TRANSFERRING FEDERALLY-FUNDED TECHNOLOGIES:
NEW STRATEGIES FOR SUCCESS

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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. As pointed out by Salvador, this federally-funded research has resulted in the development of "market/application oriented" technology that, for the most part, has failed to reach the commercial marketplace (1).

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 corpus 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 implicit 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).

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.
The National Competitiveness and Technology Transfer Act (NCTTA), passed in 1989, appeared to recognize that effecting the development and transfer of federally-funded technologies within the ever-constricting periods of time available to bring them to increasingly competitive global markets requires the active involvement of industry from project initiation through execution and commercialization. This Act 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 Competitiveness 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, Salvador reports that all of the activity within the laboratories and universities has had surprisingly little impact on U.S. industry (11). Among the reasons 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 remains both a significant lack of appreciation for the facilities, capabilities, and technologies available from federal laboratories and universities and a general lack of awareness of 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, although 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 the laboratories and universities 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 non-trivial obstacles to interaction. Not the least of these are contracting and procurement rules. An example that strikes close to home is the criticism leveled at the Department of Energy by the Council on Competitiveness for taking up to two years to approve joint R&D projects with industry (13).

Given the real and perceived obstacles to interaction among the nation’s industries, laboratories, and universities, more than mere legislation permitting these parties to work together-- regardless of the incentives provided--will be required to assure a truly collaborative approach to developing and commercializing federally-funded technology. What is needed are the institutional mechanisms to make such collaboration attractive and effective.

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. Written in November, 1992, it observes that changes in regulations and orientation are needed to get industry/laboratory cooperation on technology development for commercial application. The document outlines the policies and strategies a Clinton-Gore administration would pursue to leverage existing federal investment in technology to maximize its contributions to industrial performance. To help stimulate this, 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. In addition, 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 ever-constricting periods of time available to bring them to successful commercialization in increasingly competitive global markets. 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). 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. 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.
Since April of 1992, a Task Force of 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. The Task Force and its 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 research and development investment strategy that would address both the near- and long-term solutions to remediation and waste management problems in the DOE complex and the nation’s needs to enhance income, employment, and U.S. competitiveness. In essence, the Task Force was charged with increasing the "return on the federal investment" (ROI) in environmental restoration and waste management by finding, adapting, or developing new technologies and methods that would both cut the costs and time associated with cleaning up and managing environmental wastes and by getting these technologies into the hands of U.S. industry where, through their manufacture, distribution, and application, they could increase domestic income and employment, bring efficiencies to the remediation of federal and private sites, and contribute to the development of a U.S. environmental industry capable of enhancing U.S. competitiveness.

The Task Force approached its charge by stating clearly the mission: to maximize the benefits to the U.S. economy, human health and safety, and the environment from DOE’s investment in environmental restoration and waste management. To accomplish this mission, 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."

As its premise, developed from considerable research and discussion with a variety of parties, the Task Force found 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 and are therefore not available to bring about the efficiencies needed in the remediation of federal and private sites or to contribute to U.S. competitiveness. To address this, the Task Force determined that the enterprise should involve as partners with the DOE laboratories, other federal and state agencies and their laboratories, industry, and universities. 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. In this regard, the enterprise represents yet another shift in the paradigm for transferring federally-funded technologies.

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, it seeks to obviate the problems most frequently cited as responsible for industry's aversion to the use of laboratories and universities and, in this author's opinion, represents a new set of strategies for success that again shifts the paradigm for transferring federally-funded technologies.
REFERENCES CITED

1. Salvador, p. 50.


5. Salvador, p. 53.


