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Technology Transfer: Use of Federally Funded Research and Development

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Technology Transfer: Use of Federally Funded Research and Development

Summary

The federal government spends approximately one third of its annual research and development budget[1] for intramural R&D to meet mission requirements in over 700 government laboratories (including Federally Funded Research and Development Centers). The technology and expertise generated by this endeavor may have application beyond the immediate goals or intent of federally funded R&D. These applications can result from technology transfer, a process by which technology developed in one organization, in one area, or for one purpose is applied in another organization, in another area, or for another purpose. It is a way for the results of the federal R&D enterprise to be used to meet other national needs, including the economic growth that flows from new commercialization in the private sector; the government's requirements for products and processes to operate effectively and efficiently; and the demand for increased goods and services at the state and local level.

Congress has established a system to facilitate the transfer of technology to the private sector and to state and local governments. Despite this, use of federal R&D results has remained restrained, although there has been a significant increase in private sector interest and activities over the past several years. Critics argue that working with the agencies and laboratories continues to be difficult and time-consuming. Proponents of the current effort assert that while the laboratories are open to interested parties, the industrial community is making little effort to use them. At the same time, State governments are increasingly involved in the process. At issue is whether incentives for technology transfer remain necessary, if additional legislative initiatives are needed to encourage increased technology transfer, or if the responsibility to use the available resources now rests with the private sector.

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[1] The total federal R&D budget was estimated by the National Science Foundation to be approximately $133.7 billion in FY2006.

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Most Recent Developments

Past Administrations have made expanded use of federal laboratories and industry-government cooperation integral to efforts associated with technology development. In support of this approach, Congress enacted various laws facilitating cooperative research and development agreements (CRADAs) between federal agencies and the private sector, and increasing funding for technology transfer activities included in the Advanced Technology Program (ATP) and the Manufacturing Extension Partnership (MEP) at the National Institute of Standards and Technology (NIST), a laboratory of the Department of Commerce. However, many of these efforts have been revisited since the 104th Congress, reflecting the then Republican majority's preferences for indirect measures such as tax policies, intellectual property rights, and antitrust laws to promote technology development rather than direct federal funding of private sector technology initiatives. While none of the relevant programs have been terminated, several have seen significant decreases in support.

Enacted in the 110th Congress, P.L. 110-5 provides FY2007 appropriations of $104.6 million for the MEP and $79 million for ATP. Also introduced in the current Congress, H.R. 255, the Manufacturing Technology Competitiveness Act of 2007, establishes several new manufacturing technology programs for small and medium-sized firms. Appropriations for MEP through 2012 would be authorized by S. 69. Several initiatives detailed in the "American Competitiveness Initiative" announced by the President in the 2006 State of the Union Address are included in bills before the current Congress. The ACI proposed various innovation-related activities including increased basic research funding, making permanent the research and experimentation tax credit, and improved math and science education. S. 833, the Competitiveness Through Education, Technology, and Enterprise Act of 2007, would make the research tax credit permanent, as does S. 41, the Research Competitiveness Act of 2007, which also creates tax exempt facility bonds for the development of research park facilities, among other things. H.R. 85, the Energy Technology Transfer Act, would create a program of grants to non-profit institutions, state and local governments, cooperative extension services, or universities to transfer energy efficient methods and technologies. As passed by the Senate, S. 761, the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act, provides for the creation of several programs, studies, and initiatives designed to improve U.S. innovation and competitiveness, among other things.

Background and Analysis

The federal government is estimated to have spent $133.7 billion in FY2006 on research and development to meet the mission requirements of the federal departments and agencies. Approximately one-third of this is for intramural research and development (R&D) by federal laboratories (including support for Federally Funded Research and Development Centers). While the major portion of this activity has been in the defense arena, government R&D has led to new products and processes for the commercial marketplace including, but not limited to, antibiotics, plastics, airplanes, computers, microwaves, and bioengineered drugs. Given the increasing competitive pressures on U.S. firms in the international marketplace, proponents of technology transfer argue that there are many other technologies and techniques generated in the federal laboratory system which could have market value if further developed by the industrial community. Similarly, the knowledge base created by the agencies' R&D activities can serve as a foundation for additional commercially relevant efforts in the private sector.

The movement of technology from the federal laboratories to industry and to state and local governments is achieved through technology transfer. Technology transfer is a process by which technology developed in one organization, in one area, or for one purpose is applied in another organization, in another area, or for another purpose. In the defense arena it is often called "spin-off." Technology transfer can have different meanings in different situations. In some instances, it refers to the transfer of legal rights, such as the assignment of patent title to a contractor or the licensing of a government-owned patent to a private firm. In other cases, the transfer endeavor involves the informal movement of information, knowledge, and skills through person-to-person interaction. The crucial aspect in a successful transfer is the actual use of the product or process. Without this, the benefits from more efficient and effective provision of goods and services are not achieved. However, while the United States has perhaps the best basic research enterprise in the world — as evidenced in part by the large number of Nobel Prizes awarded to American scientists — other countries sometimes appear more adept at taking the results of this effort and making commercially viable products to be sold in U.S. and world markets. (For further discussion of innovation and economic growth, see CRS Report RL33528, *Industrial Competitiveness and Technological Advancement: Debate Over Government Policy*, by Wendy Schacht.)

Despite the potential offered by the resources of the federal laboratory system, the commercialization level of the results of federally funded research and development remained low through the 1980s. Studies indicated that only approximately 10% of federally owned patents were ever used. There were various reasons for this, including the fact that many of these technologies and patents had no commercial application. A major factor in successful transfer is a perceived market need for the technology or technique. However, because federal laboratory R&D is generally undertaken to meet an agency's mission or because there are insufficient incentives for private sector research that the government deems in the national interest, decisions reflect public sector, rather than commercial needs. Thus, transfer often depends on attempts to ascertain commercial applications of technologies developed for government use — "technology push" — rather than on

"market pull." In other words, a technology is developed and a use for it established because the expertise exists rather than because it is perceived to be needed.

Additional barriers to transfer involve costs. Studies have estimated that research accounts for approximately 25% of expenditures associated with bringing a new product or process to market. Thus, while it might be advantageous for companies to rely on government-funded research, there are still significant added costs of commercialization after the transfer of technology has occurred. However, industry unfamiliarity with these technologies, the "not invented here" syndrome, and ambiguities associated with obtaining title to or exclusive license for federally owned patents also contribute to a limited level of commercialization. Complicating the issue is the fact that the transfer of technology is a complex process that involves many stages and variables. Often the participants do not know or understand each other's work environment, procedures, terminology, rewards, and constraints. The transfer of technology appears to be most successful when it involves one-to-one interaction between committed individuals in the laboratory and in industry or state and local government. "Champions" are generally necessary to see a transfer through to completion because it is so often a time- and energy-consuming process. Given this, technology transfer is best approached on a case-by-case basis that can take into account the needs, operating methods, and constraints of the involved parties.

Technology Transfer to Private Sector: Federal Interest

The federal interest in the transfer of technology from government laboratories to the private sector is based on several factors. The government requires certain goods and services to operate. Much of the research it funds is directed at developing the knowledge and expertise necessary to formulate these products and processes. However, the government has neither the mandate nor the capability to commercialize the results of the federal R&D effort. Technology transfer is a mechanism to get federally generated technology and technical know-how to the business community where it can be developed, commercialized, and made available for use by the public sector.

Federal involvement in technology transfer also arises from an interest in promoting the economic growth that is vital to the nation's welfare and security. It is through further development, refinement, and marketing that the results of research become diffused throughout the economy and can generate growth. It is widely accepted that technological progress is responsible for up to one-half the growth of the U.S. economy and is the principal driving force in long-term economic growth and increases in our standard of living. Economic benefits of a technology or technique accrue when a product, process, or service is brought to the marketplace where it can be sold or used to increase productivity. When technology transfer is successful, new and different products or processes become available to meet or induce market demand. Transfer from the federal laboratories can result in substantial increases in employment and income generated at the firm level.

Cooperation with the private sector provides a means for federal scientists and engineers to obtain state-of-the-art technical information from the industrial community, which in various instances is more advanced than that available in the government. Technology transfer is also a way to assist companies that have been dependent on defense contracts and procurement to convert to manufacturing for the civilian, commercial marketplace. Successful efforts range from advances in the commercial aviation industry, to the development of a new technology for use in advanced ceramics, to the evolution of the biotechnology sector.

Technology Transfer to State and Local Governments: Rationale for Federal Activity

The increasing demands on state and local governments to provide improved goods and services have been accompanied by a recognition that expanded technological expertise can help meet many of these needs. The transfer of technology and technical knowledge from government laboratories to state and local jurisdictions can allow for additional use of ideas and inventions that have been funded and created through federal R&D. Intergovernmental technology transfer can also help state and local officials meet responsibilities imposed by federal legislation.

As state and local governments increasingly look for technological solutions, the concept of "public technology" — the adaptation and utilization of new or existing technology to public sector needs — has emerged. The application of technology to State and local services is a complex and intricate procedure. In transferring technology from the federal laboratories, the application often can be direct. At other times, alterations in technical products and processes may be necessary for application in the state and local environment. However, this "adaptive engineering" generally is not extensive or expensive and can be accomplished by federal laboratory and state and local personnel working together.

State and local government concerns with regional economic growth also have focused attention on technology transfer as a mechanism to increase private sector innovation related activities within their jurisdiction. In order to develop and foster an entrepreneurial climate, many states and localities are undertaking the support of programs that assist high technology businesses, and that often use the federal laboratory system. State and local efforts to develop "incubator centers" for small companies may rely on cooperation with federal laboratories, which supply technical expertise to firms locating at the center. Other larger programs to promote innovation in the state, such as the Ben Franklin Partnership in Pennsylvania, use the science and technology resources of federal personnel. Additional programs have been created involving state universities, private companies, and the federal laboratories, with each program geared to the specific needs and desires of the participating parties. (For more discussion see CRS Report 98-859, *State Technology Development Strategies: The Role of High Tech Clusters*, by Wendy Schacht.)

Current Federal Efforts to Promote Technology Transfer

Over the years, several federal efforts have been undertaken to promote the transfer of technology from the federal government to state and local jurisdictions and to the private sector. The primary law affording access to the federal laboratory system is P.L. 96-480, the Stevenson-Wydler Technology Innovation Act of 1980, as amended by the Federal Technology Transfer Act of 1986 (P.L. 99-502), the Omnibus Trade and Competitiveness Act (P.L. 101-418), the 1990 Department of Defense (DOD) Authorization Act (P.L. 101-189), the National Defense Authorization Act for FY1991 (P.L. 101-510), the Technology Transfer Improvements and Advancement Act (P.L. 104-113), and the Technology Transfer Commercialization Act (P.L. 106-404). Several practices have been established and laws enacted that are aimed at encouraging the private sector to utilize the knowledge and technologies generated by the federal R&D endeavor. These are discussed below.

Federal Laboratory Consortium for Technology Transfer

One of the primary federal efforts to facilitate and coordinate the transfer of technology among various levels of government and to the private sector is the Federal Laboratory Consortium for Technology Transfer (FLC). The Consortium was originally established under the auspices of the Department of Defense in the early 1970s to assist in transferring DOD technology to state and local governments. Several years later, it was expanded to include other federal departments in a voluntary organization of approximately 300 federal laboratories. The Federal Technology Transfer Act of 1986 (P.L. 99-502) provided the FLC with a legislative mandate to operate and required the membership of most federal laboratories. Today, over 600 laboratories are represented.

The basic mission of the Federal Laboratory Consortium is to promote the effective use of technical knowledge developed in federal departments and agencies by "networking" the various member laboratories with other federal entities, with state, local, and regional governments, and with private industry. To accomplish this, the Consortium establishes channels through which user needs can be identified and addressed. It also provides a means by which federal technology and expertise can be publicized and made available through individual laboratories to private industry for further development and commercialization. Access to the resources of the full federal laboratory system can be made through any laboratory representative, the FLC regional coordinators, the Washington area representative, or by contacting the Chairman or Executive Director.

The FLC itself does not transfer technology; it assists and improves the technology transfer efforts of the laboratories where the work is performed. In addition to developing methods to augment individual laboratory transfer efforts, the Consortium serves as a clearinghouse for requests for assistance and will refer to the appropriate laboratory or federal department. The work of the Consortium is funded by a set-aside of 0.008% of the portion of each agency's R&D budget used for the laboratories.

P.L. 96-480, P.L. 99-502, and Amendments

In 1980, the U.S. Congress enacted P.L. 96-480, the Stevenson-Wydler Technology Innovation Act. Recognizing the benefits to be derived from the transfer of technology, the law explicitly states that:

> It is the continuing responsibility of the federal government to ensure the full use of the results of the Nation's federal investment in research and development. To this end the federal government shall strive where appropriate to transfer federally owned or originated [non-classified] technology to state and local governments and to the private sector.

Prior to this law, technology transfer was not part of the mission requirements of the federal departments and agencies, with the exception of the National Aeronautics and Space Administration. This left laboratory personnel open to questions as to the suitability of their transfer activities. However, P.L. 96-480 "legitimized" the transfer effort and mandated that technology transfer be accomplished as an expressed part of each agency's mission.

Section 11 created the mechanisms by which federal agencies and their laboratories can transfer technology. Each department with at least one laboratory must make available not less than 0.5% of its R&D budget for transfer activities, although this requirement can and has been waived. To facilitate transfer from the laboratories, each one is required to establish an Office of Research and Technology Applications (ORTA); laboratories with annual budgets exceeding $20 million must have at least one full-time staff person for this office (although the latter provision can also be waived). The function of the ORTA is to identify technologies and ideas that have potential for application in other settings.

Additional incentives for the transfer and commercialization of technology are contained in various amendments to Stevenson-Wydler. P.L. 99-502, the Federal Technology Transfer Act, amends P.L. 96-480 to allow government-owned, government- operated laboratories (GOGOs) to enter into cooperative research and development agreements (CRADAs) with universities and the private sector. The authority to enter into these agreements was extended to government-owned, contractor-operated laboratories (generally the laboratories of the Department of Energy) in the FY1990 Defense Authorization Act (P.L. 101-189). A CRADA is a specific legal document (not a procurement contract) which defines the collaborative venture. It is intended to be developed at the laboratory level, with limited agency review. In agencies which operate their own laboratories, the laboratory director is permitted to make decisions to participate in CRADAs in an effort to decentralize and expedite the technology transfer process. Generally, at agencies which use contractors to run their laboratories, specifically DOE, the CRADA is to be approved by headquarters. P.L. 106-398, however, allows the agency to define certain conditions under which the CRADA may be approved by a laboratory itself rather than headquarters.

The work performed under a cooperative research and development agreement must be consistent with the laboratory's mission. In pursuing these joint efforts, the laboratory may accept funds, personnel, services, and property from the collaborating

party and may provide personnel, services, and property to the participating organization. The government can cover overhead costs incurred in support of the CRADA, but is expressly prohibited from providing direct funding to the industrial partner. In GOGO laboratories, this support comes directly from budgeted R&D accounts. Prior to the elimination of a line item in the budget to support non-defense energy technology transfer, the Energy Department generally relied on a competitive selection process run by headquarters to allocate funding specifically designated to cover the federal portion of the CRADA. Now these efforts are to be supported through programmatic funds. A line item still exists for DOE defense program technology transfer, but at reduced levels from previous years.

Under a CRADA, title to, or licenses for, inventions made by a laboratory employee may be granted in advance to the participating company, university, or consortium by the director of the laboratory. In addition, the director can waive, in advance, any right of ownership the government might have on inventions resulting from the collaborative effort regardless of size of the company. This diverges from other patent law which only requires that title to inventions made under federal R&D funding be given to small businesses, not-for-profits, and universities. In all cases, the government retains a nonexclusive, nontransferable, irrevocable, paid-up license to practice, or have practiced, the invention for its own needs.

Laboratory personnel and former employees are permitted to participate in commercialization activities if these are consistent with the agencies' regulations and rules of conduct. Federal employees are subject to conflict of interest restraints. In the case of government-owned, contractor-operated laboratories, P.L. 101-189 required the establishment of conflict of interest provisions regarding CRADAs to be included in the laboratories' operating contracts within 150 days of enactment of the law. Preference for cooperative ventures is given to small businesses, companies which will manufacture in the United States, or foreign firms from countries that permit American companies to enter into similar arrangements. According to the Department of Commerce, between FY1999 and FY2003, approximately 2,800 - 3.000 traditional CRADAs were active each year. During this time frame, between 700 - 950 new, traditional agreements were initiated yearly (including NASA Space Act Agreements).

P.L. 99-502 provides for cash awards to federal laboratory personnel for activities facilitating scientific or technological advancements which have either commercial value or contribute to the mission of the laboratory and for the transfer of technology leading to commercialization. As an additional incentive, federal employees responsible for an invention are to receive at least 15% of royalties generated by the licensing of the patent associated with their work. The agencies may establish their own royalty sharing programs within certain guidelines. If the government has the right to an invention but chooses not to patent, the inventor, either as a current or former federal employee, can obtain title subject to the above-mentioned licensing rights of the government.

To further facilitate the transfer process, a provision of the National Defense Authorization Act for FY1991 (P.L. 101-510) amends Stevenson-Wydler allowing government agencies and laboratories to develop partnership intermediary programs augmenting the transfer of laboratory technology to the small business sector.

P.L. 104-113, the Technology Transfer Improvements and Advancement Act, clarifies existing policy with respect to the dispensation of intellectual property under a CRADA by amending the Stevenson-Wydler Act. Responding to criticism that ownership of patents is an obstacle to the quick development of CRADAs, this bill guarantees an industrial partner the option to select, at the minimum, an exclusive license for a field of use to the resulting invention. If the invention is made solely by the private party, then they may receive the patent. However, the government maintains a right to have the invention utilized for compelling public health, safety, or regulatory reasons and the ability to license the patent should the industrial partner fail to commercialize the invention.

P.L. 100-418, Omnibus Trade and Competitiveness Act

In response to concerns over the development and application of new technology, the 1988 Omnibus Trade and Competitiveness Act contained several provisions designed to foster technology transfer. The law redesignated the National Bureau of Standards as the National Institute of Standards and Technology (NIST), and mandated the establishment of (among other things): (1) an Advanced Technology Program to encourage public-private cooperative efforts in the development of industrial technology and to promote the use of NIST technology and expertise; (2) Regional Manufacturing Technology Transfer Centers; and (3) a Clearinghouse on State and local innovation related activities. The set-aside for operation of the Federal Laboratory Consortium created in P.L. 99-502 was also increased from 0.005% of the laboratory R&D budget to 0.008%.

The Advanced Technology Program (ATP) provides seed funding, matched by private-sector investment, to companies or consortia of universities, industries, and government laboratories to accelerate the development of generic technologies that have broad application across industries. The first awards were made in 1991. As of the end of 2004 (the last year that new awards were made), 768 projects had been funded representing approximately $2.3 billion in federal dollars matched by $2.1 billion in financing from the private sector.

The first four ATP competitions (through August 1994) were all general in nature. However, in response to large increases in federal funding, NIST, in conjunction with industry, identified various key areas for long-range support including information infrastructure for healthcare; tools for DNA diagnostics; component-based software; manufacturing composite structures; computer-integrated manufacturing for electronics; digital data storage; advanced vapor-compression refrigeration systems; motor vehicle manufacturing technology; materials processing for heavy manufacturing; catalysis and biocatalysis technologies; advanced manufacturing control systems; digital video in information networks; engineering; photonics manufacturing; premium power; microelectronics manufacturing infrastructure; selective-membrane platforms; and adaptive learning systems. The general competition continued. Since FY1999, NIST dropped the focused areas in favor of one competition open to all areas of technology. (For additional information see CRS Report 95-36, *The Advanced Technology Program*, by Wendy H. Schacht.)

Appropriations for the Advanced Technology Program included $36 million in FY1991, $48 million in FY1992, $67.9 million in FY1993, and $199.5 million in

FY1994. Appropriations for FY1995 expanded significantly to $431 million, but $90 million of this amount was rescinded by P.L. 104-6 as funding for ATP met with opposition in the 104th Congress. The initial House budget proposal associated with the House Republican "Contract with America" would have eliminated the Advanced Technology Program. The FY1996 appropriations bill that originally passed Congress, H.R. 2076, was vetoed by the President, in part, because it offered no support for ATP. The legislation that was finally signed into law, P.L. 104-134, funded the program at $221 million. In FY1997, P.L. 104-208 provided $225 million in financing for ATP. P.L. 105-18 rescinded $7 million from this amount. The following year, P.L. 105-119 appropriated $192.5 million for ATP.

The Clinton Administration's FY1999 budget proposed $259.9 million for ATP, an increase of 35%. While not providing such a large increase, P.L. 105-277 did fund ATP at $197.5 million, 3% above the previous year. This reflected a $6 million rescission of "deobligated" funds resulting from early termination of certain projects. For FY2000, the Administration requested support for ATP at $238.7 million, an increase of 21% above earlier funding. The appropriation bill originally passed by the House contained no funding for the program. The report to accompany the bill (H.R. 2670) stated that "... the program has not produced a body of evidence to overcome those fundamental questions about whether the program should exist in the first place." Yet P.L. 106-113 provided $142.6 million for ATP, although this represented a 28% decrease over the earlier fiscal year.

Former President Clinton's FY2001 budget called for financing ATP at $175.5 million, 23% above the prior year's support. The original version of the appropriations bill passed by the House again did not fund the program. However, P.L. 106-553 appropriated $145.7 million for ATP, an increase of 2% from the previous funding level.

For FY2002, the Bush Administration's budget proposal would have suspended support for all new awards pending an evaluation of the program; $13 million would be made available to meet financial commitments for on-going projects. H.R. 2500, as initially passed by the House, contained no funding for new ATP grants but also provided $13 million to support prior project commitments. The original version of H.R. 2500 passed by the Senate funded ATP at $204.3 million. The final legislation, P.L. 107-77, financed the program at $184.5 million, an increase of almost 27% over the previous fiscal year.

In the FY2003 budget request, the Advanced Technology Program would have received $108 million, 35% below the FY2002 figure. No relevant appropriations legislation was enacted in the 107th Congress. A series of Continuing Resolutions provided support at the FY2002 level until the 108th Congress passed P.L. 108-7 which appropriated $178.8 million for the program in FY2003 (after a 0.65% across the board recision mandated by the legislation).

The President's FY2004 budget would have provided $27 million for ATP to cover on-going commitments; no new projects would be funded. Again, the appropriation bill initially passed by the House contained no money for ATP. However, P.L. 108-199, the FY2004 Consolidated Appropriations Act, provided $170.5 million for the program after a rescission mandated in the bill. The following

year, the Administration's budget request and H.R. 4754, the appropriations bill originally passed by the House, did not include funding for ATP. S. 2809, as reported to the Senate by the Committee on Appropriations, would have provided $203 million for the program. P.L. 108-447, the FY2005 Omnibus Appropriations Act, funds ATP at $136.5 million (after several rescissions mandated in the legislation), a 20% decrease from the previous fiscal year.

The Administration's FY2006 budget, and H.R. 2862, as initially passed by the House, did not include support for the Advanced Technology Program. The version of H.R. 2862 originally passed by the Senate would have provided $140 million for the program. The final FY2006 appropriation legislation, P.L. 109-108, finances ATP at $79 million (after mandated rescissions), 42% below the FY2005 funding level.

For FY2007, the Administration budget did not provide any support for ATP, nor did H.R. 5672, the FY2007 Science, State, Justice, Commerce, and Related Agencies Appropriations Act, as passed by the House on June 29, 2006 and as reported from the Senate Committee on Appropriations. While no final FY2007 appropriations legislation was enacted by the 109th Congress, ATP continued to be funded through February 15, 2007 at the FY2006 level by a series of continuing resolutions. Passed by the 110th Congress, P.L. 110-5 appropriates $79 million for the program in FY2007.

The President's FY2008 budget request does not include any support for ATP.

The Omnibus Trade and Competitiveness Act (P.L. 100-418) also created a program of regional centers to assist small manufacturing companies' use of knowledge and technology developed under the auspices of the National Institute of Standards and Technology and other federal agencies. Federal funding for the centers is matched by non-federal sources including state and local governments and industry. Originally, seven Regional Centers for the Transfer of Manufacturing Technology were selected and are operational: the Great Lakes Manufacturing Technology Center at the Cleveland Advanced Manufacturing Program in Ohio; the Northeast Manufacturing Technology Center at Rensselaer Polytechnic Institute in Troy, New York (now called the New York Manufacturing Extension Partnership); the South Carolina Technology Transfer Cooperative based at the University of South Carolina in Columbia; the Midwest Manufacturing Technology Center at the Industrial Technology Institute in Ann Arbor, Michigan; the Mid-American Manufacturing Technology Center at the Kansas Technology Enterprise Corporation of Topeka; the California Manufacturing Technology Center at El Camino College in Torrance; and the Upper Midwest Manufacturing Technology Center in Minneapolis.

The original program expanded in 1994 creating the Manufacturing Extension Partnership (MEP) to meet new and growing needs of the community. In a more varied approach, the Partnership involves both large centers and smaller, more dispersed organizations sometimes affiliated with larger centers. Also included is the NIST State Technology Extension Program which provides states with grants to develop the infrastructure necessary to transfer technology from the federal government to the private sector (an effort which was also mandated by P.L.

100-418) and a program that electronically ties the disparate parties together along with other federal, state, local, and academic technology transfer organizations. There are now centers in all 50 states and Puerto Rico. Since the program was created in 1989, awards made by NIST for extension activities resulting in the creation of approximately 400 regional offices. [It should be noted that the Department of Defense also funded 36 centers through its Technology Reinvestment Project (TRP) in FY1994 and FY1995. When the TRP was terminated, NIST took over support for 20 of these programs in FY1996 and financed the remaining ones during FY1997.]

Funding for this program was $11.9 million in FY1991, $15.1 million in FY1992, and $16.9 million in FY1993. The FY1994 appropriation for the expanded Manufacturing Technology Partnerships was $30.3 million. P.L. 103-317 appropriated $90.6 million for this effort in FY1995, although P.L. 104-19 rescinded $16.3 million from this appropriation. For FY1996, H.R. 2076, which passed the Congress but was vetoed by the President, included appropriations of $80 million for MEP. This amount was retained in the final legislation, P.L. 104-134. P.L. 104-208 appropriated $95 million for manufacturing extension in FY1997, while temporarily lifting the six-year limit on federal support for individual centers. For FY1998, P.L. 105-119 provided $113.5 million in funding and permitted government support for centers to be extended, for periods of one year and at a rate of one-third the centers annual cost, if a positive evaluation was received. The following year, P.L. 105-277 appropriated $106.8 million for the program, reflecting a reduced federal financial commitment as centers mature, not a decrease in program support. In addition, the Technology Administration Act of 1998, P.L. 105-309, permitted the federal government to fund centers at one-third the cost after the six years if a positive independent evaluation is made every two years. In FY2000, $104.2 million (after a mandated rescission) was appropriated for MEP by P.L. 106-113. The next year, P.L. 106-553 provided $105.1 million for manufacturing extension; for FY2002, P.L. 107-77 funded MEP at $106.5 million.

The Bush Administration's FY2003 budget proposed an 89% decrease in funding for MEP to $13 million. According to the budget document, "... consistent with the program's original design, the President's budget recommends that all centers with more than six years experience operate without federal contribution." A series of Continuing Resolutions financed the activity at the FY2002 level until the 108th Congress enacted P.L. 108-7 which appropriates $105.9 million for FY2003 (after a mandated rescission).

The President's FY2004 budget included another cut in support for MEP, proposing $12.6 million to support those centers that have not reached six years of federal financing. H.R. 2799, the FY2004 appropriations bill, as initially passed by the House, financed the Partnership at $39.6 million. This bill was incorporated into H.R. 2673, which was signed into law as P.L. 108-199, the FY2004 Consolidated Appropriations Act. The legislation funded MEP at $38.7 million after a mandated rescission contained in the bill.

For FY2005, the Bush Administration's budget included $39.2 million for MEP. H.R. 4754, the Commerce, Justice, State appropriations bill originally passed by the House, would have financed manufacturing extension at $106 million. S. 2809,

reported to the Senate by the Committee on Appropriations, would have provided $112 million to "fully fund" existing centers and to provide additional assistance to small and rural States. The FY2005 Omnibus Appropriations Act, P.L. 108-447, restored earlier cuts to the program and financed MEP at $107.5 million after several rescissions mandated by the legislation.

In the President's FY2006 budget proposal, support for manufacturing extension would have been reduced to $46.8 million, 63% below the previous fiscal year. H.R. 2862, as originally passed by both the House and the Senate, would have funded the program at $106 million. After mandated rescissions, MEP was appropriated $104.6 million by P.L. 109-108.

The Administration's FY2007 budget provided $46.3 million for MEP. The FY2007 appropriations legislation passed by the House during the 109th Congress, H.R. 5672, funded the program at $92 million. The version of H.R. 5672 reported from the Senate Committee on Appropriations included $106 million for manufacturing extension. While no final FY2007 appropriations legislation was enacted during the 109th Congress, the program was funded through February 15, 2007 by a series of continuing resolutions. P.L. 110-5, passed during the 110th Congress, provides $104.6 million in FY2007 appropriations for MEP.

The FY2008 budget proposed by the President includes $46.3 million for the Manufacturing Extension Partnership, a significant decrease in funding from the current fiscal year. (For additional information see CRS Report 97-104, *Manufacturing Extension Partnership Program: An Overview*, by Wendy H. Schacht.)

Patents

The patent system was created to promote innovation. Based on Article I, Section 8 of the U.S. Constitution which states: "The Congress Shall Have Power ... To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries...", the patent system encourages innovation by simultaneously protecting the inventor and fostering competition. Originally, it provided the inventor with a lead time of 17 years (from the date of issuance) to develop his idea, commercialize, and thereby realize a return on his initial investment. Today, in response to the Uruguay Round Agreements Act, the term of the patent has been changed to 20 years from date of filing. The process of obtaining a patent places the idea in the public domain. As a disclosure system, the patent can, and generally does, stimulate other firms or inventors to invent "around" existing patents to provide parallel technical developments or meet similar market needs.

Ownership of patents derived from research and development performed under federal funding affects the transfer of technology from federal laboratories to the private sector. Generally, the government retains title to these inventions and can issue to companies either an exclusive license or, more commonly, a nonexclusive license. However, it is argued that without title (or at least an exclusive license) to an invention and the protection it conveys, a company will not invest the additional time and money necessary for commercialization. This contention is supported by

the fact that, although a portion of ideas patented by the federal government have potential for further development, application, and marketing, only about 10% of these are ever used in the private sector. However, there is no universal agreement on this issue. It also is asserted that title should remain in the public sector where it is accessible to all interested parties since federal funds were used to finance the work.

Despite the disagreements, the Congress has accepted to some extent the proposition that vesting title to the contractor will encourage commercialization. P.L. 96-517, Amendments to the Patent and Trademark Laws (commonly known as the Bayh-Doyle Act), provides, in part, for contractors to obtain title if they are small businesses, universities, or not-for-profit institutions. Certain rights are reserved for the government and these organizations are required to commercialize within a predetermined and agreed-on time. (For more information see CRS Report RL32076, *The Bayh-Dole Act: Selected Issues in Patent Policy and the Commercialization of Technology* and CRS Report 98-862, *R&D Partnerships and Intellectual Property: Implications for U.S. Policy*, both by Wendy H. Schacht.) Yet it continues to be argued that patent exclusivity is important for both large and small firms. In a February 1983 memorandum concerning the vesting of title to inventions made under federal funding, President Reagan ordered all agencies to treat, as allowable by law, all contractors regardless of size as prescribed in P.L. 96-517. This, however, does not have a legislative basis.

Further changes in the patent laws made by the enactment of P.L. 98-620 also affect the transfer of technology from federal laboratories to the private sector. In a provision that was designed to increase interaction and cooperation between government-owned, contractor-operated (GOCO) laboratories and private industry in the transfer of technology, Title V permits decisions to be made at the laboratory level as to the award of licenses for laboratory generated patents. The contractor is also permitted by this legislation to receive patent royalties for use in additional research and development, for awards to individual inventors on staff, or for education. A cap exists on the amount of the royalty returning to the laboratory so as not to distort the agency's mission and congressionally mandated R&D agenda. However, the creation of discretionary funds gives laboratory personnel added incentive to encourage and complete technology transfers.

P.L. 98-620 also permits private companies, regardless of size, to obtain exclusive license for the full life of the government patent. Prior restrictions on large firms allowed exclusive license for only 5 of the (then) 17 years of the patent. The law permits those government laboratories that are run by universities or nonprofit institutions to retain title to inventions made in their institution (within certain defined limitations). Federal laboratories operated by large companies are not included in this provision.

The Federal Technology Transfer Act and the FY1990 DOD authorization gives all companies (not just small businesses, universities, and nonprofits) the right to retain title to inventions resulting from research performed under cooperative R&D agreements with government laboratories. If this occurs, the federal government retains a royalty-free license to use these patents. In addition, the Federal Technology Act states that the government agencies may retain a portion of royalty income rather

than returning it to the Treasury. After payment of the prescribed amount to the inventor, the agencies must transfer the balance of the total to their government-operated laboratories, with the major portion distributed to the laboratory where the invention was made. The laboratory may keep all royalties up to 5% of their annual budget plus 25% of funds in excess of the 5% limit. The remaining 75% of the excess returns to the Treasury. Funds retained by the laboratory are to be used for expenses incurred in the administration and licensing of inventions; to reward laboratory personnel; to provide for personnel exchanges between laboratories; for education and training consistent with the laboratories' and agencies' missions; or for additional transfer.

P.L. 106-404, the Technology Transfer Commercialization Act, signed into law on November 1, 2000, made alterations in current practices concerning patents held by the government to make it easier for federal agencies to license such inventions. The law amends P.L. 98-480 and P.L. 96-517 to decrease the time necessary to obtain an exclusive or partially exclusive license on federally owned patents. Previously, agencies were required to publicize the availability of technologies for three months using the *Federal Register* and then provide an additional 60 day notice of intent to license by an interested company. The new law shortens the period to 15 days in recognition of the ability of the Internet to offer widespread notification and the time constraints faced by industry in commercialization activities. Certain rights would be retained by the government. The legislation also allows licenses for existing government-owned inventions to be included in CRADAs.

The CREATE Act, P.L. 108-453, makes changes in the patent laws to promote cooperative research and development among universities, government, and the private sector. The legislation amends section 103(c) of title 25, United States Code, such that certain actions between researchers under a joint research agreement will not preclude patentability. (For more detail see CRS Report RS21882, *Collaborative R&D and the Cooperative Research and Technology Enhancement (CREATE) Act*, by Wendy H. Schacht.)

Small Business Technology Transfer Program

P.L. 102-564 created a three-year pilot program designed to facilitate the commercialization of university, nonprofit, and federal laboratory R&D by small companies. The Small Business Technology Transfer program (STTR) provides funding for research proposals which are developed and executed cooperatively between a small firm and a scientist in a research organization and fall under the mission requirements of the federal funding agency. Up to $100,000 in Phase I financing is available for one year to test the viability of the concept. Phase II awards of $500,000 may be made for two years to perform the research. Funding for commercialization of the results is expected from the private sector. Financial support for this effort comes from a phased-in set-aside of the R&D budgets of departments which spend over $1 billion per year on research and development. Originally set to expire at the end of FY1996, the program was extended one year. P.L. 105-135 reauthorized funding through FY2001, while P.L. 107-50 extended the STTR program through FY2009. The set-aside used to fund the activity was increased to 0.3% in FY2004. In addition, the amount of money available for individual Phase II grants increased from $500,000 to $750,000. (For additional

information see CRS Report 96-402, *Small Business Innovation Research Program*, by Wendy H. Schacht.)

Further Considerations

The federal laboratories have received a mandate to transfer technology. This, however, is not the same as a mandate to help the private sector in the development and commercialization of technology for the marketplace. While the missions of the government laboratories are often broad, direct assistance to industry is not included, with the exception of the National Institute of Standards and Technology. The laboratories were created to perform the R&D necessary to meet government needs, which typically are not consistent with the demands of the marketplace.

The missions of the federal laboratories are under review, due, in part, to budget constraints and the changing world order. National security is now being redefined to include economic well-being in addition to weapons superiority. The laboratories which have contributed so much to the defense enterprise are being re-evaluated. These discussions provide an opportunity to debate whether the mandate of the federal R&D establishment should include expanded responsibilities for assistance to the private sector. Whether or not the missions of the U.S. government laboratories are changed to include expanded assistance to industry, there are various initiatives which may facilitate the technology transfer process under the laboratories' current responsibilities. These include making the work performed in government institutions more relevant to industry through augmented cooperative R&D, increased private sector involvement early in the R&D efforts of the laboratories, and expanded commercialization activities.

Because a significant portion of the laboratories are involved in defense research, questions arise as to whether or not the technologies in these institutions can be transferred in such a way as to be useful to commercial companies. In addition, the selection of one company over another to be involved in a transfer or in a cooperative R&D agreement raises issues of fairness and equity of access, as well as conflict of interest. And, while it is virtually impossible to prevent the flow of scientific and technical information abroad, there is ongoing interest in the extent of foreign access to the federal laboratory establishment. How these concerns are addressed may be fundamental to the success of U.S. technology transfer.

Over the past 25 years, the Congress has enacted various laws designed to facilitate cooperative R&D between and among government, industry, and academia. These laws include (but are not limited to) tax credits for industrial payments to universities for the performance of R&D, changes in the antitrust laws as they pertain to cooperative research and joint manufacturing, and improved technology transfer from federal laboratories to the private sector. The intent behind these legislative initiatives is to encourage collaborative ventures and thereby reduce the risks and costs associated with R&D as well as permit work to be undertaken that crosses traditional boundaries of expertise and experience leading to the development of new technologies and manufacturing processes for the marketplace.

Since the 104th Congress, the perspectives on joint R&D, technology transfer, and cooperative research and development agreements appear mixed. The results of legislative activity are open to discussion. In the recent past, both national political parties have supported measures to facilitate technological advancement. There are indications that the congressional majority favors refocusing federal support for basic research as well as indirect measures to encourage technology development in the private sector. CRADAs, in particular, are a means to take this government-funded basic research from the federal laboratory system and move it to the industrial community for commercialization to meet both agency mission requirements and other national needs associated with the economic growth which comes from new products and processes. It should also be recognized that the government is expressly prohibited from providing direct financial support to partners in the cooperative venture under a CRADA. Thus, it appears that this approach may meet the criteria expressed as acceptable to the Congress. While the Advanced Technology Program has faced much opposition in the House, the program continues to be funded, although at decreased levels. Recently, the Manufacturing Extension Partnership had its budget cut, but these cuts were restored the following fiscal year with the support of the Congress. As the 110th Congress begins to make decisions concerning funding for R&D, the role of the federal government in technology transfer, technology development, and commercialization might be expected to be explored further.

109th Congress Legislation

P.L. 109-108 (H.R. 2862)

Makes appropriations for science and the Departments of State, Justice, and Commerce. As passed by the House, the bill would provide $106 million for the Manufacturing Extension Partnership and no financing for the Advanced Technology Program. The version of the legislation reported to the Senate from the Committee on Appropriations would fund MEP at $106 million and provide $140 for ATP. The final appropriations legislation financed MEP at $104.6 million and ATP at $79 million (after mandated rescissions). Introduced June 10, 2005; referred to the House Committee on Appropriations. Passed the House, amended, on June 16, 2005. Received in the Senate on June 16, 2005; referred to the Senate Committee on Appropriations. Reported to the Senate, with an amendment in the nature of a substitute, on June 23, 2005. Passed the Senate, amended on September 15, 2005. Conference report filed November 7, 2005. House agreed to conference report on November 9, 2005; Senate agreed on November 16, 2005. Signed into law by the President on November 22, 2005.

H.R. 250 (Ehlers)/S. 2134 (Smith)

Manufacturing Technology Competitiveness Act. Creates an interagency committee to coordinate federal manufacturing R&D. Establishes and authorizes funding for a pilot collaborative manufacturing research grants program to promote the development of new manufacturing technologies through cooperative applied research among the private sector, academia, states, and other non-profit institutions. Mandates and authorizes financing for a manufacturing fellowship program. Creates and authorizes support for a manufacturing extension center competitive grants program to focus on new or emerging manufacturing technologies. Authorizes

funding for the Manufacturing Extension Partnership, among other things. Introduced January 6, 2005; referred to the Committee on Science. Reported to the House, amended, May 23, 2005. Passed House on September 21, 2005. Received in Senate and referred to the Senate Committee on Commerce, Science, and Transportation on September 22, 2005. S. 2134 introduced December 16, 2005; referred to the Senate Committee on Commerce, Science, and Transportation.

H.R. 3331 (Miller, B.)

Creates and authorizes funding for a grant program in the National Science Foundation to assist universities in promoting the application of new inventions developed within their institutions. Introduced July 27, 2005; referred to the House Committee on Science.

H.R. 4845 (Goodlatte)

Innovation and Competitiveness Act. Makes permanent the research and experimentation tax credit, among other things. Introduced March 2, 2006; referred to the House Committees on the Judiciary, Ways and Means, science, Education and the Workforce, and Energy and Commerce.

H.R. 5672 (Wolf)

FY2007 Science, State, Justice, Commerce, and Related Agencies Appropriations Act. Funds the Manufacturing Extension Partnership at $92 million but provides no support for the Advanced Technology Program, among other things. Introduced on June 22, 2006; referred to the House Committee on Appropriations. Reported to the House on June 22, 2006 and passed the House on June 29, 2006. Reported from the Senate Committee on Appropriations, with an amendment in the nature of a substitute, on July 13, 2006.

H.R. 6111 (Tauscher)

Amends the Internal Revenue Code of 1986 to extend the research and experimentation tax credit through the end of 2007, among other things. Introduced September 19, 2006; referred to the House Committee on Ways and Means. Passed the House, amended on December 5, 2006. Passed the Senate, amended, by unanimous consent, on December 7, 2006. The Senate agreed to the House amendment by unanimous consent on December 9, 2006.

S. 1581 (Bingaman)

Provides financing and other assistance (including tax incentives for private sector investments) for the development of science parks, among other things. Introduced July 29, 2005; referred to the Senate Committee on Finance.

S. 2109 (Ensign)/H.R. 4654 (Schiff)/S. 2390 (Ensign)

National Innovation Act. Establishes a President's Council on Innovation and provides innovation acceleration grants. Promotes innovation through regional economic development and makes permanent the research and experimentation tax credit, among other things. S. 2109 introduced December 15, 2005; referred to the Senate Committee on Finance. H.R. 4654 introduced January 3, 2006; referred to the House Committees on Science, Energy and Commerce, Ways and Means, Armed Services, Judiciary, Transportation and Infrastructure, and Financial Services. S.

2390 introduced March 8, 2006; referred to the Senate Committee on Commerce, Science, and Transportation.

S. 2198 (Domenici)

Protecting America's Competitive Edge Through Education Act. Among other things creates mechanisms to develop and fund Science Parks. Introduced January 26, 2006; referred to the Senate Committee on Health, Education, Labor, and Pensions. Hearings held February 28, 2006 and March 1, 2006.

S. 2199 (Domenici)

Protecting America's Competitive Edge Through Tax Incentives Act. Expands and makes permanent the research and development tax credit, among other things. Introduced January 26, 2006; referred to the Senate Committee on Finance.

S. 2720 (Baucus)

Research Competitiveness Act of 2006. Simplifies the research tax credit and makes it permanent. Allows for tax exempt financing of research park facilities, among other things. Introduced May 4, 2006; referred to the Senate Committee on Finance.

S. 2802 (Ensign)

American Innovation and Competitiveness Act of 2006. Among other things, establishes the President's Council on Innovation and Competitiveness, provides innovation acceleration grants, and facilitates regional economic development. Introduced May 15, 2006; referred to the Senate Committee on Commerce, Science, and Transportation. Reported, with amendments, on July 18, 2006.

Legislation in the 110th Congress

H.R. 85 (Biggert)

Energy Technology Transfer Act. Creates a program of grants to non-profit institutions, state and local governments, cooperative extension services, or universities to transfer energy efficient methods and technologies. Introduced January 4, 2007; referred to the House Committee on Science and Technology.

H.R. 255 (Ehlers)

Manufacturing Technology Competitiveness Act of 2007. Creates an interagency committee to coordinate federal manufacturing R&D. Establishes and authorizes funding for a pilot collaborative manufacturing research grants program to promote the development of new manufacturing technologies through cooperative applied research among the private sector, academia, states, and other non-profit institutions. Mandates and authorizes financing for a manufacturing fellowship program. Creates and authorizes support for a manufacturing extension center competitive grants program to focus on new or emerging manufacturing technologies. Authorizes funding for the Manufacturing Extension Partnership, among other things. Introduced January 5, 2007; referred to the House Committee on Science and Technology.

S. 41 (Baucus)

Research Competitiveness Act of 2007. Amends the Internal Revenue Code to make the research and experimentation tax credit permanent. Among other things, this bill would allow the issuance of tax exempt facility bonds for research park facilities used for research and experimentation. Introduced January 4, 2007; referred to the Senate Committee on Finance.

S. 69 (Kohl)

Authorizes appropriations for the Manufacturing Extension Partnership through 2012, among other things. Introduced January 4, 2007; referred to the Senate Committee on the Judiciary. Discharged from the Senate Committee on the Judiciary by unanimous consent on January 22, 2007 and referred to the Senate Committee on Commerce, Science, and Transportation the same day.

S. 592 (Collins)

GoMe Act. Extends the research tax credit through 2012, among other things. Introduced February 14, 2007; referred to the Senate Committee on Finance.

S. 761 (Reid)

America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act. Mandates a National Science and Technology Summit to access the state of U.S. science and technology. Requires a study on barriers to innovation and creates a National Innovation Medal and a President's Council on Innovation and Competitiveness. Requires that federal agencies establish an Innovation Acceleration Research Program to facilitate innovation, among other things. Introduced March 5, 2007; placed on Senate Legislative Calendar under General Orders March 6, 2007. Passed the Senate, amended, on April 25, 2007.

S. 883 (Coleman)

COMPETE Act of 2007. Makes the research and experimentation tax credit permanent, among other things. Introduced March 9, 2007; referred to the Senate Committee on Finance.