TRANSFERRING FEDERALLY-FUNDED TECHNOLOGIES: NEW STRATEGIES FOR SUCCESS

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ABSTRACT

In almost every year of the post-war era, the federal government has spent more on research and development (R&D) than has U.S. industry. These expenditures have been divided largely among the nation's federal laboratories and universities and, contrary to widely held beliefs, devoted in greater measure to applied R&D than basic research. Unfortunately, while this federally-funded research often resulted in the development of "market/application oriented" technology, it did not, for the most part, reach the commercial marketplace (1). With increased attention focused on mounting U.S. deficits in the balance of trade and growing concerns that the U.S. was failing to keep pace with its major trading partners in bringing new technologies to the global marketplace, a series of new federal policies were initiated to expand the national economy and improve its competitiveness internationally by actively promoting the transfer to and use by U.S. industry of federally-funded technologies. This paper identifies and explores several stages in the evolution of these policies.

In the first stage, which spanned much of the decade of the 1980's, new legislation was passed that attempted to empower and encourage the developers of federally-funded technologies to make them available to industry for commercialization. While some of the more enterprising institutions were successful in bringing their technologies to the marketplace, the principal lesson drawn from these early legislative initiatives was that simply providing industry with access to federally-funded technology is not sufficient if the objective is to develop and commercialize new products.

The second stage began in the mid- to late- 1980's following the successes of several pubic-private sector partnerships created by the Departments of Defense and Energy. These partnerships demonstrated that bringing industry, federal laboratories, and others into focused collaboration could yield both breakthroughs in the development of new technologies and increases in the speed and certainty with which they are transferred and commercialized. At the close of the decade, all federal laboratories were given the authority to enter into cooperative research agreements with industry and other entities to cost-share the joint development of new technology. While this new authority has led to the establishment of numerous cooperative research agreements (almost 1000 to date) with industry and others, cultural, perceptual, and procedural barriers stand in the way of a more wide-spread and strategic use of collaboration to achieve national objectives.

The third stage in the evolution of federal policies, which is just now beginning, is typified by the "enterprise" model being developed by the Department of Energy. This model is designed to reduce institutional barriers; promote strategic research and development alliances among laboratories, universities, and industry; and, improve information on and access to both federally-funded and privately developed technologies. Though focused initially on environmental technologies, the enterprise model seeks to obviate obstacles to collaboration and create broad strategic partnerships to leverage the federal investment in technology to improve industrial performance and enhance U.S. competitiveness.

Stage One

For more than a decade, the U.S. has witnessed an increasing sense of urgency associated with efforts to promote the transfer and commercialization of this federally-funded technology. Motivated in part by the need to develop and adapt new technologies to stimulate U.S. commerce and competitiveness in the new global economy, a body of new legislation was enacted in the decade of the 1980's. The purpose of these Acts was to get both new and archived federally-funded technologies out of the laboratories and academia and into the hands of industry where they could be adapted, manufactured and distributed domestically and internationally.

The Bayh-Dole Act of 1980 was the first law to provide an incentive to commercialize federally-funded inventions and technologies. It gave universities and small businesses the right to retain patents to and royalties from most technology developed with government funding. In 1983 it was extended to all government contractors by Executive Order. Also passed in 1980 was the Stevenson-Wydler Technology Innovation Act. This law provided federal labs and agencies with a mandate to pursue technology transfer activities. Federal agencies were allowed to choose from a variety of methods for commercializing technology including nonexclusive, partially exclusive, and exclusive licensing arrangements. This act was never fully implemented. However, it served to focus attention on technology transfer and, with its subsequent amendments, made technology transfer a mission of the federal laboratories. It required, for example, that all federal laboratories establish an Office of Research and Technology Applications to coordinate technology transfer efforts. In 1984 the National Cooperative Research Act was passed by Congress. It relaxed the application of antitrust laws to research consortia in an attempt to encourage the pooling of industrial R&D

resources. The Federal Technology Transfer Act of 1986, and a subsequent Executive Order (E.O. 12591) in 1987, sought to encourage the commercialization of federally-funded technology by providing cash awards and other incentives to federal employees who successfully transferred technologies (2).

While many of the institutions empowered by these Acts sought vigorously to comply with and take advantage of their intent to stimulate the development and transfer of federally-funded innovations in science and technology, the results failed to meet expectations. While, as reported by Salvador, there were a number of successes, many universities and government laboratories were discouraged with what appeared to be a lack of interest on the part of industry (3). In fact, during this period the non-profit Council on Competitiveness documented that it appeared easier for industry to transfer its technology to the pursuits of government than for federally developed technologies to penetrate and make substantive contributions to the private sector (4). As reported by Salvador, a decade of legislative activity produced little change in corporate attitudes--or behavior--toward the use of laboratory and university research and technology (5).

It is arguable that the emphasis of the previous legislation to encourage federal laboratories and universities to move technology into the private sector created necessary but not sufficient conditions for success. That is, the implicit assumptions underlying such legislation as the Stevenson-Wydler Act and the Federal Technology Transfer Act appear to have been that the private sector would take all new and archived technology the federal agencies and laboratories would release if sufficient incentives and/or mandates could be created to change the federal culture and motivate these institutions to offer their technologies for commercialization. In essence, these acts focused primarily on "technology push", as opposed to "market pull" solutions to the problems of technology transfer. What was lacking in the legislation of the 1980's was attention to what might be needed to enhance industry's receptivity to the adoption of federally-funded technology. As observed by former Secretary of Defense Harold Brown, just inviting industry to come in and see technology developed in the national laboratories doesn't work too well if the object is to develop new commercial products (6).

Traditionally, the process of transferring and commercializing federally-funded technology has been sequential, consisting of an orderly series of steps. In this process, technology is developed within the laboratory with little influence from industry. As the development process continues, corporate and market input may be used to help define a new product or process. This step is followed by building a prototype and testing its feasibility, completing product development and design, and starting the production process. While the actual transfer of the technology may occur any time between development and full-scale production, the fact is that too frequently federally-funded technologies remain "undiscovered" in research labs rather than being developed for the marketplace (7). This process, of developing a technology and subsequently looking for adopters, is not well-suited to industry's rapidly changing competitive environment (8).

Stage Two

A much needed shift in this linear paradigm, or way of thinking about technology transfer, occurred just prior to the close of the decade. In the mid- to late- 1980's proponents of public policy efforts to promote and transfer federally-funded technology to industry pointed to the successes of several single-purpose, public-private partnership programs supported by the Departments of Defense and Energy. Not only did the collaboration of industry, universities, and laboratories lead to breakthroughs in the development of high-risk technologies, but the involvement of industry from conceptual design to execution greatly improved the probability that the technology would be transferred and commercialized.

Recognizing the importance of collaboration in the development and ultimate transfer of federally-funded technologies within the ever-constricting periods of time available to bring new technologies to increasingly competitive global markets, the National Competitiveness and Technology Transfer Act (NCTTA) of 1989 provided an incentive to industry and others to become partners in developing--and not just adopting--federally-funded technology. The NCTTA required federal agencies to permit their laboratories to enter into Cooperative Research and Development Agreements (CRADAs) for the purpose of cost-sharing with industry--and others--the research and development of new technologies and innovations. These CRADAs provided, among other things, that commercially valuable information brought into or generated under such agreements may be withheld from public disclosure for up to 5 years and allowed the parties to the agreements to specify in advance how rights to the resulting intellectual property would be distributed.

Since the passage of the National Competiveness and Technology Transfer Act federal agencies and their laboratories have sought to create partnerships involving industry and others in the joint development, commercialization and application of new federally-funded technologies. There have been some notable successes. For example, the Lawrence Livermore National Laboratory is involved in a $3 million cooperative program with General Motors (GM) to develop a new high-energy, solid state laser that can be used to weld and cut sheet steel. It is estimated that GM may be using this new technology as early as 1995. Such programs are not restricted to the nation's largest industries. A small California machine-tool company, Industrial Tools Inc., developed with Livermore a machine that cuts materials to within an accuracy of 20 millionth of an inch. The Firm contributed approximately $400,000 to the project and currently has orders for six of the machines (9). Successes have also been achieved at the other federal and national laboratories. For example, the Pacific Northwest Laboratory has completed agreements with both the U.S. textile and automobile industries that provide for multi-laboratory involvement in solving problems of mutual concern. Los Alamos National Laboratory has entered into a CRADA with Life Technologies, Inc., to develop faster and less costly techniques for determining the composition of DNA fragments and sequencing the human genome. Argonne National Laboratory has teamed with Baxter Healthcare on a collaborative R&D project to investigate new processes for sterilizing blood donations against viral diseases. As of March, 1992, the Department of Energy and its laboratories had entered into a total of 92 CRADAs for cooperative research and development (10).

While there have been significant successes, these activities have had, in the opinion of some, surprisingly little impact on U.S. industry (11). Among the reasons often cited for this are: a) lack of awareness, b) out-moded perceptions, and c) barriers to participation. In too many instances, industry is simply unaware of the opportunities for collaboration that

have arisen from changes in legislation. In addition, there appears to be a lack of awareness both of the facilities, capabilities, and technologies available from federal laboratories and how to gain access to them. There are also perceptual problems. As observed by Salvador, the perception that government laboratories and universities focus on basic research continues to persist. This has led many in industry to conclude that little technology of interest to them is available from these institutions. Finally, there are both real and perceived barriers to interacting with government laboratories and, to a lesser extent, universities. Not the least of these are the difficulties of dealing with different cultures and procedures. As reported by Noori, there are philosophical objections to allowing corporations to have too much control over university (and laboratory) research (12). Such objections make the establishment of effective research and develop partnerships difficult. Even if federal laboratories wanted to make helping industry their key mission, there are significant bureaucratic barriers to be overcome. In addition to tractable issues such as the secrecy rules that impede physical access to many of the government laboratories, there are a host of less trivial obstacles to interaction (13). Among these are the availability and commitment of adequate funds to encourage substantive interest on the part of industry, the inconsistent and often protracted procedures for negotiating and obtaining approval of cooperative agreements, and the lack of effective mechanisms to construct and manage large, strategic partnerships involving multiple laboratories, industries, and other entities that are capable of meeting national needs and enhancing U.S. competitiveness.

In its policy statement, "Technology: The Engine of Economic Growth," the Clinton-Gore campaign outlined the critical elements of a national technology policy for America. As this document makes clear, the in-coming administration views collaboration among industry, laboratories, and universities as a cornerstone of its technology policy to assure that the federal investment in technology is leveraged to improve U.S. industrial performance and enhance U.S. competitiveness. Written in November, 1992, it observes that changes are needed to improve industry/laboratory cooperation in the development of technology for commercial application. The document outlines the policies and strategies a Clinton-Gore administration would pursue to address some of the less tractable obstacles identified above. First, the federal laboratories that can make a significant contribution to U.S. competitiveness would have 10% to 20% of their budgets assigned to establish industrial collaboration. Secondly, the directors of these laboratories would have full authority to sign, fund and implement cooperative R&D agreements (CRADAs) with industry. This would allow the laboratories to be more responsive to industry's needs for the development and transfer of federally-funded technology within the periods of time available to bring them to successful commercialization. Finally, in what may be viewed as a quid-pro-quo for the increased authority granted to the laboratories, the new administration suggests that if within 3 years the objectives of a fully-functioning collaborative program, jointly agreed to by industry and the laboratories, are not being met, laboratory funds intended to foster these relationships should be redirected to consortia, universities, and other organizations that can work more effectively with industry for results (14). Importantly, it would appear that the in-coming administration intends to place the burden of creating the institutional mechanisms needed to make such collaboration successful squarely on the shoulders of the federal agencies and their laboratories.

Given the real and perceived obstacles to collaboration, and at least preliminary indications of the expectations that the laboratories will create a fully-functioning program of collaboration within 3 years, a new model or set of strategies is needed to leverage the federal investment in technology to maximize its contributions to industrial performance. This model will have to expand significantly industry's awareness and acceptance of laboratory capabilities and programs and create broad strategic partnerships among industry, laboratories, and others that can focus on areas of significant public and private sector needs.

Stage Three

Since April of 1992, a staff from the Department of Energy's (DOE) national laboratories and maintenance and operations contractors have been at work on the development of a model to improve the prospects for collaboration among the nation's industries, universities, laboratories, and federal agencies. These efforts grew out of a meeting between the Secretary of Energy and the Directors of the National Laboratories held in Leesburg, Virginia in December 1991. As a result of this meeting, Mr. Leo Duffy, the Assistant Secretary of DOE's Office of Environmental Restoration and Waste Management charged Dr.Clyde Frank, his Deputy Assistant Secretary for Technology Development, to convene a Task Force of national laboratory staff to develop a comprehensive set of strategies to leverage the federal investment in the development of technologies to solve the near- and long-term remediation and waste management problems of the DOE complex in a way that would maximize contributions to U.S. industrial performance and competitiveness.

As a result of considerable research and discussion with a variety of parties, the Task Force concluded that U.S. environmental restoration and waste management technologies for national and global needs are not being developed or, if developed, are not coming quickly enough to the marketplace to bring about the efficiencies needed in the remediation of federal sites or to contribute to U.S. competitiveness. To address this, the Task Force envisioned the creation of an entity that would act as a primary catalyst for bringing together the resources of industry, universities, other state and federal agencies and the DOE laboratories. Because the Task Force felt unconstrained to adopt any pre-existing organizational or institutional framework, it referred to this conceptual entity as the "enterprise." Unlike other initiatives that emphasize only the development and transfer of federally-funded technologies, the enterprise would involve these partners in a variety of functions designed principally to make the marketplace between parties with environmental problems and those with potential solutions function more efficiently.

The principal functions of the enterprise involve bringing together private and public entities in need of cost-effective solutions to environmental problems (i.e., the "problem holders") with the entities having access to the best solutions available (i.e., the "problem solvers"). Referred to as "brokering" and "alliance forming," the enterprise--by gathering and maintaining information on the available and emerging technologies, user facilities and related capabilities--will perform a "market clearinghouse" function giving problem holders--perhaps for the first time--relatively easy access to a broad array of expertise within the national laboratories, universities

and private firms. As a "broker," the enterprise combines knowledge of available and emerging technologies with the information obtained from the problem holders to create complete solutions. The enterprise will also structure alliances. Alliances are formed when no available solution to a particular problem or need can be found. In these cases, the problem holder and one or more laboratory, university, and/or industry partners form an alliance to solve the problem by adapting or developing technologies to meet the need. The enterprise will nurture the formation of the alliance and the development of the new technology by maintaining a facilitating presence that begins with helping to structure the alliance and ends with the achievement of the alliance's goal. The enterprise may also arrange cost-sharing to encourage the formation of alliances in those instances in which the problem being addressed is broadly held and the solution is considered potentially useful to the Department of Energy or other source of cost-shared funds.

In addition to these important functions, the enterprise will gather and make available current information on the nature and status of available and emerging environmental technologies from all sources, both domestic and international. It will also seek to support the introduction and use of new cost-effective environmental technologies by catalyzing needed regulatory and procedural changes. In addition to working to reduce the barriers to the formation of effective collaborative relationships, it will assess the risk-cost-benefit impacts of regulations on environmental activities and, with the support of its industry, university, and state and federal agency partners, recommend regulatory changes that would reduce these impacts and increase the adoption of better, faster, safer, and more cost-effective solutions.

In essence, the enterprise model facilitates industry, laboratory, and university collaboration in the development of technology; provides, from a single source, information on and access to environmental technologies and engineered systems from research laboratories, universities, and industry; and actively supports the introduction and use of improved technological solutions to environmental problems by catalyzing regulatory and procedural changes. In so doing, the enterprise model seeks to obviate obstacles to collaboration and create broad strategic partnerships to leverage the federal investment in technology to improve industrial performance and enhance U.S. competitiveness.

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