling has previously been impossible or too environmentally damaging.

  Beyond the sampling of sediment cores for research, the market for the Hoverprobe includes industries engaged in drilling (such as oil companies); sampling and environmental impact studies (by state/federal government, engineering, and utility firms); and can be used to profile line tailings in marshlands (e.g., in marshlands, for clean-up purposes or to gauge the value of the minerals not yet extracted).

- **Map-on-demand technology.** In a CRADA with Wildflower Productions, Inc. (a small cartography company in California), the U.S. Geological Survey began exploring the use of evolving software, hardware, and data formats to make topographic maps directly available to recreation-oriented customers from map-on-demand kiosks.

  Public access to USGS paper maps and other geo-products has often been limited by the significant cost associated with the inventory and distribution of such materials. These problems are especially acute with large-scale topographic maps. A cost effective map-on-demand system will significantly reduce the cost of stocking and distributing paper maps for USGS, as well as for many other federal agencies that provide such products to the public.

  To date, several map-on-demand kiosks have been installed in USGS map sale locations, and at selected private sector locations (including the L.L.Bean retail outlet in Tysons Corner, VA) to gauge customer interest and reaction to the product and means of distribution.

  Since signing the CRADA with Wildflower, the company has since been acquired by NG Maps (a division of National Geographic Society); follow-on research activities are now underway to explore other methods, such as the Web, to deliver USGS data to the public.

- **Downhole passive water Sampler.** This technology was jointly developed by the U.S. Geological Survey and General Electric. The sampler design was developed as a result of field tests conducted by USGS at GE well sites to examine cost effective methods of well monitoring.

  The typical approach to sampling observation wells for organic compounds has involved purging the well of casing water prior to collecting a sample. Samples are taken manually and then forwarded to a lab for analysis. In contrast, the USGS/GE approach utilizes the known ability of polyethylene to transmit chlorinated volatile organic compounds (CVOCs) and aromatic VOCs such as benzene and toluene. The USGS/GE samplers are filled with deionized water and left at the sample site, where ambient CVOCs are collected naturally via diffusion through the device's polyethylene membrane; later the samplers are collected and forwarded for lab analysis.

  In FY 1999, during a comprehensive evaluation by the Air Force Center for Environmental Excellence, the USGS/GE technology was rated easiest-to-use and considerably more cost effective than its closest competitor. In FY 2000, this technology received the USGS Director's Award—the James R. Balsley, Jr. Award for Technology Excellence.

The sampler has been extensively field tested at various Department of Defense facilities. GE has been using the technology at its sites for more than two years, and has promoted the technology with its environmental consultants and suppliers. In addition, a coalition of federal and state agencies are working with the Environmental Protection Agency to prepare a revised protocol to use the VOC sampler in lieu of the existing manual sampling approach.

To date, two commercial licenses have been negotiated. The product is currently being manufactured by Eon Products, Inc. (Snellville, Georgia) and Columbia Analytical Services, Inc. (Kelso, Washington). Eon manufactures samplers for direct sale to a variety of customers, while Columbia manufactures and distributes its samplers primarily to its clinical laboratory customers.

- **Automated ground water monitoring system—ROBOWELL.** This is an automated process for monitoring selected ground water quality properties and constituents. It was developed by USGS researchers in the USGS Massachusetts Water District.

  The system monitors ground water quality using the protocols required for manual sampling, but without the high labor and laboratory costs. It eliminates expenses associated with frequent sample collection, processing, and analysis—and on this basis pays for itself after about twenty samples.

  In FY 1999, prototype systems were installed and continuously operated in Walden Pond State Park in Concord, Massachusetts, to monitor a potential nutrient plume in ground water; and at Cape Cod, near the down gradient of a ground water remediation site, to monitor geochemical changes from an experimental remediation technology.

  In FY 2000, a prototype was installed in Provincetown, Massachusetts, to monitor salt water intrusion. Based on the success of the single Provincetown unit, the USGS Technology Enterprise Office and the Massachusetts-Rhode Island District Project for Analysis of Water Resources in the Lower Cape Cod Aquifer System entered into a Technical Assistance Agreement to field-test a nested array of small diameter monitoring Robowells. Freshwater aquifers along the Atlantic Coastal Zone are among the most productive in the United States. A cost-effective, automated monitoring system capable of providing real-time information about impending salt and nutrient changes in ground water enables resource managers to better protect the drinking water of an estimated 30 million people from Maine to Florida. The technology is currently licensed to an environmental equipment manufacturer for commercialization.

3.8 National Aeronautics and Space Administration

		FY 1990	FY 1995	FY 1998	FY 1999	FY 2000
• Total active CRADAs		0	0	0	1	1
- New CRADAs executed in the FY		—	—	0	1	0
• One or more technologies transferred under a CRADA became available for consumer/ commercial use in the FY		—	—	—	Yes	Yes
• One or more industry partnerships yielded technologies that strengthen the lab's capabilities		—	—	—	Yes	Yes
• New inventions disclosed		538	517	554	525	574
• Patents applied for		181	164	55	129	109
• Patents issued		—	—	85	87	99
• Total active invention licenses		—	—	—	249	214
- New invention licenses granted in the FY		6	29	40	40	47
• Total active licenses for Other IP**		—	—	—	22	32
• One or more licensed technologies became available for consumer (public) or commercial use in the FY		—	—	—	Yes	Yes
• One or more licensees produced a licensed product/process that strengthen the lab's capabilities		—	—	—	Yes	Yes
• Total income from all licenses	(million $)	—	—	—	$0.823	$1.008
- Income from invention licenses	(million $)	$0.113	$0.349	$0.565	$0.818	$0.762
• Number of licenses earning running royalties		—	—	—	19	17
- Income from running royalties	(million $)	—	—	—	$0.388	$0.175

*Data covers the following departmental bureaus/divisions/services/offices: Comprehensive of NASA's federal labs and other intramural research facilities.

**"Other IP" is defined to include: non-patented intellectual property (tangible research products such as biological materials), authored works (such as software, engineering drawings, reference data), and information deemed commercially valuable by a partner and appropriately protected by the lab (such as know-how used at the lab and applied to solve specific problem relating to the partner's product).

"—": Data not requested from agency in previous years' reports.

A more complete time series of data (FY 1987–2000, as available) appears in Appendix 2 of this report.

Program Background

The National Aeronautics and Space Administration (NASA) was created in 1958, in response to concerns about our national space programs in light of the Soviet's launch of the Sputnik satellite. Over the years, NASA has made the United States the leader in human space flight, aeronautics, space science, and space applications.

NASA currently operates four Strategic Enterprises to carry out its mission. They are centered on aerospace, space science, earth science, and human exploration and development of space. In the course of carrying out its mission over the past four decades, NASA has developed a system of laboratories that are a significant component of the nation's overall science and technology infrastructure. In addition to leading the exploration of space through those laboratories, NASA has made contributions to the advancement of the aircraft industry, expanded our knowledge of the universe including the planet Earth, and fostered the development of scores of commercial products.

The Department's overall budget authority in FY 2000 was $13.6 billion. Of this, authority for all R&D across the department totaled $9.494 billion.[33] A sizable portion of this R&D budget authority is devoted to R&D activities related to science, aeronautics, and technology (about $5.6 billion in FY 2000). The balance is distributed between human space flight R&D (about $2.3 billion) and mission support R&D (about $1.9 billion).

NASA conducts its intramural research at eleven facilities throughout the United States, including the Ames Research Center in California, which is NASA's center for research in information technology; the Goddard Space Flight Center in Maryland, which conducts a range of research relating to space flight; the Jet Propulsion Laboratory, which is operated by the California Institute of Technology; and the Langley Research Center in Virginia, which is responsible for R&D related to structures and materials.[34]

From its creation, NASA has been charged by the Congress to ensure the widest possible dissemination of its research and development results. While the bulk of this work involves the sharing and transfer of technologies in the aeronautics and space industries, many technologies are produced that also have commercial value in other sectors. To accomplish its commercial

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[33] This figure includes basic and applied research, development, R&D facilities, and equipment. Source: Documents from the Office of Management and Budget (OMB) and the American Association for the Advancement of Science.

[34] The other Centers are the Dryden Flight Research Center (Atmospheric Flight Operations), Glenn Research Center (Turbomachinery), Independent Validation and Verification Facility (Sophisticated Software Systems), Johnson Space Center (Human Operations in Space), Kennedy Space Center (Launch and Cargo Processing Systems), Marshall Space Flight Center (Space Propulsion), Moffett Federal Airfield (Shared Federal Facility), Stennis Space Center (Propulsion Testing Systems), Wallops Flight Facility (Suborbital Research Programs), and White Sands Test Facility (Testing and Evaluating Hazardous Materials, Components, and Rocket Propulsion Systems).

technology goals, NASA created the Commercial Technology Network, building on its ten field centers, its nationwide network of Regional Technology Transfer Centers,[35] the National Technology Transfer Center, and other organizations and publications focused on NASA technologies.

Importantly, NASA uses its own legal authorities as the primary basis for its cooperative research with the private sector. Under the Space Act of 1958, NASA has broad authority to enter into "other agreements" with the private sector and others. These agreements are not regarded as procurements, grants or cooperative agreements and are, like CRADAs not subject to the rules governing those types of agreements. NASA has used this authority as a basis for technology transfer agreements ranging from nondisclosure agreements to funded cooperative research projects. Because of its use of the Space Act authority, NASA does not routinely use CRADAs believing its technology transfer objectives can be achieved with greater flexibility through the use of the Space Act. NASA, however, does have the authority to enter into CRADAs and will use them in appropriate situations.

NASA maintains an ORTA at each of its ten research centers, including the Jet Propulsion Laboratory, which is located at and managed by the California Institute of Technology.

The NASA Administrator, each of the Associate Administrators, the Directors of NASA's Centers, and the Manager of the NASA Management Office—Jet Propulsion Laboratory are all authorized to enter into Space Act agreements. NASA's Space Act Agreement Manual is available at http://www.hq.nasa/ogc/samanual.html.

The NASA General Counsel's office is responsible for all of the Agency's licensing activities. Licenses are negotiated at the Centers and are signed by the NASA General Counsel.

Selected Examples of Downstream Outcomes from Agency Technology Transfer

- **New polyimide materials for space applications.** Prior to NASA/Langley Research Center's development of two new polyimide materials, the lack of optical transparency and long-term thermal stability needed for space applications such as solar arrays, reflectors, and thermal control systems was a critical issue. Applications such as these require high optical transparency, thermal stability, and resistance to UV radiation. Two NASA/

[35] The Regional Technology Transfer Centers include the Center for Technology Commercialization, serving the Northeast from Westborough, MA; the Mid-Atlantic Technology Applications Center, serving the mid-Atlantic region from the University of Pittsburgh; the Southern Technology Applications Center, located at the University of Florida in Alachua, FL; the Mid-Continent Technology Transfer Center, located in College Station, TX; the Great Lakes Industrial Technology Center in Cleveland, OH; and the Far West Regional Technology Transfer Center at the University of Southern California in Los Angeles. NASA also supports the Research Triangle Institute in North Carolina, the MSU-NASA TechLink Center in Bozeman, MT, and four technology incubators to assist start-up companies with commercializing NASA technologies.

Langley-developed polyimides provided this combination of desirable materials properties.

The transparency and UV-resistant characteristics of these two polyimide materials are vastly superior to existing polymers. They are the enabling technology for entirely new solar propulsion, solar power, and space-based antenna concepts. In addition, thin film, flat solar panels made with these polyimides augment current generation photo-voltaic arrays and increase the capacity to provide solar power to spacecraft with very minimal weight and volume additions. These thin films can also be used as antennas and as multi-functional upper stages for propulsion and power. Furthermore, large "solar sails" enabled by these materials might provide power for deep space exploration missions.

Overall, these lightweight, transparent, UV-resistant polyimides enable revolutionary concepts in space propulsion, space power, space insulation, and space-based antenna design. These new concepts could lessen overall user costs associated with ever increasing dependency on satellites for communications, navigation, weather, and environmental monitoring.

A NASA/Langley partnership with SRS Technologies, Inc. (Huntsville, AL), active over many years, resulted in a patent license agreement for the polyimide materials. SRS currently manufactures these materials in powder, resin, and film form. SRS has invested over $400K in corporate capital for facilities, equipment, and personnel. Capital investments are projected to increase as SRS continues production of powder, flat film, rolled film, and thin film parabolic antennas and solar concentrators. SRS led the development of novel fabrication processes to cast these polyimides into large thin-film elements for use in applications as varied as space-based antennas, solar sails, power augmentation panels for photo-voltaic (PV) arrays, and for use in advanced solar propulsion and power concepts. The NASA/Langley and SRS technical partnership evolved because of mutual recognition of the opportunity to merge unique materials with innovative designs and processes. The polyimide technology has been awarded the prestigious "R&D100 Award" by *R&D Magazine* for outstanding achievements in the development of these materials. The availability of these materials for the applications described above will influence NASA's advanced design and development programs for future missions.

3.9 Department of Transportation

Table 3.9 - Technology Transfer Activities and Outcomes at the Department's Federal Labs and Research Centers*

		FY 1990	FY 1995	FY 1998	FY 1999	FY 2000
• Total active CRADAs		1	37	39	51	79
- New CRADAs executed in the FY		—	—	13	5	38
• One or more technologies transferred under a CRADA became available for consumer/ commercial use in the FY		—	—	—	Yes (1)	n/a
• One or more industry partnerships yielded technologies that strengthen the lab's capabilities		—	—	—	Yes (2)	n/a
• New inventions disclosed		1	0	4	1	0
• Patents applied for		1	2	3	0	3
• Patents issued		—	—	1	0	3
• Total active invention licenses		—	—	—	0	0
- New invention licenses granted in the FY		0	n/a	1	0	0
• Total active licenses for Other IP**		—	—	—	0	0
• One or more licensed technologies became available for consumer (public) or commercial use in the FY		—	—	—	No	n/a
• One or more licensees produced a licensed product/process that strengthen the lab's capabilities		—	—	—	n/a	n/a
• Total income from all licenses	(million $)	—	—	—	$0.000	$0.000
- Income from invention licenses	(million $)	n/a	n/a	$0.000	$0.000	$0.000
• Number of licenses earning running royalties		—	—	—	0	0
- Income from running royalties	(million $)	—	—	—	$0.000	$0.000

*Data covers the following departmental bureaus/divisions/services/offices: Federal Aviation Administration (FAA), Federal Highway Administration (FHWA), the Volpe National Transportation Systems Center. (Does not include statistics for the U.S. Coast Guard.)

**"Other IP" is defined to include: non-patented intellectual property (tangible research products such as biological materials), authored works (such as software, engineering drawings, reference data), and information deemed commercially valuable by a partner and appropriately protected by the lab (such as know-how used at the lab and applied to solve specific problem relating to the partner's product).

"—": Data not requested from agency in previous years' reports.

"n/a": Data not available from agency at time of this report.

A more complete time series of data (FY 1987–2000, as available) appears in Appendix 2 of this report.

OFFICE OF TECHNOLOGY POLICY

Program Background

The Department of Transportation (DoT) is the federal steward of the nation's transportation system. It houses many transportation agencies and programs, all of which aim to use their research & development work to fulfill the key goals of the Department's strategic plan: improving safety, ensuring mobility, fostering economic growth, enhancing the human and natural environment, and advancing the nation's security interests.[36]

The Department's overall budget authority in FY 2000 was $14.5 billion. Of this, authority for all R&D across the department totaled $0.607 billion.[37] Much of this R&D budget comprised activities of the Federal Aviation Administration ($226 million in FY 2000) and the Federal Highway Administration ($257 million). The balance was spread among a half dozen other agencies and programs, most notably the National Highway Traffic Safety Administration, the Federal Railroad Administration, the U.S. Coast Guard, and the Federal Transit Administration.

The Federal Highway Administration (FHWA) plays a key role in improving the quality of the nation's transportation systems, providing grants and an aggressive research program to support the state and local agencies primarily responsible for our highways. The research it sponsors explores material, structural, and information technologies designed to promote efficient and safe use of the highways. The Intelligent Transportation System (ITS) is one of its most interesting programs, working with industry, state and local agencies, and consumers to support research applying information technologies to improve highway safety, increase efficiency, and reduce energy use and adverse environmental impacts. Many other programs promote the development and transfer of innovative transportation technologies to state and local agencies.

The Federal Aviation Administration (FAA) plays a variety of regulatory roles in air transportation and carries out an extensive research and technology program to support those responsibilities. The program is carried out in cooperation with the regulated industries and other federal agencies and includes research on air traffic control systems, weather research, airport technology, aircraft safety technology, and airport security technology.

The National Highway Traffic Safety Administration (NHTSA) also carries out a research program in support of its regulatory responsibilities for motor vehicle and equipment safety. This research relates to highway safety, including crashworthiness and crash avoidance as well as participation in the ITS research program.

The Federal Railroad Administration (FRA) promotes and enforces railroad safety, provides support to rail transportation, and supports research and development to improve rail safety

[36] DOT Strategic Plan 1997–2002.

[37] This figure includes basic and applied research, development, R&D facilities, and equipment. Source: Documents from the Office of Management and Budget (OMB) and the American Association for the Advancement of Science.

and to advance high-speed rail passenger technology. Some of this research is conducted at the agency's Transportation Technology Center, operated for FRA by a railroad industry association.

The Federal Transit Association (FTA) is the principal federal source of financial and technical support for public transportation. It provides grants and other funding to support transportation systems and also provides technical help to the systems through its research, development, and demonstration programs.

The U.S. Coast Guard has a wide-ranging mission that includes setting standards for commercial vessels, licensing seamen, safeguarding ports and waterways, and providing radionavigation systems. Its research programs support all of these missions, including work on search and rescue capabilities, marine navigation, marine safety, maritime law enforcement and integrated command, control, communications, computer, and intelligence systems.

Finally, the Research and Special Programs Administration (RSPA) is responsible for the safe and secure movement of hazardous materials to industry and consumers by all modes of transportation, including pipelines; coordination of rapid response to transportation emergencies; and advancement of science and technology for national transportation needs. RSPA manages DOT's multi-modal research programs, coordinates DOT's research and development strategic planning efforts; supports multi-modal research, education, and technology transfer through thirty-three University Transportation Centers (UTCs); and oversees the work of the Transportation Safety Institute (TSI). Through research and development, engineering, and analysis, RSPA's Volpe National Transportation Systems Center in Cambridge, Massachusetts, helps decision-makers define problems and pursue solutions to lead transportation into the 21st century. Its work includes a broad mix of projects that cut across traditional transportation modes and technical disciplines.

The bulk of the Department's research funds support extramural research. Nonetheless, three bureaus operate research and development facilities of a type that warrant participation in the CRADA and patent licensing programs: the Federal Aviation Administration, the Federal Highway Administration, and the United States Coast Guard.

The Federal Aviation Administration (FAA) has authorized its Technical Center at Atlantic City, New Jersey, to enter into CRADAs. The Federal Highway Administration (FHWA) has given similar authority to its laboratory in McLean, Virginia. The United States Coast Guard delegates its technology transfer work to its Research and Development Center at Groton, Connecticut.

The Department's Patent Counsel coordinates patent licensing, although some agencies, like FAA, also have patent counsel at their laboratories to help with applications and paperwork.

Selected Examples of Downstream Outcomes from Agency Technology Transfer

- **FAA-certified emergency life raft for oceanic aviation safety.** FAA research facilities assisted a private company, the Switlik Parachute Company, Inc., (Trenton, NJ) to test and successfully design its product and materials to meet tough, new performance standards. The result was a new, commercially available, life raft that has been certified to above FAA requirements and can be used by airlines in oceanic flights.

  In FY 1999, the FAA's William J. Hughes Technical Center (Atlantic City, NJ) entered into a CRADA with the Switlik Parachute Company, Inc. to test its products and determine if they met new standards developed by the U.S. Coast Guard and other international agencies. The new standards for emergency life raft performance require that the raft demonstrate the ability to inflate in and withstand a Category 1 hurricane wind field. (FAA provided the company with use of its Airflow Induction Facility, along with a small amount of engineering and technical support. FAA also modified the low speed section of the facility to accommodate the life rafts. The company provided the rafts and manpower to install the rafts and operate the inflation mechanisms.) The initial tests indicated the Switlik rafts were not strong enough to meet the new standards. Nonetheless, several subsequent design iterations by the company yielded much stronger seam designs. The final version of the raft easily passed the new standards, as certified by U.S. Coast Guard inspectors.

  Based on these results, the final design version was placed into immediate production and became commercially available worldwide.

- **Smartcard electronic fare collection system for public transit.** New technology for this purpose is presently being exhibited to the public through the Advanced Public Transportation Systems (APTS) Mobile Showcase program.

  The APTS Mobile Showcase is a Federal Transit Administration (FTA) program, directed at demonstrating and displaying state-of-the-art proven transit technology (see http://www.ornl.gov/fta/showcase). The program is intended to serve as a platform for researching and evaluating the integration of advanced technologies. A large number of technology manufacturers, suppliers, vendors, and consultants participate. The program is managed by DoT's Research and Special Programs Administration at the Volpe National Transportation Systems Center (Cambridge, MA).

  The electronic fare collection system is technology developed by the Smartclic Corporation (Newport News, VA). It is being displayed (starting in August 2000) in the Showcase via a CRADA between Smartclic and DoT's Volpe Center.

- **Fleet management system, crash data recorder, and in-vehicle navigation system for public transit.** This is also new technology being displayed to the public via the APTS Mobile Showcase program.

The CARIN navigation system is an in-vehicle, turn-by-turn navigation and guidance capability. The UDS recorder records crash data. The FM-200 fleet management system monitors vehicle mechanical systems and provides information on system operations.

These technologies have been developed by VDO North America, LLC (Troy, MI). They are being displayed in the Showcase via a CRADA between VDO North America and DoT's Volpe Center.

3.10 Department of Veterans Affairs

		FY 1990	FY 1995	FY 1998	FY 1999	FY 2000
• Total active CRADAs		2	14	15	1	2
- New CRADAs executed in the FY		—	—	9	1	2
• One or more technologies transferred under a CRADA became available for consumer/ commercial use in the FY		—	—	—	No	No
• One or more industry partnerships yielded technologies that strengthen the lab's capabilities		—	—	—	No	No
• New inventions disclosed		58	36	50	48	85
• Patents applied for		1	2	3	0	3
• Patents issued		—	—	1	0	3
• Total active invention licenses		—	—	—	n/a	n/a
- New invention licenses granted in the FY		0	n/a	n/a	47	3
• Total active licenses for Other IP**		—	—	—	0	0
• One or more licensed technologies became available for consumer (public) or commercial use in the FY		—	—	—	No	No
• One or more licensees produced a licensed product/process that strengthen the lab's capabilities		—	—	—	No	No
• Total income from all licenses	(million $)	—	—	—	n/a	$1.021
- Income from invention licenses	(million $)	n/a	n/a	$0.000	n/a	$1.021
• Number of licenses earning running royalties	(million $)	—	—	—	n/a	n/a
- Income from running royalties	(million $)	—	—	—	n/a	n/a

*Data covers the following departmental bureaus/divisions/services/offices: comprehensive of the VA's federal labs and intramural research facilities.

**"Other IP" is defined to include: non-patented intellectual property (tangible research products such as biological materials), authored works (such as software, engineering drawings, reference data), and information deemed commercially valuable by a partner and appropriately protected by the lab (such as know-how used at the lab and applied to solve specific problem relating to the partner's product).

"—": Data not requested from agency in previous years' reports.

"n/a": Data not available from agency at time of this report.

A more complete time series of data (FY 1987–2000, as available) appears in Appendix 2 of this report.

OFFICE OF TECHNOLOGY POLICY

Program Background

The Department of Veterans Affairs (VA) has a long history of healthcare innovation for the benefit of veterans and the American public. Many well-known medical devices and materials, including the cardiac pacemaker, energy-storing artificial limbs, and the anti-smoking nicotine patch, were developed with the VA's Research and Development Office (RDO) support. The dedication of clinicians, researchers, scientists, and engineers of the VA's R&D Program made these advances possible.

The VA's research program has fostered scientific discovery—at times leading to innovations—that are attractive to entrepreneurs seeking to develop clinical products. The VA clinical network provides an extensive evaluative clinical testing ground to assess the efficacy of these innovations.

The Department's overall budget authority in FY 2000 was $20.9 billion. Of this, authority for all R&D across the department totaled $0.645 billion.[38]

The VA RDO is an intramural system with four services:

> *Medical Research Service* manages laboratory-based research projects related to veteran health problems.
>
> *Rehabilitation R&D Service* coordinates the development of treatments and procedures related to the rehabilitation of veterans with disabilities.
>
> *VA Cooperative Studies Program* establishes statistically based evidence on the outcomes of new products and procedures by conducting large clinical trials with support from the VA, other federal agencies, and pharmaceutical manufacturers.
>
> *VA Health Services Research* defines and guides us toward valuable systematic changes based on outcome studies of various treatments and procedures.

The VA also has a commitment to developing collaborations with commercial partners. Such partners provide production, packaging, marketing, and servicing of products to complete the cycle started by VA research.

The VA is directed by the Congress to move discovery to the public domain, as associated with the series of federal technology transfer acts and amendments (1986–1997) to the Stevenson-Wydler Technology Innovation Act over the 1986–97 period.

[38] This figure includes basic and applied research, development, R&D facilities, and equipment. Source: Documents from the Office of Management and Budget (OMB) and the American Association for the Advancement of Science.

OFFICE OF TECHNOLOGY POLICY

In August 1996, Dr. Feussner, the VA's Chief Research and Development Officer, announced two fundamental goals:

(1) Make inventions readily available and accessible across the U.S. healthcare market; and,

(2) Adhere to the spirit of the congressional challenge for the federal R&D efforts to improve the lives of our citizens, fuel our economy, and maintain U.S. competitiveness in the international market.

The VA's technology transfer program (TTP) has the mission of serving the American public by translating the results of worthy discoveries made by employees of VA into practice. This requires a program that evaluates inventions, educates inventors concerning their rights and obligations, obtains patents, and assists in the commercialization of new products. It also requires consistent policies that govern the necessary relationships between investigator/inventor, academic partners, local VA medical centers, industry, and the Department of Commerce, and requires close collaboration between the VA's RDO and Office of General Counsel (OGC).

The TTP's public mission demands aggressive dissemination. It is also necessary that VA retain internal licensing rights, so that new discovery can be built upon past/current achievements. This ensures veterans' access to technologies.

The TTP is committed to the RDO's mission of supporting the highest quality intramural research program. This means moving discovery from the laboratory to clinical practice in a timely manner; it also means assuring that inventors and their host VA Medical Centers receive optimal advice and support so that they may realize equitable compensation and recognition. This requires a continuing education program that promotes an accurate understanding of inventor's rights and obligations. Accordingly, the OGC recently completed a document entitled "PATENTS—Government and Employee Rights and Responsibilities," which provides a clear, well-defined, and legally sound definition of federal rights. This document is intended to provide a quick overview of who, what, why, when, and how concerning intellectual property (IP). In addition, major efforts are underway to expand and improve the quality and quantity of information available on the VA's technology transfer web site (www.vard.org).

TTP is committed to realistic and timely processing from receipt of disclosure to determination of rights and, where appropriate, patent application comparable to other federal agencies such as the National Institutes of Health. In addition, the TTP has assembled a Technology Transfer advisory group to assist in its functions. TTP is consulting with these experts in the field to assist in guiding VA Technology Transfer operations.

To help investigators and administrators identify and understand Technology Transfer steps and associated time estimates, the TTP has worked closely with VA OGC and has implemented major procedural changes that have already shortened the time from ID to a determination of rights and all subsequent actions as required. In addition, a VA representative was appointed to the Federal Laboratory Consortium (FLC) for and to the federal Interagency Working Group on Technology Transfer.

While still in its infancy, the TTP initiative has already produced results. There has been an increase in the number of invention disclosures submitted, and, more importantly, an increase in the number of disclosures in which the VA has retained ownership rights and VA patent applications filed. Each patent application represents potential for licenses, commercial products, sponsored research, and royalty to both the inventor(s) and the laboratories.

The TTP provides analysis of commercial and patent potential of inventions by VA employees. And, when indicated, it supports the patenting process and markets inventions to industry. When beneficial to veterans, we will seek to partner with local affiliated university technology transfer programs for management of patenting and marketing.

Many VA investigators have dual appointments with a university. As such, an invention may have taken place in a VA laboratory but was sponsored with funds from the VA and the university.

In cases where there is co-ownership of an invention with an academic affiliate, a model inter-institutional agreement (IIA) has been developed. This legal agreement outlines relevant definitions, terms, and conditions for handling IP between both organizations. Using the IIA allows ownership to remain with the VA while providing the university unimpeded access and authority to patent and market the IP in question. This makes the invention attractive to manufacturers to assure that if they develop the product for the marketplace, they will have exclusive rights to produce and market the invention. The overall benefit to the government and taxpayers is that an invention resulting from federally funded research will be protected by a patent. Successful patents licensed to manufacturers provide a royalty stream. VA inventors will benefit from royalties for their personal use as well as from a return of royalties to their research laboratories and facilities. The American taxpayer gains by the return of funds to the laboratories to further biomedical research. Overall, IIAs provide a win/win situation for the VA and academic affiliates while at the same time maintaining, strengthening, and/or expanding existing partnerships to the mutual benefit of both organizations. Accordingly, IIAs will be used with academic affiliates whenever possible.

To date, the VA has executed IIAs with the following universities:

- University of California System
- University of Oklahoma
- Tulane University

- Wisconsin Alumni Research Foundation
- Medical College of Wisconsin
- St. Louis University
- University of Maryland
- Baylor
- University of Colorado
- University of Minnesota
- LSU
- University of Tennessee Research Corp.

For those investigators with no academic affiliation, or when the VA is sole owner of an invention, patents are processed by VA medical center research offices and funded by the RDO. This approach has been taken to insure there are no delays in processing patents that the TTP deems viable.

Finally, the VA has contracted with the National Technology Transfer Center (NTTC), on a trial basis, to assist in assessing, marketing, and licensing technologies owned by the VA. In conjunction with the VA TTP, the NTTC will facilitate partnerships and license agreements of VA intellectual properties that will help to accelerate and lead to rapid and widespread commercialization.

Selected Examples of Downstream Outcomes from Agency Technology Transfer

No cases examples were provided by the department for this edition of the Biennial Report. (As indicated in the table above, the department responded that there were "no" reportable commercial outcomes or benefits to agency lab capabilities or technologies in FYs 1999 or 2000 that resulted from past/current CRADAs or licenses.)

Appendix 1
The Stevenson-Wydler and Bayh-Dole Acts: A Review of the Evolution of the Federal Technology Transfer Authorities

The Technology Innovation Act of 1980 (often referred to as the Stevenson-Wydler Act) and the University and Small Business Patent Procedures Act of 1980 (often referred to as the Bayh-Dole Act) remain the primary statutory moorings for technology transfer between the federal laboratories, and the private sector. Since the mid–1980s, there has been continuing congressional review of agency experiences in implementing these laws, which has often resulted in amending legislation to both Stevenson-Wyder and Bayh-Dole. These refinements and modifications have generally provided improved technology transfer tools. Many of these statutory changes are in response to problems that industry identified as impediments to effective "partnering" with the federal laboratories.

In seeking to assess what the agencies have achieved in their technology transfer activities, it is important to appreciate the broad thrust of the evolution of the two 1980 Acts over the last two decades. This short section is provided with this purpose in mind.

Establishment of the Technology Transfer Office

Prior to any Congressional action in the technology transfer arena, there were many individuals at federal laboratories who carried out activities to support their local communities and assist private companies. These individuals formed an *ad hoc*, inter-laboratory coordinating effort in 1974 that was later chartered by Congress as the Federal Laboratory Consortium (FLC).

During 1979 and 1980, the Congress sought ways to more effectively access technologies at the federal laboratories. The Stevenson-Wydler Act of 1980[39] authorized the establishment of laboratory-based offices dedicated to fostering technology transfer between the laboratories, state and local governments, and the private sector. Under this legislation, each federal laboratory with a total annual budget of more than $20 million was required to assign at least one full-time professional to staff an "Office of Research and Technology Applications" (ORTA). Beginning in fiscal year 1982, each agency was to make available at least 0.5% of the agency's R&D budget to support the ORTAs at those laboratories.[40]

[39] P.L. 96-480, 15 USC §§ 3701-3714.

[40] In 1986, the Act was amended to require an ORTA at any laboratory having a staff of over 200 full-time equivalent scientific, engineering and related positions. P.L. 99-502, amending 15 USC § 3710(b).

Establishment of the ORTAs at the federal laboratories was an important first step in formally authorizing what had been informal technology transfer activities. However, this action had minimal impact at many laboratories, which assessed how much money was being spent on activities that fell within the parameters of the act, and found that they were already exceeding the 0.5% minimum expenditure. Through publishing papers, attending conferences, and engaging in activities to support local schools, businesses, and communities, many laboratories easily met the prescribed minimum expenditures. As a result, many regarded the congressional mandate as fully satisfied by designating a laboratory employee to fill the mandated ORTA position, without assigning additional funds for the technology transfer mission. While the ORTA position lacked much stature within the laboratories' management structure in the early years, the ORTA was given authority to interact with state and local governments and the private sector and to strengthen such activities through inter-laboratory cooperation.

Licensing Laboratory Intellectual Property to Industry Under Statutory Authority

At the same time the Stevenson-Wydler Act was being developed to bolster laboratory technology transfer to industry, Congress was also developing what became the University and Small Business Patent Procedures Act, referred to as the Bayh-Dole Act.[41] The Bayh-Dole Act sought to improve the commercialization of federal research in two distinct ways. First, it allowed non-profit organizations (principally universities) and small businesses to retain title to inventions arising from federally supported R&D. Second, the Act authorized federal agencies to patent their inventions and to grant licenses.

The licensing provisions applicable to universities and federal agencies are somewhat similar, but the federal laboratories have somewhat more restrictions on their activities. Both must honor a statutory preference for small businesses and both retain "march-in rights" in the event a licensee does not live up to its commercialization objectives.[42] Both are required to share royalties with their inventors but only the federal agencies are required to share a specified minimum amount.[43] The universities do not have to give public notice of their intention to grant exclusive licenses, as do federal agencies.[44] Although both must require the domestic manufacture of products to be sold in the United States, this requirement is applicable to all government licenses but only to exclusive licenses granted by universities.[45] In addition, the process for waiving the manufacturing requirement is more clearly stated for universities.

[41] P.L. 96-517, 35 USC §§ 200-211.

[42] Cf. 35 USC § 202(c)(7)(D) and 35 USC § 209(c)(3) (small business preference); 35 USC § 203 and 35 USC § 209(f)(2) (march-in rights).

[43] Cf. 35 USC § 202(c)(7)(B) and 15 USC § 3710c.

[44] 35 USC § 209(d) (agency notice requirement).

[45] Cf. 35 USC § 204 and 35 USC § 209(b).

In 1984, in an effort to strengthen the licensing activities of federal agencies, the Bayh-Dole Act was amended to give the Secretary of Commerce new oversight authority.[46] The Secretary was to assist federal agencies in efforts to promote the protection, licensing, and utilization of government owned inventions. The Secretary was authorized to issue regulations governing agency licensing practices and to provide assistance and advice to the agencies in their efforts. The legislative history of the bill stated:

> *The Secretary of Commerce is to develop guidelines and a number of aids to help the agencies make best use of these authorities. These aids will include techniques for evaluating the commercial potential of inventions, instruction courses for laboratory employees on the innovation process, model agreements covering the disposition of inventions for use in establishing cooperative arrangements, and advice and assistance to laboratory directors. The Secretary is to monitor the results of the program and provide annual reports to the President and the Congress.*[47]

New Technology Transfer Tools Through the Use of Cooperative Research and Development Agreements

Beginning in 1984, several bills were introduced in Congress to add emphasis to the transfer of technology from the federal laboratories to the private sector. As stated in the legislative history of P.L. 98-620, *"There is broad agreement that with about $17 billion going to the Federal laboratories, which employ about one-sixth of the nation's research workers, ways must be found to increase the flow of technology from those laboratories to the private sector."* During Senate hearings on technology transfer legislation in 1984, several speakers argued that the Federal laboratories were an untapped resource.[48]

A common theme in these legislative proposals was the need for incentives for laboratory inventors to work with industry and for a formal legal mechanism by which the federal laboratories could perform cooperative research with the private sector. Based on the positive experiences with university licensing and the anticipated competitive advantages to U.S. industry,

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[46] Trademark Clarification Act of 1984, P.L. 98-620, Title V, § 501, amending 35 USC § 206. This legislation also amended the procedures by reducing some of the requirements applicable to non-profit organizations and small businesses claiming rights in inventions arising under federal funding agreements.

[47] S. Rep. no. 98-662 (October 5, 1984) reprinted in U.S. Code, Cong. & Ad. News, 5799.

[48] Governor Dick Thornburg of Pennsylvania noted, "*There are over 380 federal laboratories in the United States. The eight in Pennsylvania are performing research in areas ranging from coal and forestry to food quality. We should be certain that we are taking maximum advantage of their resources and results to stimulate economic growth in this country. Although these laboratories perform a significant amount of the research taking place in our country today, they have not always been as aggressive as they might be in transferring their technology from the laboratory to the private sector.*" S. Rep. No. 98-662, (Oct. 5, 1984).

Congress began to consider ways to better leverage the intellectual property generated under the significant federal R&D investments at the federal laboratories.

In 1986, the ideas were merged into a single bill that was enacted as the Federal Technology Transfer Act of 1986 (FTTA). Under the new authority, government-owned, government-operated (GOGO) laboratories were empowered to cooperate with industry and other non-federal entities and to use technology transfer tools, which previously had not been available to all GOGO laboratories. Specific authorities granted under the act included:

- Authority for the laboratories to enter into formal contracts (called Cooperative Research and Development Agreements—CRADAs) with non-federal entities to cooperate in the advancement of technologies toward commercial application;
- Direction to the laboratories to identify, protect, and license to the CRADA partner inventions made at the laboratory under the CRADA;
- Authority for the laboratories to establish a cash awards program to reward laboratory technical staff for inventions, innovations, and other activities that promoted commercial and mission application of technologies and domestic technology transfer;
- Authority for the laboratories to retain income from licensing of laboratory intellectual property to reward inventors and other technical staff members who made technology transfer contributions and to fund mission-related education and training, intellectual property management costs, or mission-related scientific R&D; and
- Authority for agencies to waive their rights in inventions and assign title to CRADA partners.

In addition, the FTTA provided important guidance to the federal laboratories about the role that technology transfer should play in each laboratory's culture:

- Technology transfer, consistent with mission responsibilities, was to become a responsibility of each laboratory science and engineering professional.
- Each laboratory director was to ensure that efforts to transfer technology were considered positively in laboratory job descriptions, employee promotion policies, and evaluation of the job performance of scientists and engineers in the laboratory.
- Individuals filling positions in an ORTA were to be included in the overall laboratory/agency management development program to ensure that highly competent technical managers were full participants in the technology transfer process.

- To enhance the effectiveness of laboratory-based technology transfer programs, each ORTA was to prepare application assessments for selected R&D projects in which that laboratory was engaged and which, in the opinion of the laboratory, might have potential commercial applications.

- Each laboratory was encouraged to participate, where feasible, in regional, state, and local programs designed to facilitate or stimulate the transfer of technology to benefit the region, state, or local jurisdiction in which the federal laboratory is located.

In 1988 Congress amended the Stevenson-Wydler Act to expand the scope of intellectual property that could be licensed under a CRADA. The amended law permitted laboratories *"to negotiate license agreements ... for inventions and other intellectual property developed at the laboratory."*[49] Congress explained the change as intended *"to allow parties negotiating a cooperative agreement to permit contractual considerations of all intellectual property arising under the agreement."*

Reinforcing Federal Technology Transfer Initiatives: Executive Order 12591

In 1987, President Reagan issued Executive Order 12591 to encourage federal agencies and their laboratories to move knowledge from the research laboratories into the development of new products and processes by fully implementing the statutory authorities granted by the Bayh-Dole Act, Federal Technology Transfer Act, and related legislation.

The Order directed the agencies, to the extent permitted by law and within funding allocations, to extend rights to all contractors, regardless of size, to elect to retain title to all inventions made under federally- funded R&D. In addition, the Order recognized the international implications of these activities and set guidelines to ensure the protection and preservation of United States interests in CRADAs or patent licenses involving foreign entities. These guidelines require that agencies, "in consultation with the United States Trade Representative, give appropriate consideration" to several factors relating to the foreign country whose entities are involved in the transaction. These factors include the ability of U.S. companies to participate in cooperative research and licensing in the country, the country's intellectual property protection policies, and the adequacy of its export control measures.

[49] P.L. 100-519, amending 15 USC § 3710a(a).

Granting CRADA Authority to DoE Laboratories and Other Amendments

The National Competitiveness Technology Transfer Act of 1989[50] (NCTTA) gave all government-owned, contractor-operated (GOCO) laboratories authority to enter into CRADAs under the Federal Technology Transfer Act. Most of the GOCO laboratories were part of the Department of Energy laboratory system and this law effectively empowered all federal laboratories to participate in federal technology transfer activities. The NCTTA provided a number of special provisions applicable to the GOCO CRADA process.

The NCTTA also increased reporting requirements relating to intellectual property management. The federal agencies were required to submit to the Congress, with their annual budget request, an explanation of the agency's technology transfer program for the preceding year and the agency's plans for conducting its technology transfer function for the upcoming year. Plans for an upcoming year were to include provisions for securing intellectual property rights in laboratory innovations with commercial promise and plans for managing such innovations to benefit United States industrial competitiveness.

Other significant changes in the 1989 Act related to the treatment of proprietary information generated in connection with a CRADA. The Congress believed that the threat of disclosure under the Freedom of Information Act of confidential information had been a significant impediment to corporate participation in CRADAs. For that reason, the NCTTA included language authorizing the laboratories to withhold from disclosure certain types of information either supplied by the private sector partner or generated in the course of the CRADA activities. Congress authorized the laboratories to protect from disclosure (including disclosure under the Freedom of Information Act) "information that results from research and development activities" under the Act for a period of up to five years from its development. This CRADA information must be of a type "that would be a trade secret or commercial or financial information that is privileged or confidential, if the information had been obtained from a non-Federal party" participating in a CRADA.[51]

Establishing Minimum Expectations for Licensing CRADA Inventions

In 1995, legislation was introduced to provide statutory guidance to both the federal laboratories and their private sector partners in licensing rights to intellectual property generated under a CRADA. The National Technology Transfer and Advancement Act of 1995[52] (NTTAA), ensures that a private sector CRADA partner will have sufficient rights in laboratory inventions

[50] P.L. 101-189, amending 15 USC §§ 3710a and 3710b.

[51] 15 USC § 3710a(c)(7)(B).

[52] P.L. 104-113, amending portions of 15 USC §§ 3710-3710d.

made under the CRADA to obtain whatever competitive advantage may result from commercializing the resulting technology. The law requires the collaborating party be offered, at a minimum, "the option to choose an exclusive license for a pre-negotiated field of use" for any laboratory invention under the agreement.[53] In return, the laboratory is to receive a license to practice the invention on behalf of the government and may also, in certain defined circumstances, require the collaborator to license to others on reasonable terms.[54]

New Technology Transfer Law in 2000

On November 1, 2000, the President signed Pub. L. 106-404, "The Technology Transfer Act of 2000" (TTCA). This law resulted from H.R. 209, sponsored by Representative Constance A. Morella (R-MD), and incorporated many changes proposed by the Interagency Working Group on technology transfer chaired by the Technology Administration of the Department of Commerce. This law made changes to both the Bayh-Dole Act and the Federal Technology Transfer Act.

Some of the significant changes include the authority to license (a) inventions without first filing a patent application and (b) certain background inventions under a CRADA. (Although, the procedures in 35 USC 209 still apply to the licensing of the background invention.) Also, the new law specified that public notice for an exclusive license be at least 15 days. Congress felt that the extant 60-day notice in the regulation was too long for all inventions. The licensing regulation in 37 CFR Part 404 is being revised to implement the new law, but, because the agencies felt it was important, the 15-day notice was published as a final rule in 66 Fed. Reg. 34545 (June 29, 2001).

In addition, the TTCA established several significant new reporting requirements. The Department of Commerce's Biennial Report to Congress on technology transfer (established by the FTTA in 1986) is to be submitted annually, and certain items specified to be included in the report. In addition, each department was required to submit an annual department report to OMB, in conjunction with the department's annual budget proposal materials. The report must discuss department plans for conducting technology transfer and must report on technology transfer achievements in the most recently closed fiscal year. Finally, the Committee on National Security of the National Science and Technology Council was required to submit a report to Congress on the adequacy of existing procedures for federal laboratories entering into CRADA or exclusive license relationships with foreign entities.

[53] 15 USC § 3710a(b).

[54] The government may exercise such rights "only in exceptional circumstances" and only if it determines that the collaborator has failed to meet commitments intended to ensure economic benefit to the United States or that certain other defined conditions are met. 15 USC § 3710a(b)(1)(B) and (C).

The TTCA also required that the Department of Energy establish a Technology Partnerships Ombudsman for each national laboratory. The Ombudsman, a senior official of the laboratory, is to assist the public and industry in resolving complaints or disputes with the laboratory over partnerships, patents, and licensing.

Appendix 2
Statistical Tables FY: 1987–2000

Table A2.1 Collaborative Relationships for Research, Development, and Demonstration at Federal Labs and Research Centers

Table A2.2 Invention Disclosure and Patenting at Federal Labs and Research Centers

Table A2.3 Licensing—Inventions and Other Intellectual Property at Federal Labs and Research Centers

Table A2.4 Income from Licensing at Federal Labs and Research Centers

Table A2.1 - Collaborative Relationships for Research, Development, and Demonstration at Federal Labs and Research Centers

		FY1985	FY1986	FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000
Agriculture	Total active CRADAs			9	51	98	128	177	172	172	208	229	244	273	288	298	257
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	93	102	101	69
Commerce	Total active CRADAs			0	9	44	82	115	177	292	368	407	406	377	337	261	208
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	90	77	62	40
Defense	Total active CRADAs			3	10	36	113	193	277	365	563	845	1,086	1,360	1,424	1,350	1,364
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	408	399	449	425
Air Force	Total active CRADAs			0	2	7	13	26	6	25	32	66	223	251	246	327	339
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	72	55	88	71
Army	Total active CRADAs			3	8	27	80	115	212	260	389	549	531	740	817	724	769
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	189	210	219	233
Navy	Total active CRADAs			0	0	2	20	52	59	80	142	230	332	369	361	299	256
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	147	134	142	121
Energy	Total active CRADAs			0	0	0	1	43	250	582	1,094	1,392	1,677	963	868	715	687
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	274	266	240	151
EPA	Total active CRADAs			0	0	2	11	31	30	28	35	30	35	34	37	38	44
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	11	12	13	10
HHS *	Total active CRADAs			22	28	89	110	144	146	149	147	152	158	161	163	237	244
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	32	43	65	50
Interior	Total active CRADAs			0	0	1	12	11	1	3	9	15	22	23	30	30	40
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	9	7	10	8
NASA **	Total active CRADAs			0	0	0	0	0	0	0	0	0	0	0	0	1	1
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	0	0	1	0
Transportation	Total active CRADAs			0	0	0	1	9	17	30	38	37	43	36	39	51	79
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	14	13	5	38
Veterans Affairs	Total active CRADAs			0	0	1	2	8	8	7	9	14	17	12	15	1	2
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	6	9	1	2
Totals	Total active CRADAs			34	98	271	460	731	1,078	1,628	2,471	3,121	3,688	3,239	3,201	2,982	2,926
	New CRADAs in FY			---	---	---	---	---	---	---	---	---	---	937	928	947	793

--- = data not requested from agency.

The numbers of CRADAs reported by the agencies are for CRADAs done under the authority of 15 USC Sec. 3710a.
*NIH began using the CRADA authority in 1996 to transfer the research materials of its intramural laboratories. These material transfer-CRADAs are not included in the HHS figures reported above.
** Prior to 1999, NASA performed all of its technology transfer under the provisions of the 1958 Space Act.

Notes: The Biennial Reporting process was established by the Federal Technology Transfer Act of 1986. As such, the first data year in the series is FY 1987.
Figures on the number of new CRADAs yearly were not requested from the agencies until FY 1997 and, in general, are not readily available for the prior years.
For several of the years reported, the government-wide totals for lab patent applications and patents issued ignore the presence of n/a entries in the departmental data. However, the missing figures are few and small in magnitude and do not substantially bias the picture provided by the government-wide totals.

			FY1986	FY1987	FY1988	FY1989		FY1991	FY1992	FY1993	FY1994		FY1996	FY1997	FY1998	FY1999	
Agriculture		Inventions disclosed		83	144	127	158	127	83	110	111	133	129	260	208	162	109
		Patent applications filed		44	50	71	76	110	70	68	40	80	91	56	64	84	78
		Patents issued		---	---	---	---	---	---	---	---	---	---	45	75	74	64
Commerce		Inventions disclosed		43	31	49	46	30	55	66	51	65	71	58	40	35	32
		Patent applications filed		8	15	28	28	18	53	43	41	35	60	49	66	27	18
		Patents issued		---	---	---	---	---	---	---	---	---	---	23	19	26	14
Defense		Inventions disclosed		953	1,147	1,153	1,383	1,524	1,283	1,189	1,172	1,168	1,115	1,150	1,028	1,060	991
		Patent applications filed		343	447	616	807	919	850	835	732	759	716	735	755	703	774
		Patents issued		---	---	---	---	---	---	---	---	---	---	554	579	547	553
	Air Force	Inventions disclosed		83	90	169	160	102	160	140	140	200	190	138	121	88	174
		Patent applications filed		49	47	122	145	178	155	161	122	148	108	100	116	87	108
		Patents issued		---	---	---	---	---	---	---	---	---	---	88	89	85	80
	Army	Inventions disclosed		248	348	276	376	463	438	413	388	363	338	312	264	306	250
		Patent applications filed		177	203	216	236	274	260	246	232	218	204	192	219	208	243
		Patents issued		---	---	---	---	---	---	---	---	---	---	169	168	165	152
	Navy	Inventions disclosed		622	709	708	847	959	685	636	644	605	587	700	643	666	567
		Patent applications filed		117	197	278	426	467	435	428	378	393	404	443	420	408	423
		Patents issued		---	---	---	---	---	---	---	---	---	---	297	322	297	321
Energy		Inventions disclosed		857	1,003	1,053	1,335	1,666	1,698	1,443	1,588	1,758	1,886	1,500	1,313	1,474	1,371
		Patent applications filed		252	336	382	366	397	432	497	543	571	564	705	751	850	788
		Patents issued		---	---	---	---	---	---	---	---	---	---	384	512	525	515
EPA		Inventions disclosed		0	0	0	12	20	9	22	19	15	20	9	14	5	11
		Patent applications filed		4	5	5	6	8	12	15	15	24	18	13	11	15	10
		Patents issued		---	---	---	---	---	---	---	---	---	---	12	1	8	6
HHS		Inventions disclosed		194	226	209	215	215	311	282	307	307	305	268	287	328	375
		Patent applications filed		98	145	225	239	261	224	193	171	166	147	148	132	241	263
		Patents issued		---	---	---	---	---	---	---	---	---	---	152	171	180	132
Interior		Inventions disclosed		3	6	3	26	26	1	2	2	2	2	5	5	8	16
		Patent applications filed		5	4	11	15	21	1	2	2	2	2	2	5	3	5
		Patents issued		---	---	---	---	---	---	---	---	---	---	1	3	1	4
NASA		Inventions disclosed		496	462	532	538	570	416	384	457	517	550	550	554	525	574
		Patent applications filed		94	129	125	181	205	225	185	179	164	123	140	105	129	109
		Patents issued		---	---	---	---	---	---	---	---	---	---	94	105	87	99
Transportation		Inventions disclosed		0	0	0	1	2	1	1	1	0	4	2	4	1	0
		Patent applications filed		0	0	0	1	1	0	0	1	2	2	1	3	0	3
		Patents issued		---	---	---	---	---	---	---	---	---	---	0	1	0	3
Veterans Affairs		Inventions disclosed		33	28	42	58	33	44	39	45	36	71	40	50	48	85
		Patent applications filed		n/a	n/a	3	8	n/a	0	0	0		0	1	2	37	35
		Patents issued		---	---	---	---	---	---	---	---	---	---	n/a	n/a		1
												0					
Totals		Inventions disclosed		2,662	3,047	3,168	3,772	4,213	3,901	3,538	3,753	4,001	4,153	3,842	3,503	3,646	3,564
		Patent applications filed		848	1,131	1,466	1,727	1,940	1,867	1,838	1,724	1,803	1,723	1,850	1,8940	2,089	2,083
		Patents issued		---	---	---	---	---	---	---	---	---	---	1,265	1,466	1,448	1,391

n/a = requested agency data not available. - = data not requested from agency.

Notes: The Biennial Reporting process was established by the Federal Technology Transfer Act of 1986. As such, the first data year in the series is FY 1987.
Figures on the number of patents issued yearly were not requested from the agencies until FY 1997 and, in general, are not readily available for the prior years.
For several of the years reported, the government-wide totals for lab patent applications and patents issued ignore the presence of n/a entries in the departmental data. However, the missing figures are few and small in magnitude and do not substantially bias the picture provided by the government-wide totals.

Table A2.3 - Licensing—Inventions and Other Intellectual Property at Federal Labs and Research Centers

		FY1985	FY1986	FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000
Agriculture	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	218	225
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	218	225
	New inv. licenses granted in the FY			30	24	23	33	29	31	28	9	21	26	22	23	29	24
	All "Other IP" licenses active			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
Commerce	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	40	39
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	40	39
	New inv. licenses granted in the FY			0	0	1	0	2	5	3	3	4	10	11	17	7	3
	All "Other IP" licenses active			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	0	0
Defense	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	193	208
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	177	189
	New inv. licenses granted in the FY			10	10	14	15	25	19	20	28	34	41	34	34	61	67
	All "Other IP" licenses active			---	---	---	---	---	---	---	---	---	---	---	---	16	19
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	16	19
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	0	0
Air Force	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	62	59
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	46	40
	New inv. licenses granted in the FY			1	2	2	4	1	1	3	3	4	6	7	5	40	40
	All "Other IP" licenses active			---	---	---	---	---	---	---	---	---	---	---	---	16	19
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	16	19
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	0	0
Army	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	88	98
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	88	98
	New inv. licenses granted in the FY			3	6	2	3	9	7	3	12	12	19	14	13	8	12
	All "Other IP" licenses active			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
Navy	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	43	51
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	43	51
	New inv. licenses granted in the FY			6	2	10	8	15	11	14	13	18	16	13	16	13	15
	All "Other IP" licenses active			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
Energy	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	2,384	2,846
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	981	1,094
	New inv. licenses granted in the FY			37	43	57	62	75	81	96	118	140	154	175	162	202	169
	All "Other IP" licenses active			---	---	---	---	---	---	---	---	---	---	---	---	1,403	1,752
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	49	92
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	1,316	1,620
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	38	40

		FY1985	FY1986	FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000
EPA	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	17	18
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	17	18
	New inv. licenses granted in the FY			0	0	0	1	2	2	2	9	1	2	1	0	2	3
	All "Other IP" licenses active*			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
HHS	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	1,364	1,608
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	1,041	1,222
	New inv. licenses granted in the FY			35	42	48	47	69	96	99	151	176	193	208	215	208	192
	All "Other IP" licenses active*			---	---	---	---	---	---	---	---	---	---	---	---	323	386
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	323	386
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	0	0
Interior	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	12	6
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	12	6
	New inv. licenses granted in the FY			3	3	0	0	0	n/a	n/a	8	3	n/a	0	0	0	2
	All "Other IP" licenses active*			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	0	0
NASA	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	190	205
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	168	173
	New inv. licenses granted in the FY			13	7	7	6	4	5	12	11	29	36	36	40	40	47
	All "Other IP" licenses active*			---	---	---	---	---	---	---	---	---	---	---	---	22	32
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	22	32
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	0	0
Transportation	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	New inv. licenses granted in the FY			0	0	0	0	0	n/a	n/a	n/a	n/a	n/a	0	1	0	0
	All "Other IP" licenses active*			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	0	0
Veterans Affairs	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	New inv. licenses granted in the FY			0	0	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	47	3
	All "Other IP" licenses active*			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	0	0
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	0	0
Totals	Total licenses active in the FY			---	---	---	---	---	---	---	---	---	---	---	---	4,418	5,155
	All invention licenses active			---	---	---	---	---	---	---	---	---	---	---	---	2,654	2,966
	New inv. licenses granted in the FY			128	129	150	164	206	239	260	337	408	462	487	492	596	510
	All "Other IP" licenses active*			---	---	---	---	---	---	---	---	---	---	---	---	1,764	2,189
	For non-patented IP			---	---	---	---	---	---	---	---	---	---	---	---	388	497
	For authored works			---	---	---	---	---	---	---	---	---	---	---	---	1,338	1,652
	For other info. deemed commercially valuable			---	---	---	---	---	---	---	---	---	---	---	---	38	40

n/a = requested agency data not available. --- = data not requested from agency.

*For the purposes of this survey "Other IP" is comprised by: "non-patented intellectual property" (tangible research products such as biological materials), "authored works" (such as software, engineering drawings, reference data), and information deemed commercially valuable by a partner and appropriately protected by the lab (such as know-how used at the lab and applied to solve a specific problem relating to a partner's product).

Notes: The Biennial Reporting process was established by the Federal Technology Transfer Act of 1986. As such, the first data year in the series is FY 1987. Nonetheless, the request to the agencies for the data for these measures did not commence until FY 1999.
In addition, as apparent, many of the agencies could provide only n/a responses to these questions. Thus, while government-wide totals are reported, the extent of bias due to this unavailable information is presently unclear, but potentially substantial.

Table A2.4 - Income from Licensing at Federal Labs and Research Centers

Agency	Measure	Unit	FY1985	FY1986	FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000
Agriculture	Total income, all active licenses	(mil $)															$2.377	$2.555
	Income from invention licenses	(mil $)			$0.133	$0.120	$0.420	$0.559	$0.836	$1.044	$1.483	$1.450	$1.635	$2.091	$2.300	$2.400	$2.377	$2.555
	Income from "Other IP" licenses	(mil $)															n/a	n/a
	Number of licenses earning running royalties																n/a	n/a
	Income from running royalties	(mil $)															$1.843	$1.843
Commerce	Total income, all active licenses	(mil $)															$0.394	$0.123
	Income from invention licenses	(mil $)			$0.034	$0.081	$0.062	$0.052	$0.026	$0.000	$0.000	$0.000	$0.042	$0.000	$0.196	$0.241	$0.394	$0.123
	Income from "Other IP" licenses	(mil $)															$0.000	$0.000
	Number of licenses earning running royalties																n/a	n/a
	Income from running royalties	(mil $)															n/a	n/a
Defense	Total income, all active licenses	(mil $)															$2.005	$2.213
	Income from invention licenses	(mil $)			$0.044	$0.049	$0.211	$0.239	$0.286	$0.331	$0.567	$1.081	$0.646	$0.836	$0.924	$1.560	$2.005	$2.213
	Income from "Other IP" licenses	(mil $)															$0.000	$0.000
	Number of licenses earning running royalties																42	29
	Income from running royalties	(mil $)															$0.865	$0.672
Air Force	Total income, all active licenses	(mil $)															$0.792	$0.648
	Income from invention licenses	(mil $)			$0.027	$0.031	$0.027	$0.044	$0.043	$0.047	$0.090	$0.059	$0.102	$0.142	$0.190	$0.212	$0.792	$0.648
	Income from "Other IP" licenses	(mil $)															$0.000	$0.000
	Number of licenses earning running royalties																25	21
	Income from running royalties	(mil $)															$0.792	$0.648
Army	Total income, all active licenses	(mil $)															$0.536	$0.866
	Income from invention licenses	(mil $)			$0.010	$0.005	$0.041	$0.058	$0.113	$0.078	$0.077	$0.110	$0.100	$0.335	$0.256	$0.430	$0.536	$0.866
	Income from "Other IP" licenses	(mil $)															$0.000	$0.000
	Number of licenses earning running royalties																0	0
	Income from running royalties	(mil $)															$0.000	$0.000
Navy	Total income, all active licenses	(mil $)															$0.677	$0.699
	Income from invention licenses	(mil $)			$0.007	$0.013	$0.143	$0.137	$0.130	$0.206	$0.400	$0.912	$0.444	$0.359	$0.478	$0.918	$0.677	$0.699
	Income from "Other IP" licenses	(mil $)															n/a	n/a
	Number of licenses earning running royalties																17	8
	Income from running royalties	(mil $)															$0.073	$0.024
Energy	Total income, all active licenses	(mil $)															$11.764	$15.840
	Income from invention licenses	(mil $)			$0.346	$0.545	$1.499	$2.560	$3.193	$2.369	$2.703	$2.915	$3.455	$4.122	$8.009	$10.536	$10.199	$12.710
	Income from "Other IP" licenses	(mil $)															$1.545	$2.836
	Number of licenses earning running royalties																193	220
	Income from running royalties	(mil $)															$1.975	$2.228
EPA	Total income, all active licenses	(mil $)															n/a	n/a
	Income from invention licenses	(mil $)			$0.000	$0.000	$0.000	$0.003	$0.074	$0.060	$0.075	$0.230	$0.110	$0.300	$0.060	$0.100	n/a	n/a
	Income from "Other IP" licenses	(mil $)															n/a	n/a
	Number of licenses earning running royalties																n/a	n/a
	Income from running royalties	(mil $)															n/a	n/a
HHS	Total income, all active licenses	(mil $)															$44.821	$52.547
	Income from invention licenses	(mil $)			$4.245	$5.434	$4.804	$5.839	$13.384	$10.133	$13.584	$18.654	$19.727	$27.277	$35.692	$39.500	$42.599	$48.592
	Income from "Other IP" licenses	(mil $)															$2.222	$3.955
	Number of licenses earning running royalties																223	230
	Income from running royalties	(mil $)															$34.599	$43.892
Interior	Total income, all active licenses	(mil $)															$1.640	$0.850
	Income from invention licenses	(mil $)			$1.000	$0.038	$0.061	$0.041	$0.058	$0.000	$0.000	$2.000	$2.000	$2.000	$2.000	$2.000	$1.640	$0.850
	Income from "Other IP" licenses	(mil $)															$0.000	$0.000
	Number of licenses earning running royalties																11	5
	Income from running royalties	(mil $)															$1.640	$0.850

			FY1985	FY1986	FY1987	FY1988	FY1989	FY1990	FY1991	FY1992	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000
NASA	Total income, all active licenses	(mil $)			---	---	---	---	---	---	---	---	---	---	---	---	$0.823	$1.008
	Income from invention licenses	(mil $)			$0.073	$0.079	$0.084	$0.113	$0.292	$0.133	$0.158	$0.311	$0.349	$0.343	$0.521	$0.565	$0.818	$0.762
	Income from "Other IP" licenses	(mil $)			---	---	---	---	---	---	---	---	---	---	---	---	$0.005	$0.246
	Number of licenses earning running royalties				---	---	---	---	---	---	---	---	---	---	---	---	19	17
	Income from running royalties	(mil $)			---	---	---	---	---	---	---	---	---	---	---	---	$0.388	$0.175
Transportation	Total income, all active licenses	(mil $)			---	---	---	---	---	---	---	---	---	---	---	---	$0.000	$0.000
	Income from invention licenses	(mil $)			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	$0.000	$0.000	$0.000	$0.000
	Income from "Other IP" licenses	(mil $)			---	---	---	---	---	---	---	---	---	---	---	---	$0.000	$0.000
	Number of licenses earning running royalties				---	---	---	---	---	---	---	---	---	---	---	---	0	0
	Income from running royalties	(mil $)			---	---	---	---	---	---	---	---	---	---	---	---	$0.000	$0.000
Veterans Affairs	Total income, all active licenses	(mil $)			---	---	---	---	---	---	---	---	---	---	---	---	n/a	$1.021
	Income from invention licenses	(mil $)			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	$0.000	$0.000	n/a	$1.021
	Income from "Other IP" licenses	(mil $)			---	---	---	---	---	---	---	---	---	---	---	---	$0.000	$0.000
	Number of licenses earning running royalties				---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
	Income from running royalties	(mil $)			---	---	---	---	---	---	---	---	---	---	---	---	n/a	n/a
Totals	Total income, all active licenses	(mil $)			---	---	---	---	---	---	---	---	---	---	---	---	$63.824	$76.156
	Income from invention licenses	(mil $)			$5.875	$6.346	$7.141	$9.406	$18.149	$14.070	$18.570	$26.641	$27.964	$36.969	$49.702	$56.902	$60.032	$68.825
	Income from "Other IP" licenses	(mil $)			---	---	---	---	---	---	---	---	---	---	---	---	$3.772	$7.037
	Number of licenses earning running royalties				---	---	---	---	---	---	---	---	---	---	---	---	488	501
	Income from running royalties	(mil $)			---	---	---	---	---	---	---	---	---	---	---	---	$41.310	$49.660

n/a = requested agency data not available.

--- = data not requested from agency.

Notes: The Biennial Reporting process was established by the Federal Technology Transfer Act of 1986. As such, the first data year in the series is FY 1987. Nonetheless, the request to the agencies for the data for these measures did not commence until FY 1999.

In addition, as apparent, a few of the agencies could provide only n/a responses to these questions. Nonetheless, government-wide totals are reported. The extent of bias due to this unavailable information is presently unclear, but could vary widely—small in some cases, large in others.