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# Cooperative R&D: Federal Efforts to Promote Industrial Competitiveness

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LEGISLATION

# Cooperative R&D: Federal Efforts to Promote Industrial Competitiveness

## SUMMARY

In response to the foreign challenge in the global marketplace, the United States Congress has explored ways to stimulate technological advancement in the private sector. The government has supported various efforts to promote cooperative research and development activities among industry, universities, and the federal R&D establishment designed to increase the competitiveness of American industry and to encourage the generation of new products, processes, and services. Among the issues before Congress are whether joint ventures contribute to industrial competitiveness and what role, if any, the government has in facilitating such arrangements.

Collaborative ventures are intended to accommodate the strengths and responsibilities of all sectors involved in innovation and technology development. Academia, industry, and government often have complementary functions. Joint projects allow for the sharing of costs, risks, facilities, and expertise.

Cooperative activity covers various institutional and legal arrangements including industry-industry, industry-university, and industry-government efforts. Proponents of joint ventures argue that they permit work to be done that is too expensive for one company to support and allow for R&D that crosses traditional boundaries of expertise and experience. Such arrangements make use of existing, and support the development of new, resources, facilities, knowledge, and skills. Opponents argue that these endeavors dampen competition necessary for innovation.

Federal efforts to encourage cooperative activities include the National Cooperative Research Act; the National Cooperative Production Act; tax changes permitting credits for industry payments to universities for R&D and deductions for contributions of equipment used in academic research; and amendments to the patent laws vesting title to inventions made under federal funding in universities. Technology transfer from the government to the private sector is facilitated by several laws. In addition, there are various ongoing cooperative programs supported by various federal departments and agencies.

Given the increased popularity of cooperative programs, questions might be raised as to whether they are meeting expectations. It may be too soon to determine the effectiveness of the joint R&D venture as a mechanism to increase technological advancement in the United States. There is often a long time lag between research and the availability of a product, process, or service. Many of the collaborative activities fostered by the federal government are of recent origin and therefore have not had sufficient time to generate measurable results. However, raising certain issues might serve to develop a framework for addressing future, near-term decisions concerning technology development and cooperative R&D. These include questions about the emphasis on collaborative ventures in research rather than in technology development; cooperative manufacturing; defense vs. civilian support; and access by foreign companies.

## MOST RECENT DEVELOPMENTS

*Over the past 20 years, congressional initiatives have promoted cooperative research and development among industry, universities, and the federal R&D establishment. This is evident in legislation creating technology transfer mechanisms as well as in support for the Advanced Technology Program (ATP) and the Manufacturing Extension Partnership (MEP) at the National Institute of Standards and Technology (NIST). However, many of these activities were revisited beginning in the 104th th Congress given the Republican majority's statements in favor of indirect measures such as tax policies, intellectual property rights, and antitrust laws to promote technology development; increased government support for basic research; and decreased direct federal funding for private sector technology initiatives. Although none of the cooperative programs have been terminated, several were funded at reduced levels. In the 106th Congress, while support for ATP significantly decreased, there was funding despite the absence of financing for the program in the original House-passed FY2000 and FY2001 appropriations bills. For FY2001, P.L. 106-553 funds ATP at $145.7 million and provides $105.1 million for MEP. Also enacted was Title V of P.L. 106-170 extending the research tax credit through June 30, 2004. P.L. 106-404 makes changes in the technology transfer laws to improve licensing of federally-owned inventions. P.L. 106-39, creates a pilot program to facilitate collaborative R&D between the national laboratories of the Department of Energy and industry. In the current Congress, S. 259 would make this pilot program permanent; S. 517 would extend it through FY2006. Also introduced in the 107th Congress, H.R. 1418 and S. 432, the Entrepreneurial Incubators Development Act of 2001, would establish a grants program to support business incubators for small and medium-sized firms. H.R. 1417 and S. 429 would expand the Manufacturing Extension Program to increase the application of new technologies by small and medium-sized businesses to create jobs. The Bush Administration's FY2002 budget proposed $106.3 million in support for MEP but suspended all funding for new awards under ATP pending an evaluation of the program. However, $13 million would have been provided ATP to meet financial commitments for on-going projects. H.R. 2500, as initially passed by the House, funded these programs at similar levels. The original Senate-passed version of H.R. 2500 provided $105.1 million for MEP and $204.2 million for ATP. The final legislation, P.L. 107-77, finances MEP at $106.5 million and ATP at $184.5 million. For FY2003, the President's budget includes $108 million for ATP and $13 million for MEP. The latter figure is based on the recommendation that all manufacturing extension centers in operation more than 6 years continue without federal support. The FY2002 and FY2003 budget proposals also call for making the research and experimentation tax credit permanent as would H.R. 41, H.R. 1137, H.R. 1329, S. 41, S. 189 and S. 515. P.L. 107-50 extends the Small Business Technology Transfer Program through FY2009.*

## BACKGROUND AND ANALYSIS

### Rationale

In response to concerns over competition from foreign firms, the U.S. Congress has increasingly looked for ways the federal government can stimulate technological innovation

in the private sector. This technological advancement is critical in that it contributes to economic growth and long term increases in our standard of living. New technologies can create new industries and new jobs; expand the types and geographic distribution of services; and reduce production costs by making more efficient use of resources. The development and application of technology also plays a major role in determining patterns of international trade by affecting the comparative advantages of industrial sectors. Since technological progress is not necessarily determined by economic conditions, it can have effects on trade independent of shifts in macroeconomic factors that may affect the marketplace.

Joint ventures are an attempt to facilitate technological advancement within the industrial community. Academia, industry, and government can play complementary roles in technology development. While opponents argue that cooperative ventures stifle competition, proponents assert that they are designed to accommodate the strengths and responsibilities of these sectors. Collaborative projects attempt to utilize and integrate what the participants do best and to direct these efforts toward the goal of generating new goods, processes, and services for the marketplace. They allow for shared costs, shared risks, shared facilities, and shared expertise.

The lexicon of current cooperative activity covers various different institutional and legal arrangements. These ventures might include industry-industry joint projects involving the creation of a new entity to undertake research, the reassignment of researchers to a new effort, and/or hiring new personnel. Collaborative industry-university efforts may revolve around activities in which industry supports centers (sometimes cross-disciplinary) for research at universities, funds individual research projects, and/or exchanges personnel. Cooperative activities with the federal government might include projects that use federal facilities and researchers, federal funding for industry-industry or industry-university efforts, or financial support for centers of excellence at universities to which the private sector has access.

There are many different types of cooperative arrangements. The flexibility associated with this concept can allow for the development of institutional and organizational plans tailored to the specific needs of the particular project. Issues of patent ownership, disclosure of information, licensing, and antitrust are to be resolved on an individual basis within the general guidelines established by law governing joint ventures.

Collaborative ventures can be structured either “horizontally” or “vertically.” The former involves efforts in which companies work together to perform research and then use the results of this research within their individual organizations. The latter involves activities where researchers, producers, and users work together. Both approaches are seen as ways to address some of the perceived obstacles to the competitiveness of American firms in the marketplace.

## Joint Industrial Research

Traditionally, the federal government has funded research and development to meet mission requirements; in areas where the government is the primary user of the results; and/or where there is an identified need for R&D not being performed in the private sector. Most government support is for basic research which is often long-term and highly risky for individual companies; yet research can be the foundation for breakthrough achievements

which can revolutionize the marketplace. Studies have shown that inventions based on R&D are the more important ones. However, the societal benefits of research tend to be greater than those that can be captured by the firm performing the work. Thus the rationale for federal funding of research in industry.

The major emphasis of legislative activity has been on augmenting research in the industrial community. This focus is reflected in efforts to encourage companies to undertake cooperative research arrangements and expand the opportunities available for increases in research activities. Collaboration permits work to be done which is too expensive for one company to fund and also allows for R&D that crosses traditional boundaries of expertise and experience. A joint venture makes use of existing, and supports development of new resources, facilities, knowledge, and skills.

The concentration on increased research as a prelude to increased technological advancement was based upon the "pipeline model" of innovation. This process was understood to be a series of distinct steps from an idea through product development, engineering, testing, and commercialization to a marketable product, process, or service. Thus increases at the beginning of the pipeline — in research — were expected to result in analogous increases in innovation at the end. However, this model is no longer considered valid. Innovation is rarely a linear process and new technologies and techniques often occur that do not require basic or applied research or development. Most innovations are actually incremental improvements to existing products and processes. In some areas, particularly biotechnology, research is closer to a commercial product than this conception would indicate. In others, the differentiation between basic and applied research is artificial. The critical factor is the commercialization of the technology. Economic benefits accrue only when a technology or technique is brought to the marketplace where it can be sold to generate income and/or applied to increase productivity.

In the recent past, it was increasingly common to find that foreign companies were commercializing the results of U.S. funded research at a faster pace than American firms. In the rapidly changing technological environment, the speed at which a product, process, or service is brought to the marketplace is often a crucial factor in its competitiveness. The recognition that more than research needs to be done has lead to other approaches at cooperative efforts aimed at expediting the commercialization of the results of the American R&D endeavor. These include industry-university joint activities, use of the federal laboratory system by industry, and industry-industry development efforts where manufacturers, suppliers, and users work together.

## Industry-University Cooperative Efforts

Industry-university cooperation in R&D is one important mechanism intended to facilitate technological innovation. Traditionally, universities perform much of the basic research integral to certain technological advancements. They are generally able to undertake fundamental research because it is part of the educational process and because they do not have to produce for the marketplace. The risks attached to work in this setting are fewer than those in industry where companies must earn profits. Universities also educate and train the scientists, engineers, and managers employed by companies.

Academic institutions do not have the commercialization capacity available in industry and necessary to translate the results of research into products and processes that can be sold in the marketplace. Thus, if the work performed in the academic environment is to be integrated into goods and services, a mechanism to link the two sectors must be available. Prior to World War II, industry was the primary source of funding for basic research in universities. This financial support helped shape priorities and build relationships. However, after the war the federal government supplanted industry as the major financial contributor and became the principal determinant of the type and direction of the research performed in academic institutions. This situation resulted in a disconnection between the university and industrial communities. Because industry and not the government is responsible for commercialization, the difficulties in moving an idea from the research stage to a marketable product or process appear to have been compounded.

Efforts to encourage increased collaboration between the academic and industrial sectors might be expected to augment the contribution of both parties to technological advancement. Company support for research within the university provides additional funds and information on the concerns and direction of industry. For many companies, access to expertise and facilities outside of the firm expands or complements available internal resources. Yet, such cooperation should not necessarily be seen as a panacea. Oftentimes, collaborative ventures fail because of various factors including conflicting goals, differing research cultures, and financial disagreements.

### Federal Laboratory-Industry Interaction

The federal government can share its extensive facilities, expertise, knowledge, and new technologies with partners in a cooperative venture. In certain cases, the government laboratories have scientists and engineers with experience and skills, as well as equipment, not available elsewhere. The government also has a vested interest in technology development. It does not have the mandate or resources to manufacture goods but has a stake in the availability of products and processes to meet mission requirements. In addition, technological advancement contributes to the economic growth vital to the health and security of the nation.

Collaboration between government laboratories and industry is not, however, just a one way street. In several technological areas, particularly electronics and computer software, the private sector is more advanced in technologies important to the national defense and welfare of this country. Interaction with industry offers federal scientists and engineers valuable information to be used within the government R&D enterprise.

## Federal Initiatives in Cooperative R&D

The cooperative venture concept is not new. In the early 1970s, the National Science Foundation established its Industry-University Cooperative Research Centers program. The Electric Power Research Institute, a research organization supported by the electric power utilities, has been in operation since 1973. In the private sector, the Microelectronics and Computer Technology Corporation (MCC), which performs research for its member firms, and the Semiconductor Research Corporation (SRC), which funds research in universities,

were created in the early 1980s. The difference today is the number of projects and the scope of legislative activity designed to promote cooperative ventures.

Faced with pressures from foreign competition, the government's interest appears to be expanding beyond that of funding R&D, to meeting other critical national needs including the economic growth that flows from new commercialization in the private sector. While acknowledging that the commercialization of technology is the responsibility of the business community, in the past several years the government has attempted to stimulate innovation and technological advancement in industry. These activities often involve the removal of barriers to technology development in the private sector, thereby permitting market forces to operate and the provision of incentives to encourage increased innovation related efforts in industry. Cooperative R&D efforts are a part of both these trends.

The National Cooperative Research Act (P.L. 98-462) is designed to encourage companies to undertake joint research which is typically long-term, risky, and often too expensive for one company to finance. This legislation clarifies the antitrust laws and requires that the "rule of reason" standard be applied in determinations of violations of these laws; that cooperative research ventures are not to be judged illegal "per se". It also eliminates treble damage awards for those research ventures found in violation of the antitrust laws if prior disclosure (as defined in the law) has been made. In addition, P.L. 98-462 makes some changes in the way attorney fee awards are made to discourage frivolous litigation against joint research ventures without simultaneously discouraging suits of plaintiffs with valid claims. Over 750 joint ventures have filed with the Justice Department since this law was enacted.

P.L. 103-42, the National Cooperative Production Amendments Act of 1993, amends the National Cooperative Research Act by, among other things, extending the original law's provisions to joint manufacturing ventures. These provisions are only applicable, however, to cooperative production when the principal manufacturing facilities are "located in the United States or its territories, and each person who controls any party to such venture...is a United States person, or a foreign person from a country whose law accords antitrust treatment no less favorable to United States persons than to such country's domestic persons with respect to participation in joint ventures for production."

The Omnibus Trade and Competitiveness Act of 1988 (P.L. 100-418) created the Advanced Technology Program (ATP) at the Department of Commerce's National Institute of Standards and Technology. This program provides seed funding, matched by private sector investment, to companies or consortia comprised of universities, companies, and/or government laboratories for the development of generic technologies that have broad application across industrial sectors. To date, 522 projects have been funded representing approximately $1,638 million in federal financing matched by over $1,651 million in private sector support. Eleven initial R&D programs were selected for funding, almost half of which involved consortia. Twenty-seven awards were made to programs in the second year; approximately one-third were *consortia*. In December 1992, 21 new ATP awards were made, including three joint ventures. Thirty additional projects were funded in 1993, and, in October 1994, 41 awards were made in four key technology areas: information infrastructure for healthcare; tools for DNA diagnostics; component-based software; and computer-integrated manufacturing for electronics. Fourteen are cooperative efforts. In November 1994, 47 additional awards were made in the general competition and in the area

of manufacturing composite structures. Twenty-four involve collaborative R&D. Of the 24 awards announced on July 13, 1995, 35% of the projects in the general competition were joint ventures and 29% in the focused competition. The following month 21 additional awards were made of which 9 were cooperative efforts. In early September, another 44 grants were awarded including 19 joint ventures. Later in that month, 10 more awards were made of which three were to cooperative efforts. On January 25, 1996, an additional four projects received awards; three involved multiple firms. In March 1997, NIST announced that it would fund 8 new proposals from the FY1996 general competition of which 2 were collaborative projects. Sixty-four awards were made in October 1997; 15 involving multiple companies. In October 1998, NIST awarded funding for 79 new projects involving more than 150 companies, 11 universities, and several federal laboratories. This reflects changes in the ATP selection criteria designed to encourage large companies to participate in joint ventures with small firms and academic institutions. Thirty-seven awards for FY1999 were made on October 7, 1999. Of these, 27 are either joint ventures or involve additional organizations working as subcontractors. In the most recent awards, 15 of the 54 new projects selected included several partners. (For more information, see CRS Report 95-36 SPR, *The Advanced Technology Program*.)

Appropriations for the Advanced Technology Program were $35.9 million in FY1991, $47.9 million in FY1992, and $67.9 million in FY1993. FY1994 appropriations expanded significantly to $199.5 million and even further to $431 million in FY1995. However, P.L. 104-6, the DOD Emergency Supplemental Appropriations and Rescissions Act, rescinded $90 million of this amount. The President's FY1996 budget request for ATP was $490.9 million. There were no authorizations. The original appropriations bill, H.R. 2076, which passed the Congress but was vetoed by the President, provided no financing for ATP. The final appropriations legislation, P.L. 104-134, funded the Advanced Technology Program at $221 million for FY1996. The following year, FY1997, the Omnibus Consolidated Appropriations Act (P.L. 104- 208) provided support levels of $225 million, but $7 million was rescinded by P.L. 105-18. While no authorization legislation was enacted for FY1998, P.L. 105-119 funded ATP at $192.5 million. The President's FY1999 budget request included $259.9 million for this program, an increase of 35%. However, P.L. 105-277, the Omnibus Consolidated Appropriations Act, funded ATP at $197.5 million, 3% above the previous year. This figure reflected a $6 million recission to account for "deobligated" funds resulting from prior projects that had been terminated early.

In the FY2000 budget, the Administration requested $238.7 million for ATP, an increase of 21% over FY1999. No authorizations were enacted. S. 1217, as passed by the Senate on July 22, 1999, would have appropriated $226.5 million, 15% more than the previous year. H.R. 2670, as passed by the House on August 5, 1999, contained no appropriated funding for ATP. The report accompanying the House bill 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, the Consolidated Appropriations Act, provided the Advanced Technology Program with $142.6 million for FY2000, financing that was 28% below the level of the previous year. For FY2001, the Clinton Administration requested ATP funding of $175.5 million, an increase of 23% over prior year funding. The original appropriations bill, as passed by the House, again provided no support for the program. P.L. 106-553, does fund the ATP at $145.7 million for FY2001, 2% above the previous fiscal year.

The Bush Administration's FY2002 budget proposed suspending all funding for new ATP awards pending an evaluation of the program. However, $13 million would have been provided to meet financial commitments for on-going projects. H.R. 2500, as first passed by the House, provided no support for new ATP projects but did include $13 million to fund prior year commitments. The original Senate-passed version of H.R. 2500 would have funded the program at $204.2 million. P.L. 107-77 finances ATP at $184.5 million, a 27% increase over FY2001.

In the FY2003 budget, the President requests $108 million for the Advanced Technology Program. This figure is 35% below the FY2002 appropriation.

Several laws have attempted to facilitate industry-university cooperation. Title II of the Economic Recovery Tax Act of 1981 (P.L. 97-34) provided, in part, a temporary 25% tax credit for 65% of all company payments to universities for the performance of basic research. Firms were also permitted a larger tax deduction for charitable contributions of equipment used in scientific research at academic institutions. The Tax Reform Act of 1986 (P.L. 99-514) kept this latter provision, but reduced the credit for university basic research to 20% of all corporate expenditures for this work over the sum of a fixed research floor plus any decrease in non-research giving.

The 1981 Act also provided an increased charitable deduction for donations of new equipment by a manufacturer to an institution of higher education. This equipment must be used for research or training for physical or biological sciences within the United States. The tax deduction was equal to the manufacturer's cost plus one-half the difference between the manufacturer's cost and the market value, as long as it does not exceed twice the cost basis.

This research and experimentation tax credit expired in June 1992 when an extension contained in H.R. 11, the Enterprise Zone Tax Act, was vetoed by former President Bush. The Omnibus Budget Reconciliation Act, P.L. 103-66, reinstated the credit through July 1995 and made it retroactive to the date of its previous expiration. The credit again expired. However, P.L. 104-188, the Small Business Job Protection Act, reinstated the tax credit for application between July 1, 1996 and May 31, 1997. The Taxpayer Relief Act of 1997, P.L. 105-34, extended the credit for 13 months from June 1, 1997 through June 30, 1998. The tax credit expired once again but was reinstated through June 30, 1999, by P.L. 105-277. Several bills also were introduced that would have permitted the research tax credit to be applied to support for certain collaborative research consortia. The 106$^{th}$ Congress once again extended the credit. Title V of P.L. 106-170 reinstates the research and experimentation tax credit through June 30, 2004 and increases the credit rate applicable under the alternative incremental research credit by one percentage point per step.

Amendments to the patent and trademark laws contained in P.L. 96-517 also were designed to foster interaction between academia and the business community. This law provides, in part, for title to inventions made by contractors receiving federal R&D funds to be vested in the contractor if it is a university, not-for-profit institution, or a small business. Certain rights to the patent are reserved for the government and these organizations are required to commercialize within a predetermined and agreed upon time frame. Providing universities with patent title is expected to encourage licensing to industry where the technology can be manufactured or utilized, thereby creating a financial return to the academic institution. University patent applications and licensing have increased since this

law was enacted. (For more discussion on this topic see CRS Report RL30320, *Patent Ownership and federal Research and development: A Discussion on the Bayh-Dole Act and the Stevenson-Wydler Act* and CRS Report 98-862, *R&D Partnerships and Intellectual Property: Implications for U.S. Policy*.)

Many cooperative industry-industry or industry-university programs are supported and/or organized by the federal departments and agencies. These include, but are not limited to, the National Science Foundation's Engineering Research Centers, the approximately 40 Industry-University Cooperative Research Programs, and the more recent Science and Technology Centers. A program to match small businesses interested in joint manufacturing technology efforts has been created in the Department of Commerce.

While most legislative activities are intended to facilitate technological advance across industries, there have been several recent efforts to provide direct assistance for cooperative ventures in a particular industry. These initiatives are based, in part, on national defense and economic security concerns over specific technologies that are, or are perceived as, potentially critical to a wide range of businesses. Among the joint ventures, funded primarily by the Department of Defense, have been SEMATECH (a joint private sector semiconductor manufacturing research effort which is now privately financed), the National Center for Manufacturing Sciences, and the steel initiative. In addition, DOD supports the Software Engineering Institute and the Department of Energy assists in the Partnership for a New Generation Vehicle initiative that, among other things, encourages joint R&D between federal laboratories and private firms leading to commercialization.

Cooperation between industry and the federal R&D enterprise is another facet of the effort to increase industrial competitiveness through joint ventures. The federal government will spend an estimated $83 billion for research and development in FY2000 to meet the mission requirements of the federal departments and agencies. This has led to many technologies and techniques, as well as to the generation of knowledge and skills, which may have applications beyond their original intent. To foster their development and commercialization in the industrial community, various laws have established institutions and mechanisms to facilitate the movement of ideas and technologies between the public and private sectors.

The Stevenson-Wydler Technology Innovation Act (P.L. 96-480), as amended by the Federal Technology Transfer Act (P.L. 99-502) and the Department of Defense FY1990 Authorizations (P.L. 101-189), provides, in part, a legislative mandate for technology transfer from the federal government to the private sector, establishes a series of offices in the agencies and/or laboratories to administer transfer efforts, provides incentives for federal laboratory personnel to actively engage in technology transfer, and creates new contractual means for industry to work with the laboratories including cooperative research and development agreements. P.L. 104-113, the National Technology Transfer and Advancement Act, attempts to clarify existing policy with respect to the dispensation of intellectual property under a CRADA by amending the Stevenson-Wydler Act. P.L. 106-404, the Technology Transfer Commercialization Act, makes changes in current practices concerning patents held by the government to make it easier for federal agencies to license such inventions to the private sector for commercialization. (For additional information see CRS Issue Brief IB85031, *Technology Transfer: Use of Federally Funded Research and Development*.)

The Omnibus Trade and Competitiveness Act (P.L. 100-418) established a program of regional Centers for the Transfer of Manufacturing Technology (now part of the Manufacturing Extension Partnership effort) to facilitate the movement to the private sector of knowledge and technologies developed under the aegis of the National Institute of Standards and Technology. (For more discussion, see CRS Report 97-104, *Manufacturing Extension Partnership Program*.) In addition, the law required that NIST provide technical assistance to state technology extension programs in an effort to improve private sector access to federal technology. (For additional Information, see CRS Issue Brief IB91132, *Industrial Competitiveness and Technological Advancement: Debate over Government Policy*.) Government-industry collaboration is further facilitated by a provision of the FY1991 National Defense Authorization Act (P.L. 101- 510) that amends Stevenson-Wydler to allow government agencies and laboratories to develop partnership intermediary programs to augment the transfer of laboratory technology to the small business community. A pilot activity under the Small Business Development Act of 1992, the Small Business Technology Transfer program, facilitates cooperative work between small companies and federal labs leading to the commercialization of new technology. Scheduled to sunset in FY1996, the program was extended for one year until P.L. 105-135 reauthorized it through FY2001. Passed in the current Congress, P.L. 107-50 extends the STTR activity through FY2009 and increases the set-aside used to fund the program to 0.3% beginning in FY2004 when the amount of money available of individual Phase II grants increases to $750,000 (see CRS Report 96-402, *Small Business Innovation Research Program*).

## Issues

It is not yet known whether federal support of cooperative ventures signals a long-term commitment to the development of technology. However, statements issued by President Clinton and Vice President Gore during their first term in office (see *A Vision of Change for America and Technology for America's Economic Growth, A New Direction to Build Economic Strength*) set out a policy to actively promote joint development activities as well as joint research. The proposed initiatives discussed above were part of the Administration's strategy to provide both direct and indirect federal support for expanded cooperative R&D leading to commercialization. Given concerns over the federal budget, it is unlikely that large sums of government money will be forthcoming for such efforts in the future. However, other actions may reflect federal interest in the process of technological advancement. The use of the extensive government R&D system, with its expensive state-of-the-art facilities, can provide both academia and industry with resources that may be beyond their financial ability. And despite the often short-term focus of budget decisions, federal funds and non-monetary contributions to cooperative ventures may be leveraged by contributions from state and local agencies and the private sector.

If the proliferation of programs is any indication, state and local jurisdictions have been in the forefront of cooperative endeavors. Many state and local economic development activities focus on increasing innovation and the use of technology in the private sector. Instead of competing for companies to relocate, many of these jurisdictions now see additional benefits accruing from the creation of new firms and the modernization of existing ones through the application of new technology. Various states and localities are attempting to foster an entrepreneurial climate by undertaking the development and support of a variety of programs to assist existing high technology businesses, to promote the establishment of

new companies, and to facilitate the use of new technologies and processes in traditional industries. While these efforts vary by state and locality, many of them include industry-university-government cooperation. Several of the former President's proposals for increasing cooperative ventures built upon existing state and local activities in these areas. (For additional discussion, see CRS Report 96-958 SPR, *Technology Development: Federal-State Issues* and CRS Report 98-859, *State Technology Development Strategies: The Role of High Tech Clusters*.)

Proponents of cooperative work argue that certain benefits are associated with joint ventures. The increased popularity of this concept, and expanding federal support for this approach, however, might suggest some questions be raised to assess whether cooperative ventures are meeting expectations. Are there drawbacks to this effort in general and in specific instances? Are cooperative projects addressing the problems associated with the competitiveness of U.S. industry? Are they moving technology development in the right direction?

It is perhaps too soon to determine whether the cooperative R&D venture is an effective, or the most effective, mechanism to increase technological advancement. The time between research and the availability of a marketable product or process is generally thought to be from 10-15 years; less in those areas such as biotechnology where research and commercial commodity tend to be more closely linked. Many of the cooperative activities fostered by the federal government are of recent origin and therefore have not had sufficient time to generate measurable results. However, raising certain issues and/or questions might serve to develop a framework within which future, near term decisions concerning technology development and cooperative R&D might be addressed.

It might be expected that an increasing number of industries and/or companies will come to the federal government for assistance in supporting cooperative R&D activities. Despite opposition by some to what has been described as "picking winners or losers," various sectors of the government have chosen to provide funding for cooperative ventures in specific industries while requiring that the private sector generate matching funds. At the same time, there are programs and policies that attempt to facilitate cooperative efforts across industry in general. Decisions might need to be made whether one approach is better than the other, or if both should continue.

If part of government policy is to respond to individual industry requests for assistance, Congress may wish to consider developing procedures to select between industries and/or companies competing for limited federal funds. Can, and should, federal guidelines be established? In addition, is it possible to determine at this time what type of cooperative ventures are the most effective and efficient? Is there, in fact, one best model or should each venture be tailored to the specific situation? And finally, what are the implications of these decisions for policymaking in Congress?

## Development

As noted above, innovation is a dynamic process that can involve idea origination, research, development, commercialization, and diffusion throughout the economy. However, it is not a linear process and an innovation may occur without developing through these steps. In fact, most innovations are actually incremental changes in existing goods and services in

response to unmet market needs. The most crucial factor is the availability or use of the technology or technique in the marketplace.

In the recent past, the commercialization and diffusion of products and processes often stood out as significant problems in terms of the ability of U.S. industries to compete. Firms in several other countries, particularly Japan and the East Asian newly industrializing countries, have been successful in commercializing the results of R&D. In various instances, this was research initially performed in the United States, as evidenced by the VCR and semiconductor chips. Basic research and the pursuit of science are done successfully in the United States as indicated, in part, by the number of Nobel prizes awarded to Americans. However, excellence in science does not necessarily assure leadership in world markets. It has been noted that the United States was the world's premiere economic power in the 1920s when this nation was far from being in the forefront of science. Instead, market leadership is significantly affected by the development and application of technology to make the goods and services the consumers want to purchase.

Thus, questions may be raised as to whether programs and policies encouraging increased cooperative research, without concomitant efforts to facilitate the development and commercialization of technologies and techniques, can be effective mechanisms to increase the competitiveness of American industry. Do we need to know more about how to encourage the application of the research resulting from joint ventures in the manufacture of products and processes and in the delivery of services? Do these cooperative activities include mechanisms to facilitate the effective and timely transfer of the results back to the companies where they can be developed into goods for the marketplace? Since the major portion of the costs associated with bringing out a new product occur at the development and marketing stages, not in the research phase, should there be additional government incentives to encourage companies to spend funds for commercialization in addition to research?

## Manufacturing

It is in the manufacturing arena where American companies appear to be the most vulnerable to foreign competition. Process technologies (those used in manufacturing) can significantly lower the costs of production and increase the quality of goods and services. In *Global Competition*, the President's Commission on Industrial Competitiveness (under former President Reagan) concluded that ". . . competitive success in many industries today is as much a matter of mastering the most advanced manufacturing processes as it is in pioneering new products."

The costs associated with the development and purchase of new manufacturing equipment are high. This is particularly true for the 381,000 small companies which make up a major segment of the manufacturing community. Several of the cooperative efforts supported by the federal government address these manufacturing concerns. The Manufacturing Technology program of the Department of Defense, the Advanced Manufacturing Technical Initiative of the Department of Energy, and the Manufacturing Technology Centers operated by the National Institute of Standards and Technology, although all different, are examples of government activities devoted to facilitating the development of new manufacturing techniques and their use in industry.

Considering the importance of manufacturing, the existing cooperative programs may not be sufficient to increase the competitiveness of American industry. Are there more effective types of joint ventures? Cooperative efforts, where resources could be pooled and the equipment shared, may be one way to improve the manufacturing capability of U.S. firms, large or small. Will joint manufacturing prove to be a viable option? Should existing cooperative manufacturing programs in certain agencies be expanded or should new efforts in other departments be developed? Should one government agency have the lead in policy determinations; if so, which federal department?

## Defense vs. Civilian Support

Many of the industries interested in cooperative ventures with federal financial support have approached the Department of Defense and, to a lesser extent, the Department of Energy's Defense Programs because these agencies have the greatest amount of available resources and/or funding. They also tend to have the expertise to operate large-scale programs and maintain close ties with certain industrial sectors which could be encouraged to increase cooperation. In addition, both DOD and DOE have a vested interest in the availability of certain technologies which could be provided by a healthy domestic commercial market. However, questions remain whether sponsorship of certain cooperative ventures by DOD and the Department of Energy's defense-related programs will lead to increased commercialization in the civilian marketplace.

Critics argue that defense spending is not an effective mechanism to increase industry's ability to innovate and develop new technologies. Much of the research and development in the defense arena may be too specialized, overdesigned, and/or too costly to have value for commercial markets. The R&D also tends to concentrate on weapon systems and other defense hardware rather than on process technologies that are often necessary to improve manufacturing productivity. One reason cited for the competitive problems of the machine tool industry was its focus on defense needs rather than on the commercial market which is larger in the aggregate.

On the other hand, the U.S. commitment to military R&D has contributed to a favorable balance of trade in the defense and aerospace industries. In the SEMATECH effort, the purpose of DOD support was to facilitate the *commercial* development of technologies with critical defense applications. The companies involved in SEMATECH are experienced semiconductor manufacturers and are knowledgeable about the markets' needs and operations. Thus, although the initial work performed by this semiconductor consortium may have been partially funded by the Defense Advanced Research Project Agency, it was designed to result in new products and processes in the civilian marketplace where both defense and commercial demand can be met. SEMATECH now operates without direct federal financing.

The issue of cooperative work between the Defense Department and the private sector leading to commercial technologies was addressed in the former Technology Reinvestment Project and is part of the more recent Dual-Use Partnership Project. The Department of Energy has been expanding cooperative R&D activities in Defense Program laboratories in conjunction with an increase in all DOE collaborative efforts with industry. Recent significant decreases in the technology transfer budgets may impeded this effort, but several DOE defense laboratories are actively pursuing joint ventures with industry. (See CRS

Report 98-81, *Cooperative Research and Development Agreements and Semiconductor Technology: Issues Involving the "DOE-Intel CRADA"*.)

## Access by Foreign Firms

With worldwide communications systems, it is virtually impossible to prevent the flow of scientific and technical information. What is critical to competitiveness is the speed at which this knowledge is used to make products, processes, and services for the marketplace. However, it appears that many foreign firms are willing and able to take the results of research performed both in the United States and their own countries and rapidly make high quality commercial goods. Many of these companies are purchasing American businesses or establishing U.S. subsidiaries to access American expertise. With the increased activity in research consortia, particularly those with federal support, questions might be asked as to whether or not foreign companies should or could be barred from access to the results. A larger issue is how to define an "American company." Is it determined by majority ownership, manufacturing, location, value added to the U.S. economy, or by some other definition? In addition, since technology is most effectively transferred by person-to-person interaction, would cooperative activities between American industry and foreign firms produce an outflow of information which could be used to increase competitive pressures?

## Direct vs. Indirect Support

Government efforts to facilitate cooperative ventures have included both indirect supports and direct federal funding. Indirect measures include such things as tax policies, intellectual property rights, and antitrust laws that create incentives for the private sector. Other initiatives include government financing (on a cost shared basis) of joint efforts such as the Advanced Technology Program and Manufacturing Extension Partnerships. In the past, participants in the legislative process generally did not make definite (or exclusionary) choices between these two approaches. However, these activities were revisited in the 104th Congress given apparent Republican preferences for the funding of basic research and not technology development. For example, efforts to eliminate the Advanced Technology Program, funding for flat panel displays, and agricultural extension reflected concern over the role of government in developing commercial technologies and generally resulted in reductions of direct federal financing for such public-private partnerships. Issues were again raised in the 105th and 106th Congresses although no relevant, on-going program was terminated. As the 107th Congress begins its budget deliberations, the future of cooperative R&D may be expected to be explored further. (For more information, see CRS Report 95-50, *The Federal Role in Technology Development*.)

# LEGISLATION

**P.L. 107-50, H.R. 1860**

Small Business Technology Transfer Program Reauthorization Act of 2001. Reauthorizes the Small Business Technology Transfer Program through FY2009. In FY2004 the set-aside is to increase to 0.3% while Phase II awards may expand to $750,000. Introduced May 16, 2001; referred to the House Committees on Small Business and Science. Reported, amended, by the Committee on Small Business and discharged from the Committee

on Science on September 21, 2001. Passed the House, amended, September 24, 2001. Received in Senate on September 25 and passed Senate, without amendment, on September 26, 2001. Signed into law by the President on October 15, 2001.

**P.L. 107-77, H.R. 2500**

Makes FT2002 appropriations for the National Institute of Standards and Technology, among other things. The Manufacturing Extension Partnership is funded at $106.5 million while the Advanced Technology Program is provided $184.5 million. Introduced July 13, 2001; referred to the House Committee on Appropriations. Reported to the House on the same day. Passed the House, amended, on July 18, 2001. Received in Senate July 19 and passed Senate, with an amendment, on September 13, 2001. Measure amended in Senate after passage by unanimous consent on September 13 and September 21, 2001. Conference held. The House agreed to the conference report on November 14, 2001; the Senate agreed the following day. Signed into law by the President on November 28, 2001.

**H.R. 41 (Johnson, N.)**

A bill to amend the Internal Revenue Code of 1986 to permanently extend the research and experimentation tax credit and to increase the rates o the alternative incremental credit. Introduced January 3, 2001; referred to the House Committee on Ways and Means.

**H.R. 895 (Royce)**

Abolishes the Advanced Technology Program. Introduced March 6, 2001; referred to the House Committee on Science.

**H.R. 1137 (Wilson)**

Private Sector R&D Investment Act of 2001. Amends the Internal Revenue Code of 1986 to establish a permanent tax incentive for R&D. Introduced March 3, 2001; referred to the House Committee on Ways and Means.

**H.R. 1329 (Sensenbrenner)**

Amends the Internal Revenue Code of 1986 to make the research credit permanent. Introduced March 30, 2001; referred to the House Committee on Ways and Means.

**H.R. 1417 (Hinchey)**

Technology Extension Act of 2001. A bill to expand the Manufacturing Extension Program to bring the new economy to small and medium-sized businesses. Introduced April 4, 2001; referred to the House Committee on Financial Services.

**H.R. 1418 (Quinn)**

Entrepreneurial Incubators Development Act of 2001. A bill to provide for business incubator activities to promote entrepreneurial activity and job creation. Introduced April 4, 2001; referred to the House Committee on Financial Services.

**S. 41 (Hatch)**

A bill to amend the Internal Revenue Code of 1986 to permanently extend the research and experimentation tax credit and to increase the rates of the alternative incremental credit. Introduced January 22, 2001; referred to the Senate Committee on Finance.

**S. 189 (Bond)**

A bill to amend the Internal Revenue Code of 1986 to provide tax relief for small businesses and to make the research and experimentation tax credit permanent. Introduced January 25, 2001; referred to the Senate Committee on Finance.

**S. 259 (Bingaman)**

National Laboratories Partnership Improvement Act of 2001. Authorizes funding for the Department of Energy to enhance its mission areas through technology transfer and partnerships. Introduced February 6, 2000; referred to the Senate Committee on Energy and Natural Resources.

**S. 429 (Clinton)**

Technology Extension Act of 2001. A bill to expand the Manufacturing Extension Program to bring the new economy to small and medium-sized businesses. Introduced March 1, 2001; referred to the Senate Committee on Commerce, Science, and Transportation.

**S. 432 (Clinton)**

Entrepreneurial Incubators Development Act of 2001. A bill to provide for business incubator activities to promote entrepreneurial activity and job creation. Introduced March 1, 2001; referred to the Senate Committee on Banking, Housing, and Urban Affairs.

**S. 515 (Domenici)**

Private Sector R&D Investment Act of 2001. Amends the Internal Revenue Code of 1986 to establish a permanent tax incentive for R&D. Introduced March 12, 2001; referred to the Senate Committee on Finance.

**S. 517 (Bingaman)**

National Laboratories Partnership Improvement Act of 2001. Authorizes funding through FY2006 for the Department of Energy to enhance its mission areas through technology transfer and partnerships. Introduced March 12, 2001; referred to the Senate Committee on Energy and Natural Resources. Reported to the Senate on June 5, 2001.