Technology Transfer From DOE Weapons Laboratories 4

The Federal laboratories of the United States differ greatly in mission, size, and operation. A few Federal labs have transferred technology effectively to private industry for years, but most labs in the Federal system have until recently concentrated on their public missions and have done little to make their technologies available for commercial development. One school of thought holds that there is, in fact, little technology in the labs that is useful or interesting to industry. Others believe that Federal labs are full of useful technologies that have not been exploited commercially. Until the 1990s, most of the evidence regarding technology transfer, particularly from the Department of Energy (DOE) labs that are among the biggest and best funded, supported the view that there was little of commercial interest in the labs. In 1989, however, the situation began to change.

TECHNOLOGY TRANSFER AT FEDERAL LABS

The Stevenson-Wydler Technology Innovation Act of 1980 was the first of a series of laws that focused specifically on technology transfer from the Federal labs. Stevenson-Wydler was aimed at innovation throughout the economy, with technology transfer from the labs a prominent part of the law. One of its five major initiatives required most Federal labs to establish an Office of Research and Technology Applications (ORTA). ORTAs were given the responsibilities of assessing potential applications of the labs' R&D projects and disseminating information on those applications. Each Federal agency that operated or directed at least one lab was required to set aside at least 0.5 percent of the agency's R&D budget for technology transfer.[1] Before Stevenson-Wydler, only the National Aeronautics and Space Administration (NASA) and the National Institute of Standards and Technology (NIST) were directed to transfer technology as part of their missions, though several other federal agencies had good working relationships with private companies that facilitated technology transfer.

Though ORTAs were set up in response to Stevenson-Wydler, the record of technology transfer from Federal labs to other potential users was disappointing. Inadequate ORTA staffing, unfunded provisions of the Act, and the fact that the Act dealt only with technologies already on the shelf were identified as some of the culprits.[2]

Over the next 6 years, several more laws further encouraged technology transfer from Federal labs. These included the Bayh-Dole Act of 1980, the Small Business Innovation Development Act of 1982, and Section 501 of the Trademarks-State Justice Institute-Semiconductor Chips-Courts Patents Act of 1984 (amending the Bayh-Dole Act). Like Stevenson-Wydler, these laws eased the transfer of technology from labs to companies, particularly small businesses, but their combined impact was modest at best.

The next significant piece of technology-transfer legislation was the Federal Technology Transfer Act (FTTA) of 1986. It amended Stevenson-Wydler to allow government-owned, government-operated (GOGO) labs to sign cooperative research and development agreements (CRADAs) with any outside organization, including businesses, nonprofits, and state and local government organizations (e.g.. many universities). Earlier legislation had encouraged small businesses to enter cooperative R&D partnerships with labs, but the FTTA significantly broadened the range of potential cooperation. The FTTA permitted-and Executive Order 12591, issued in April 1987, required-that Federal agencies delegate to directors of GOGO labs the authority to negotiate the division of funds, services, property, and people with outside organizations in CRADAs, subject to the requirement that the lab could only contribute in-kind resources, not funds.

Although some were slow to comply, most agencies responded fully.[3] For example, NIST gives its lab directors nearly complete authority to select and negotiate CRADAs, as has DoD.[4] NASA labs do not use CRADAs,[5] but lab directors have long had the ability to negotiate and sign cooperative agreements to do R&D with outside partners under the 1958 Space Act (called Space Act Agreements).[6]

The FTTA also formalized the existence of the Federal lab Consortium for Technology Transfer (FLC). Originally established by the Defense Department as an informal coordinating group in 1971, the FLC, relying on a small staff and

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1 Public Law 96-480, Sec. 1 l(b), codified at 15 U.S.C. $3710. Agency heads could waive this requirement. In 1989, the 0.5 percent requirement was replaced with the directive to provide "sufficient funding, **either as a separate line item or from the agency's research and development budget. " Public Law 101-189, Sec. 3133(e)(l)(2),**

2 **Barry Bozeman and Karen Coker, "Assessing the Effectiveness of Technology Transfer From U.S. Government R&D Laboratories: The Impact of Market Orientation'** *Technovation, vol. 12, No. 4,* p. **241.**

3 The Department of Commerce reported in 1989 that "[m]ost [agencies] have attempted to delegate authority to the smallest unit that can realistically be called a laboratory. ' See U.S. Department of Commerce, *The Federal Technology Transfer Act of 1986: The First 2 Years,* Report to the President and the Congress from the Secretary of Commerce, July 1989, p. i. However, both the General Accounting Office and the DoD Inspector General issued reports the same year that found many agencies slow in delegating authority to their labs. See U.S. General Accounting Office, *Technology Transfer: Implementation Status of the Federal Technology Transfer Act of 1986,* RCED-89-154 (Gaithersburg, MD: 1989), pp. 23-30; U.S. Department of Defense, Office of the Inspector General, "Report on the Audit of the DOD Domestic Technology Transfer Program, ' Report No. 90-006, Oct. 19, 1989, p. 10.

4 See Council on Competitiveness, *Industry as a Customer the Federal Laboratories* (Washington, DC: Council on Competitiveness, September 1992), p. 12.

5 NASA labs are all GOGOs except the Jet Propulsion Laboratory, which is government-owned, contractor-operated (GOCO).

6 Space Act Agreements are subject to the same rule that the labs not transfer money to outside R&D performers.

volunteer representatives from hundreds of labs, tries to match inquiries from firms with the appropriate lab researcher. It has also held conferences on possible collaboration in selected areas (e.g., manufacturing technology, management of hazardous waste) and has funded projects to demonstrate technology commercialization.[7]

FTTA marked a real change in Federal technology transfer policies. By encouraging cooperative research and development, and enabling decentralization of authority to enter into cooperative agreements, FTTA implicitly recognized that technology transfer involves much more than a handoff. To use the current cliche, technology transfer is a contact sport. There were, however, two holes in FTTA's mandate, not addressed until the National Competitiveness Technology Transfer Act of 1989 (NCTTA).[8] One was protection of proprietary information and another was the treatment of GOCO (government-owned contractor-operated) labs.

According to some DOE officials, Executive Order 12591 filled part of the gap. It directed Federal agencies, "to the extent permitted by law, ' to give lab directors the authority to license, assign, or waive rights to intellectual property developed in cooperative agreements.[9] This, according to some in DOE, mitigated some of the concern of some potential cooperators that proprietary information developed in a cooperative arrangement with a Federal lab could be transferred to a competitor through the Freedom of Information Act (FOIA). But Executive Order 12591 did not really resolve concerns regarding the Freedom of Information Act.

Second, FTTA did not address the safeguarding of information developed in cooperative R&D projects. Potential partners were concerned that such information could be accessed by competitors through FOIA, which discouraged some companies from participating. NCTTA, however, permitted the lab director or, in the case of GOCOs, the parent agency, to exempt the results of collaborative R&D from release under FOIA for up to 5 years.[10]

The gap affecting GOCOs remained. While most Federal labs are GOGOs, the largest, including all nine of DOE's large multiprogram national labs are GOCOs. While some DOE labs established cooperative projects with industries and universities, broad legislative authority to do so was not granted until NCTTA, in 1989. This law, together with the Department of Defense Authorization Act for Fiscal Years 1992 and 1993, not only strongly encouraged cooperative R&D but also gave agencies more flexibility in meeting industry's concerns about the disposition of intellectual property developed in or brought to a CRADA.

TECHNOLOGY TRANSFER AT DOE LABORATORIES: EARLY EFFORTS

CRADAs are only one form of technology transfer. Others have long been available to DOE and other Federal labs. These include technology licensing, work for others (WFO), personnel exchanges, publications, user facilities, consulting arrangements, university interactions, and cooperative arrangements other than CRADAs. DOE's efforts to transfer technology have spanned a range from marketing off-the-shelf technologies to cooperative research and development. The advantages to cooperative work, or other forms of high-contact transfer like personnel exchanges, include close communication between lab and private sector researchers, creat-

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7 See U.S. Congress, Office of Technology Assessment, *Making Things Better: Competing in Manufacturing*, OTA-ITE-443 (Washington DC: U.S. Government Printing Office, February 1990), p. 190.

8 Public Law 101-189, Sees. 3131-3133.

9 Federal Register, ''Facilitating Access to Science and Technology, " Executive Order 12591 of Apr. 10, 1987, vol. 52, No. 77, Apr. 22, 1987.

10 Public Law 101-189, Sec. 3133(a)(7), adding 15 U.S.C. 3710a(C)(7).

Box 4-A–A Cooperative Lab/Industry Project: The Specialty Metals Processing Consortium

Specialty metals include a wide variety of metals and metal alloys not in common use, with exceptional properties such as high strength at unusually high or low temperatures, corrosion resistance, exceptional toughness, low density, or high or low neutron absorption. To achieve the desired properties, specialty metals require unusually complex processing. That means high R&D costs and often investment in expensive equipment. Both can be problems for the specialty metals industry, which consists of about 30 modest-sized companies (most have 500 to 1,000 employees), with no particularly dominant player. Early in the 1970s, many of the companies then in the industry curtailed R&D spending because of low profits, and continued to use existing processes with little improvement.[1] Over the next two decades, producers in Europe and Asia pursued more active research programs, with the result that the American industry's competitiveness is now threatened.

Sandia National Laboratory's involvement with specialty metals processing dates back to 1969, when Sandia established a melting and solidification laboratory to deal with problems in processing uranium alloys for nuclear weapons. In the years since, the lab's interest in specialt y metals expanded to encompass titanium and iron- and nickel-based alloys as well. The applications expanded to include a variety of aerospace and nuclear power uses. During the 1970s, Sandia's leading specialty metals researcher, Frank Zanner, began modeling specialty metals remelting processes and testing the models at furnaces Sandia installed at two companies. In 1979, Zanner first published and presented the results of his work on vacuum arc remelting (VAR), which led to his being invited to confirm his research results at many producers' plants. Informally, the consortium had begun to operate.

In 1988, Sandia hosted a workshop on melting and liquid metal processing, attended by over a hundred participants from 33 domestic companies, 5 universities, and 5 government agencies. At the end of the workshop, Sandia agreed to form a steering committee to investigate forming a joint research collaboration of the lab and industry. The collaboration, participants hoped, would help compensate for declining industry R&D spending, bolster flagging competitiveness, and improve relationships between producers and users of specialty metals.

1 F, Zanner, Sandia National Laboratories, personal communication, June 7, 1991.

ing greater likelihood of effective transfer. According to one report,

> Argonne recognizes that most of its technology transfer results from personal contacts by the Argonne staff. Although the positive impacts of such contacts are harder to document than the successful licensings and commercializations of Argonne patents, the personal contacts (numerous in number) remain the major way that Argonne interfaces with industry, business and the government sectors.[11]

Before NCTTA made CRADAs a choice for GOCOs, many of the weapons labs' most effective technology transfers were done in other kinds of cooperative arrangements with industry—consortia of firms in many cases. Examples include the three superconductivity research and information centers, and the Direct Injection Stratified Charge program (DISC) of the weapons labs together with General Motors and Princeton University. An often-cited success of laboratory/industry cooperative work is the Specialty Metals Processing Consortium (SMPC) at Sandia National Laboratories in New Mexico (see box 4-A).

SMPC, while formally initiated after the enactment of NCTTA, probably is typical of what it took to establish a good cooperative program with

11 Richard E. Engler, Jr., and Philip G. Vargas, ''Global Competition and Technology Transfer by the Federal Laboratories, ' contractor report for the Office of Renewable Energy, U.S. Department of Energy, contract number CE-AC01-85CE 30848.000, Feb. 20, 1987.

Even with a great deal of enthusiasm on all sides, it took 3 years to get the consortium started. It took time to work out solutions to issues like intellectual property rights, membership qualifications (including foreign participation), and funding. It took a year for DOE to approve legal and contractual matters. Finally, in July 1990, the contract between the Specialty Metals Processing Consortium (SMPC) and DOE was signed, officially allowing work to begin.

The consortium includes 11 companies, not including Sandia. Both industry and DOE are funding the project on an equal basis for the first 5 years, each putting up about $2.75 million. DOE's contribution peaked at $750,000 in 1992, and is scheduled to drop to zero by FY 1994. After DOE's contributions cease, industry and others are expected to fully fund the research Sandia performs for the consortium. The companies put up $50,000 per year. Each company elects one person to the board of the consortium, and the board establishes research priorities in consultation with the other companies and DOE. The work is mostly done by five employees in the Sandia metallurgy and computations analysis departments. Additional manpower comes from industrial interns sent by member companies for a year each,[2] and by postgraduate students and professors from various universities. Sandia's work is mostly on paper. Research results are tested in the production facilities of member companies; the lab provides portable test equipment as needed.

SMPC has already accomplished several things beyond the R&D itself. It helped to establish the conditions for cooperative work between labs and industry before DOE or the labs had any familiarity with the cooperative research and development agreement (CRADA) process made available to DOE labs in 1989. While the process of developing models and negotiating CRADAs has been a rocky one, the experience of SMPC may have helped to avoid still greater problems. SMPC also helped to overcome the initial reservations of many intermediate managers at Sandia about doing cooperative work in general; in part because of its experience with SMPC, Sandia has become a leader among DOE labs in initiating CRADAs. Finally, the enthusiasm of the industry participants has helped to overcome some of the resistance in the private sector to doing cooperative work with "the government." None of the companies in the consortium was happy with the red tape, delay, and bureaucracy involved in negotiating the original contract with DOE, but all are enthusiastic about the work of the SMPC. One, encouraged by the SMPC, is negotiating another cooperative agreement with Sandia dealing with welding.

2 Sending an intern to SMPC entitles the member company to a 40 percent reduction in dues that Year.

a DOE lab in the days before the labs could and were encouraged to do CRADAs. It was by no means simple; it took 3 years from the time the companies and Sandia researchers resolved to form the consortium until the agreement establishing it was signed. Much of this delay can be attributed to appropriate cautiousness in Sandia and in DOE regarding an unfamiliar way of accomplishing a government mission. A great deal, however, is also attributable to what commonly is called 'bureaucracy' '-there were many players at many levels whose concurrence was needed; actions and approvals were slow; there was much haggling over particular terms of the agreement. SMPC probably would not exist if not for the existence of a champion, Frank Zanner, at Sandia.

Superconductivity pilot centers, on the other hand, took much less effort. Superconductivity is a property of many metals, alloys, and chemical compounds at temperatures near absolute zero, where resistance to electricity vanishes. When superconductivity happens at higher temperatures--35 to 40° Kelvin and above—it is referred to as high temperature superconductivity (HTS). In the late 1980s, the U.S. scientific community became concerned that American companies, which had not been as aggressive as Japanese companies in investigating commercial applications of HTS technology, might fail to reap commercial benefits.[12] Such applications could include inexpensive bulk power transmission, magnetic resonance imaging, efficient motors, particle accelerators, sensors, hand-held supercomputers, and magnetically levitated trains.

In 1987, the Reagan Administration announced a research initiative in HTS involving cooperation of government, industry and universities. In 1988, then-Secretary of Energy Barrington announced the establishment of DOE's High Temperature Superconductivity Pilot Centers. Three labs—Argonne, Los Alamos, and Oak Ridge—were given the mission of developing applications for HTS in collaboration with industry. At the time, these labs did not have the authority to enter into CRADAs, and cooperative agreements, while possible, were rare. To make the collaboration function smoothly, DOE created Superconductivity Pilot Center Agreements (SPCAs) to provide a mechanism enabling the agency to initiate cooperative R&D agreements. The agreements were modeled after sales agreements, which were both common and legal, committing the agency to ''sell" R&D to cooperators (who also were expected to perform some research). The SPCA proved a successful mechanism: since its invention, the three labs have signed 82 of them, 39 of which are still active.[13] Funding for the program in 1993 totaled $13.9 million, split roughly evenly between the three centers; in addition, DOE funds $12 million in related basic research projects that support the work of the pilot centers.

SPCAs and CRADAs, while generally similar, have some differences. SPCAs may protect information generated in a project from FOIA requests for up to 2 years; CRADA protection stretches to five. SPCAs are only available at Argonne, Los Alamos, and Oak Ridge; CRADAs can be initiated with any DOE lab. SPCAs allow the agency to transfer finds to an industry partner, while CRADAs do not.

Perhaps a more salient difference is ease of negotiation. Companies using SPCAs mostly report few delays or disagreements with DOE or the labs in the negotiation process. CRADAs, on the other hand, were time-consuming and difficult to negotiate for nearly 3 years; only now is DOE beginning to handle CRADAs on a more routine and timely basis. A representative of Xsirius Superconductivity, Inc., for example, reported that it took only 6 weeks to propose, develop, and gain DOE approval for an SPCA at Los Alamos, while the same company's CRADA with another DOE facility took a year.[14] Richard Cass, President of HiTc, said it required only 8 to 10 weeks to get something going with one of the HTS pilot centers.[15]

Not everyone has had such a smooth ride. An official of American Superconductor reported that its first four SPCAs faced serious difficulties, and negotiations consumed a year. Subsequent agreements, however, were much faster and smoother; American Superconductor now maintains close relationships with all three centers.[16] The fact that companies using the pilot centers still apparently prefer SPCAs to CRADAs, even though proprietary information is not so well protected, is telling. Possibly, one difference is that SPCAs all dealt with a relatively narrowly specified technology, while CRADAs can apply to any technology. Moreover, total SPCA funding has been modest, compared with total finding for CRADAs. Both factors would tend to make

12 See, for example, U.S. Congress, Office of Technology Assessment, *Commercializing High Temperature Superconductivity*, OTA-ITE-388 *(Washington* DC: U.S. Government Printing Office, June 1988), passim.

13 Data provided by James Daley, HTS Program Manager, Conservation and Renewable Energy, DOE, March 1993. In addition to the SPCAs, one CRADA is also pending at the Oak Ridge Superconductivity Pilot Center.

14 Dr. Hahn, Scientist, Xsirius Superconductivity, Inc., Personal communication, February 1993.

15 Richard Cass, President of HiTc, personal communication, February 1993.

16 Alexis Malozemoff, Scientist, American Superconductor, personal communication, 1993.

SPCAs less controversial and require less in the way of elaborate selection procedures.

CRADAs AND THE NATIONAL TECHNOLOGY INITIATIVE

Much has changed in the few years since the passage of NCTTA, Throughout the 1980s, conventional wisdom correctly saw technology transfer from most government labs as a side show. Moreover, many believed that the national labs had little of more than marginal value to offer industry. Though many still regard the labs as unlikely contributors to industrial technology, there is considerable evidence that such sentiments are changing. Several developments were significant in turning the spotlight on technology transfer in the 1990s.[17] They included:

- The new authority and encouragement for cooperative work with industry conferred by the NCTTA, building on previous laws;
- The National Technology Initiative (NTI), launched in February 1992, in which 10 Federal agencies[18] invited industry to become acquainted with lab technologies and cooperate with the labs to further develop technologies with commercial promise;
- The availability of money earmarked for cooperative projects in the DOE weapons labs;
- A new interest on the part of lab directors and researchers in cooperative R&D with industry;
- The appearance of enthusiastic government support for R&D partnerships with industry at a time when the economy is in the doldrums and the climate for investment in private R&D is discouraging;
- Newfound private sector interest in technology-development partnerships with labs, partly spurred by the paucity of private resources for R&D, and partly by the identification of numerous candidate technologies within the labs that could have commercial promise. Several organizations--among them General Motors, the "Computer Systems Policy Project, and the National Center for Manufacturing Sciences-organized extensive lab visits aimed at identifying areas for promising cooperative technology development in 1990-92, and came up with lengthy lists of potential projects.

This combination of factors means that, for the first time since the efforts that began in 1980 to commercialize or transfer national lab technologies, there is broad, significant interest in the private sector in lab technologies. Several of the Federal labs-especially those of NIST, National Institutes of Health (NIH), and NASA—have done cooperative research with industry for years, but on the whole, there has never been livelier private sector interest in accessing the abilities and resources of the labs. Results can be seen in the fact that in July 1992 there were 1,175 CRADAs joining private partners and Federal labs, compared with 33 in 1987. Over the same 4-year period, government invention disclosures increased from 2,700 to 3,500, Federal patent applications rose from 840 to 1,600, and Federal patent licenses increased from 140 to 260.[19] DOE's national labs gained the authority to sign CRADAs in 1989, but by early 1991 had negotiated only 15. By April 1993, DOE's CRADAs numbered 382, with planned and committed funding of $321 million (tables 4-1 and 4-2).[20] It is noteworthy too that for every CRADA signed

17 See ch. 3 for more discussion of these developments.

18 The Departments of Commerce, Energy, Transportation, Defense, Interior, Agriculture, and Health and Human Services; NASA, the Office of Science and Technology Policy of the White House, and the Environmental Protection Agency.

19 Lucy Reilly, "An Encore Performance for the NTI Road Show," *Technology Transfer Business*, Fall 1992, p. 47.

20 Department of Energy, unpublished data.

Table 4-1—Distribution of CRADA Activities Among DOE Facilities and Programs

Laboratory	Funding source							Total
	CE	DP	EM	ER	FE	NE	Other	
	Number of CRADAs							
Ames			1					1
ANL	5	1		18	1			25
BNL				8				8
INEL	7	2	3				3	15
ITRI				3				3
K-25 Plant		2					2	4
LBL	11			6	1		1	19
LLNL		38[a]		1	2			41
LANL	4	36	2	4				46
NREL	10							10
ORISE		1					1	2
ORNL	20	7	4	12[b]	3	1	6	53
PNL	6		5[c]	7			1	19
SNL	5	83	2	1	1			92
Y-12 Plant		16	1					17
SSC Lab				1				1
METC					10			10
PETC					16			16
Totals	68	186[d]	18	61	34	1	14	382[e]

[a] Of these, 6 were cofunded by ER.
[b] One of these was cofunded by the office of Intelligence.
[c] One of these is cofunded by ER.
[d] The total of this column is 148, but one CRADA is counted six times, so the total is adjusted to reflect the actual number of agreements. The NCMS CRADA, for $10 million, is counted by Livermore, Los Alamos, Sandia, Oak Ridge, Oak Ridge Y12, and Oak Ridge K25.
[e] This is the total of the row, not the column. An adjustment was made to individual programs' column totals to eliminate double counting, as explained in the previous footnote.

KEY: ANL—Argonne National Laboratory; BNL-Brookhaven National Laboratory; CE—Conservation and Renewable Energy; DP—Defense Programs; EM-Environmental Restoration and Waste Management; ER-Energy Research; FE—Fossil Energy; INEL—Idaho National Engineering Laboratory; ITRI-Inhalation Toxicology Research Institute; K-25 Plant-Oak Ridge K-25 Plant; LBL—Lawrence Berkeley National Laboratory; METC—Morgantown Energy Technology Center; NE-Nuclear Energy; NREL—National Renewable Energy Laboratory; ORISE—Oak Ridge Institute for Science Education; ORNL-Oak Ridge National Laboratory; PETC-Pittsburgh Energy Technology Center; PNL—Pacific Northwest Laboratory; Y-12 Plant—Oak Ridge Y-12 Plant; SSC Lab—Superconducting Supercollider Laboratory.

SOURCE: Department of Energy, unpublished data.

with DOE weapons labs there are several more proposals that did not make the cut--one DOE official estimates that considerably fewer than 1 in 10 proposals are funded. The competition for getting CRADAs approved and funded is now keen.

None of this is to gainsay the fact that there are still many in industry-possibly the majority—who think there is little useful technology to be had from the national labs, and would support closing or shrinking the labs as their traditional missions decline in importance, rather than trying to find other applications for them. Even among the many companies that recognize the value of technological offerings of the labs and take advantage of the opportunity for shared research, there is a growing sense of impatience. The CRADA process, at the DOE GOCO labs in particular, has been marked by frustration and delay --enough that, if problems are not remedied, enthusiasm may begin to wane. So far, DOE and the labs have made enough improvements that there is no noticeable lessening of enthusiasm for CRADAs, though there are still vocal critics of both the usefulness of CRADAs generally, and the difficulties of initiating agreements specifically.

Table 4-2-Distribution of CRADA Federal Funding Among DOE Facilities and Programs

Laboratory	CE	DP	EM	ER	FE	NE	Other	Total
	Funding source							
	Dollar value of CRADA							
Ames			$ 160					$ 160
ANL	$3,900	$ 50		$ 3,267				7,217
BNL				685				685
INEL	2,145	706	733				$ 77	3,661
ITRI				363				363
K-25 Plant		225[a]					2,050	2,275
LBL	4,609			2,575	249	$ 77		7,510
LLNL		62,014[b]		7,429	13,065			82,508
LANL	2,657	45,628[c]	1,045	3,745				53,075
NREL	8,500							8,500
ORISE		20					21	41
ORAL	6,237	14,783[d]	2,270	3,498	90	1,050	624	28,682
PNL	700		843[e]	2,192[f]			140	3,875
SNL	5,148	91,877[g]	828	50	1,700			99,603
Y-12 Plant		11,416	150					11,566
SSC lab				17				17
METC					7,186			7,186
PETC					4,167			4,167
Totals	$33,986	$226,719	$6,029	$23,822	$26,457	$1,127	$2,912	$321,092

a The NCMS CRADA, totaling $10 million, is not included in this total. The NCMS CRADA is shared by Oak Ridge National Laboratory, Oak Ridge K-25, Oak Ridge Y-12, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and Sandia National Laboratory. For the sake of accounting, the CRADA is represented in this table by allocating $2.5 million to each of the four national laboratories, leaving out the K-25 and Y-12 plants.

b See footnote a on the allocation of NCMS CRADA funding.

c See footnote a on the allocation of the NCMS CRADA funding.

d See footnote a.

e This includes one CRADA funded by EM at $230,000, plus half of an $806,000 CRADA funded jointly by ER and EM.

f See footnote e.

9 See footnote a.

KEY: ANL—Argonne National Laboratory; BNL—Brookhaven National Laboratory; CE—Conservation and Renewable Energy; DP—Defense Programs; EM—Environmental Restoration and Waste Management; ER—Energy Research; FE—Fossil Energy; INEL—Idaho National Engineering Laboratory; ITR1-inhalation Toxicology Research Institute; K-25 Plant-Oak Ridge K-25 Plant; LBL—Lawrence Berkeley National Laboratory; M ETG-Morgantown Energy Technology Center; NE-Nuclear Energy; NREL—National Renewable Energy Laboratory; ORISE—Oak Ridge Institute for Science Education; ORNL—Oak Ridge National Laboratory; PETC—Pittsburgh Energy Technology Center; PNL—Pacific Northwest Laboratory; Y-1 2 Plant-Oak Ridge Y-12 Plant; SSC Lab—Superconducting Supercollider Laboratory.

SOURCE: Department of Energy, unpublished data.

The CRADA Process at DOE

Observers and potential R&D partners who have been through the process of trying to sign a CRADA with DOE point to many things that prolong the effort and increase the frustration. Complaints that there are too many people affecting the negotiation[21] (including, at various points in the process, the labs, the DOE field office, various officials from DOE headquarters, and the companies) were common, especially in 1991-92. Some felt that there was no clear line of authority to expedite or approve CRADAs; the terms of the model CRADAs DOE has used were unacceptable; that there was too little DOE money available to fund CRADAs, particularly considering the trouble taken to initiate them.

21 Not all the parties affecting negotiations were formally involved. For example, some company representatives told stories Of proposing a change in CRADA regulations to lab officials, who passed them to field offices and then headquarters, often involving long waits.

Things improved in 1992 and 1993. DOE has heeded many of its critics, and has made several important compromises. Some of these compromises have resulted in a more predictable process for initiating CRADAs, and DOE is still examining ways to smooth the rough spots. There are, however, limits to how far the agency is prepared or permitted to go to meet its critics, and problems remain.

There is no doubt that the relatively heavy involvement of headquarters staff makes the Defense Programs CRADA process lengthier and more irritating than the cooperative research processes at other agencies. Critics compare the DOE process unfavorably with that of NIST and sometimes NASA, both of which have delegated most of the authority for initiating and signing CRADAs to the directors of their labs. The NCTTA provides for greater agency supervision for GOCO laboratories than for GOGO labs (which include all of NIST's labs and all but one of NASA's); but if DOE could simply give its own lab directors the same authority that directors of GOGO labs have, according to critics, the frustration would evaporate. There is some evidence to support this contention: Sandia, which plunged into the CRADA business shortly after the passage of the NCTTA, signed up several potential cooperators in 1990 only to wait through months of negotiation with DOE headquarters.[22] Some lab directors have argued, as have many in the private sector, that DOE could exert appropriate control over the process if the lab directors were given both authority and money for CRADAs, and the agency used evaluations of the labs' performance in subsequent years' budgets. This would require a change in the law; the NCTTA specifically directs DOE to approve both CRADAs and Joint Work Statements before an agreement can be executed.

DOE argues for (and the law provides for) more headquarters control over the process than, for example, at NIST and for most NASA labs. Several things set DOE apart from NIST and NASA, whose cooperative agreement processes are usually compared favorably with DOE's. First and foremost, DOE's labs are contractor operated. Some people believe that the GOCO lab directors and personnel are less likely to keep the public purpose firmly in mind and conflicts of interest out than the government employees running NIST's labs and all but one of NASA's labs. Many in Congress agree that GOCO labs cannot be granted the same trust in allocating funds that GOGO labs can; DOE has had to answer to congressional inquiries about the propriety of actions at its GOCO labs, and is anxious to avoid repeating the experience.

Another factor is visibility. DOE labs, particularly the nuclear weapons labs, are far larger than most other labs in the Federal system, and their missions are among the most controversial of any undertaken by the Federal Government. Anything they do, many feel, is subject to more scrutiny than is devoted to other agencies' labs. Their CRADAs in particular are under a microscope, because the authority and process are new and have been heavily advertised through the NTI. DOE may believe that it is especially important to be above reproach about things like fairness of opportunity, U.S. preference for manufacturing, and the like. As a result, the agency has taken a great deal of time to develop a CRADA process, which is still undergoing changes, and subjects each agreement to more control and scrutiny than agencies whose processes have been operating with less agency oversight for years.

Finally, officials of Defense Programs (DP) in DOE believe that the amount of money allocated to cooperation with industry is far too large to be

22 DOE argues that Sandia cut several deals with industry that disregarded DOE's model CRADA, and that examining and evaluating all the changes took time. DOE did waive some of the conditions Sandia and its potential cooperators objected to, and the agency has been revising the model CRADA in response to similar problems over the past 2 years or so. Many observers-not all of them stakeholders—have speculated that if DOE had pulled industry in earlier to the exercise of developing its model CRADA, many of these problems could have been avoided.

spent without strategic direction. Delegating all authority to lab directors could largely preclude the agency's ability to use the CRADA process as part of strategic, multilab and possibly multiagency initiatives to develop technologies. For example, Warren Chernock, Deputy Science and Technology Advisor for Defense Programs, would like to develop and fund initiatives in semiconductor lithography, flat panel displays, a broad array of automotive and transport technologies, and advanced materials and ceramics that would include numerous lab and cooperative programs throughout DOE. Chernock believes that with this kind of strategic direction, DOE's CRADA funds can accomplish much more than the same amount of money spent on CRADAs without common purposes, avoid duplication, and exploit to best advantage the abilities of all the DP labs.[23]

However, DP, which funds the lion's share of DOE CRADAs, selects among potential projects using a process that takes quite a chunk of time—in the case of the both the June 1992 and November 1992 calls for proposals, about 5 months—to decide which proposals it is prepared to fund, DOE is required by the NCTTA to approve both the joint work statement (which lays out the proposed work of a CRADA) and the CRADA itself (the legal document governing the work), but DP's proposal selection process is not specifically required by NCTTA; other offices in DOE (e.g., Energy Research, Conservation and Renewable, Nuclear Energy) use simpler screening measures.

Partly because of the extra proposal evaluation step required by DP's selection process, it usually takes more than DP's hoped-for 6 months to initiate a CRADA (beginning with the submission of a project proposal, which, in DP's case, is supposed to happen only when there is a call for proposals). Companies have come to know this. Lab ORTA representatives report that potential industry cooperators start off armed with the expectation of a many-month wait-much more so than they had the year before—and they are now aware of certain things that could be done to expedite the process (e.g., partnering with other firms,[24] bringing specific problems to the attention of the highest ranking officials of DOE during NTI meetings). Yet nearly everyone agrees that the process needs further improvement.

Though there are no good statistics on how long it takes to put a CRADA into operation, nearly everyone involved, inside the agency and labs and in the private sector, agrees that the process has been much too slow, especially early on. For example, a model CRADA for computer systems companies (negotiated by the Computer Systems Policy Project, or CSPP) took 9 months to agree on and a year from initiation to signature (see box 4-B). The National Center for Manufacturing Sciences (NCMS) reported that it took nearly 2 years to negotiate an umbrella CRADA for its members to use. While smaller CRADAs with single firms often take considerably less time than CRADAs intended to serve as models, initiating a CRADA with a DOE lab has not been expeditious.

A variety of things can prolong the process. One, already outlined, is the selection process for fundable proposals in Defense Programs, which adds several months up front, before a formal joint work statement or CRADA agreement is

[23] OTA staff interview with Warren Chernock, Deputy Science and Technology Advisor, Defense Programs, DOE, May, 1992.

[24] For several good reasons, DOE has been more inclined to favor proposals from consortia@ from individual firms. First, CRADAs with multiple firms increase the likelihood of technology dissemination. Also, it helps DOE avoid charges that the department is unfairly favoring one firm at the expense of its competitors. This kind of allegation has arisen; officials of Convex Computer, after learning that their competitor Cray Research hoped to initiate a sizable CRADA with Los Alamos, accused the agency of picking favorites. In the end, the controversy was a key factor in DOE's decision not to fund the CRADA, which had reportedly been on a fast track for approval before objections arose. DOE is expected to restructure the CRADA to allow for greater competition among supercomputer manufacturers. See, for example, 'Convex Voices Great Displeasure Over Cray's CRADA With Los Alamos,' New Technology Week, Nov. 30, 1992; and "KAPUT: Cray's CRADA With Los Alamos, DOE, " *High Performance Computing and Communications Week,* Mar. 18, 1993, pp. 1-2.

Box 4-B–The Computer Systems Policy Project CRADA[1]

The Computer Systems Policy Project (CSPP) was organized in 1989. The 11 computer companies[2] that form the group aim to inform policymakers of the critical concerns of the computer systems industry, and to provide information to help illuminate public policy.[3]

One of the policy areas of greatest interest is technology policy. CSPP identified increasing interaction between industry and the federal laboratories as one of its goals.[4] The CEOs of the companies met with the director of the Office of Management and Budget (OMB), Richard Darman, in December of 1990 to discuss their interest in increasing the relevance of Federal R&D to the computer industry, particularly in focusing federal laboratory spending to better serve computer competitiveness needs. Darman reportedly was not interested in overhauling the entire federal laboratory system, but suggested that the CEOs look at the DOE labs. DEC assigned an engineer, Jack DeMember, to look into possibilities of CSPP-DOE lab cooperative work. DeMember did an internal survey of what technologies t he member companies were most interested in, and what laboratories they viewed as the most likely candidates for interaction. DeMember and other technical experts from CSPP companies talked extensively with people at labs, and in the Department of Commerce, OMB, and the private sector to assess the potential contributions of the DOE labs, and in spring of 1991 recommended that CSPP pursue a model CRADA, which any company could use as a starting point in CRADA negotiations with DOE.

The model CRADA approach was adopted because CSPP interviews had indicated that it was too time-consuming and difficult to pursue CRADAs on a one-on-one, Iab/company basis; CSPP hoped that by agreeing to a model CRADA, the companies would be able to initiate cooperative R&D with labs[5] as needed. The CEOs approved the plan to negotiate a model in June 1991, and set December 1991 as a target date for having a CRADA. CSPP appointed a team of CRADA negotiators, headed by Piper Cole of Sun Microsystems.

Negotiations quickly bogged down. DOE already had a draft model CRADA, which the CSPP negotiators found instantly unacceptable, The firms were concerned most about the DOE model's[6] treatment of intellectual property (including confidentiality and software protection), requirements that products resulting from CRADA technology be manufactured in the United States (the so-called U.S. preference stipulation), and the requirement that participating firms indemnify DOE and the labs for any damage from products made using technology developed in a CRADA. Departures from DOE's model, however, proved extremely difficult to negotiate; after a couple of months, representatives of the labs were brought in to try to help. In October, three of the CEOs came to Washington to meet with Admiral Watkins, the Secretary of Energy, asking for some way to reduce the difficulties

1 The sources of information for this box are OTA staff interviews with Fiona Branton, associate lawyer, Preston Gates Ellis, May 21, 1992; Jack DeMember, Federal Laboratory Liason, Digital Equipment Corporation, May 29; and Warren Chernock, Deputy Science and Technology Advisor, Defense Programs, DOE, June 5,1992.

2 The 11 companies are Apple, Compaq, Control Data, Cray Research, DEC, Hewlett-Packard, IBM, NCR, Sun Microsystems, Tandem, and Unisys.

3 Computer Systems Policy Project, "Perspectives: Success Factors in Critical Technologies," July 1990, p. 1,

4 The other two goals included improving industry input to the federal R&D budget revfew, and implementing the High Performance Computing and Communications Initiative, or HPCC. Source: CSPP, "Perspectives on U.S. Technology Policy, Part II: Increasing Industry Involvement," February 26, 1991, p. 1.

5 CSPP was interested in working with five laboratories: the three weapons labs, Oak Ridge, and Argonne.

6 Some of their concern was not with the provisions in the model, but with things that were missing.

and pick up the pace of negotiation. That worked, to some extent; Watkins responded positively, and there were many meetings in November. But the negotiations still dragged on until March, when CSPP and DOE finally initialed a letter of agreement on a model CRADA. Even then, some issues remained to be settled in individual CRADAs. For example, while some of the issues regarding allocation of software copyrights were resolved in the CSPP model CRADA, some were shunted into an appendix (appendix C), for which it was not then possible to develop a model.

The CSPP effort finally paid off, but only because of a number of favorable circumstances; without them, it would likely have taken longer or broken down entirely. CSPP members had access to Secretary Watkins, and convinced him that the CRADA was in everyone's interest. When progress slowed, Watkins directed DOE's negotiators to work hard to accelerate the process. Watkins appointed a lead negotiator for DOE who was effective in making sure that all of the key players within DOE were included in the negotiations, rather than having long delays while each iteration passed through numerous reviews off-line. CSPP also put in long hours, and spent considerable effort presenting evidence regarding the nature and needs of the computer industry. DOE showed some flexibility; when some thorny issues threatened to tear the negotiations apart, DOE finally left the labs and CSPP to work out whatever reasonable solution they could agree on.

One week after the model was initialed, Cray Research signed three individual CRADAs with Los Alamos[7] using its terms. CSPP officials did not regard these CRADAs as a true test of the speed with which individual agreements could be signed using the model, for these three had been in the pipeline for months, concurrently with the model CRADA negotiations.

Painful as it was, the CSPP CRADA accomplished several things. Together with another CRADA negotiated at the same time (an umbrella CRADA[8] of t he National Center for Manufacturing Sciences), the negotiation gave many companies the opportunist y to initiate work with t he labs. The CSPP CRADA can be used by any computer company, not just members, as long as they focus on one of the technologies covered by the agreement. The technologies include displays, software engineering, electronics packaging, microelectronics, optoelectronics, graphics, manufacturing technology, and integrated circuit fabrication equipment.

The CSPP CRADA also contributed to DOE's ongoing effort to improve its standard model CRADA offered to all potential cooperators. After the negotiation, some in DOE maintained that its model, which it hoped to use for everyone in subsequent calls, would not compromise to the extent that the CSPP model did, but the ice was broken; an official from one of the weapons labs said that several companies had asked for provisions similar to the ones in the CSPP CRADA (for example, an exemption from products liability for damage caused by lab negligence), and were likely to get them.

Finally, the CSPP negotiations, like those of NCMS, General Motors and the automobile industry, and others, uncovered boulders in the stream, and got many people in DOE, labs, and industry thinking about how to manage the process of collaborative government laboratory/industry R&D better. While many of the problems have not been solved, and the process still needs considerable improvement, the efforts devoted to dreaming up better ways of managing CRADAs have spawned several ideas that go far beyond simply making the process of initiating a CRADA easier and faster. For example, some people advocate that lab directors have authority to allocate some CRADA funds according to their own discretion, with the extensive reviews and priority-setting processes of DOE being reserved for larger CRADAs or agreements that are part of broader, multiagency technology initiatives.

7 The agreements involved global climate modeling, Computational electromagnetics, and modeling Of molecules.

8 An umbrella CRADA, unlike a model, has force and indudes commltted funds to be spent on subsequent approval of individual project task statements. A model oniy serves as a template for actual CRADAs. DOE did, however, commit itself to fund CRADAs using the CSPP model.

considered. Two others are overall funding for CRADAs, and the terms of CRADA agreements.

The Funding Bottleneck

Even if the process for selecting fundable proposals were shorter, finding money for CRADAs is sometimes difficult. This is so even though Defense Programs, which has funded the majority of all DOE CRADAs, has set aside more money for CRADAs this year than ever before ($141 million), and has asked for authority to allocate an additional $47 million.

The agency can fund CRADAs either through ordinary program funds or through a designated CRADA fund. NIST and NIH routinely use program money; DOE occasionally uses program funds, but most often, DOE CRADAs are funded with money set aside within the agency for the purpose. DP's set-aside dwarfs others within DOE.

In 1991, Congress appropriated a line item of $20 million for Technology Transfer, to get the CRADA process started. It worked; in the succeeding 2 years, DP set aside $50 million and $141 million. DP's $141 million is widely regarded as the major pot of CRADA money available in DOE, and according to one source, other assistant secretaries (for example, in energy programs) are envious of it. However, by some standards, this allocation is inadequate.

NTI contributed to the burgeoning of outside interest in R&D partnerships, and now DP routinely gets far too many proposals to fund from its setaside. In response to the avalanche of proposals, DP asked Congress for authority to reprogram $50 million for CRADAs in FY 1992, (it already had set aside $50 million in fiscal year 1992), but the request was turned down by the House Committee on Armed Services.[25] As a result, there was very little money to fund any proposals that came in response to the June call, and proposals that were approved for funding had to wait until FY 1993.

Now that DP has $141 million for CRADAs for FY 1993, DOE is able to fund proposals submitted last summer, and CRADA negotiations are underway for many of these projects. According to Dan Arvizu of Sandia, this has broken the logjam that began when DP's request for authority to reprogram $50 million was turned down in late FY 1992.

The impetus provided by FY 1993 money was short-lived. About half the money ($71 million[26]) in DP's CRADA pot this year is already ' 'mortgaged,' or committed to multiyear projects begun in FY 1991 or 1992. Of the remainder, a small amount was taken off the top for SBIR (Small Business Innovative Research) projects, and one lab official[27] estimated that funding the CRADAs approved in early November (from the June call for proposals) will take around $40 million. This leaves only $25 to $30 million for new CRADAs not already in the pipeline. DP issued another call for proposals in November of 1992, and there will be less to fund CRADAs in that round than there was in the two previous rounds, even making no precision for further calls in FY 1993. According to one report, DP hopes to be able to reprogram an additional $47 million for CRADAs in FY 1993, but it is unknown at this writing whether it can. DP is hoping to be able to allocate $191 million to technology transfer in FY 1994, and $250 million in FY 1995.

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25 Technically, DOE did not need authority to reprogram the funds as long as the spending didn't Span different appropriation line items. DP's request was turned down initially because the request to reprogram money from DP to DOE's NTI activities would have switched money from one line item to another. However, even after reformulating the request to reprogram money to CRADAs only within DP, the request was turned down. The $50 million did not disappear forever, however. DP had initially requested $91 million for CRADAs for FY 1993, which it got, along with an additional $50 million.

26 $71 million is the sum of the three preceding fiscal years' appropriations for DP CRADAs—$1.1 million in FY 1990, $20 million in FY 1991, and $50 million in FY 1992.

27 Julia Giller, Off Ice of Research and Technology Applications, Livermore.

Looking outside DP for CRADA money may bean even drier well. Certainly up to now, DP has provided the lion's share of all CRADA money available at DOE; as of April 1993, over seventy percent of committed and planned funding for DOE CRADAs came from DP.

Another option is to use program funds, without having to tap a special pot of money for CRADAs.[28] This can be done now, but the constraints in DP are tight. DP and the labs, at the beginning of each year, establish how they will spend their program finds, and allocate lab budgets to individual projects. After the planning process, there is little room for adjusting the focus or scope of project work to accommodate the interests of a potential CRADA partner, so any CRADAs funded with program money must entail essentially no change in work on the part of the lab project teams.

Several anecdotes illustrate how discouraging inadequate finding can be,[29] Dp initially agreed to put aside $1 million in FY 1991 and $5 million in FY 1992 to fund individual projects that used the model CRADA for the computer industry negotiated by the Computer Systems Policy Project (CSPP). According to one official of a CSPP member company, his company had identified $30 to $40 million in work at Los Alamos alone.

General Motors provides another illustration. In January 1992, GM hosted a meeting in Warren, Michigan. The meeting was attended by hundreds of company engineers and scientists and technical representatives from eight of DOE's nine multiprogram labs, NASA's Ames lab, the Air Force's Wright Patterson facility, and NIST. The meeting was the culmination of months of spadework on the part of a few people at GM and the labs who realized that there were enormous possibilities for collaboration that people in both organizations were mostly unaware of. The meeting was a big success; as one participant put it, lab people realized that GM presented interesting technical challenges, and GM people learned that labs had much to offer them in collaborative arrangements. Moreover, the meeting at GM had high-level management support both in the company and among the labs, which helped a great deal. Finally, GM identified very specific needs and problems up front, and provided money and support people to facilitate collaborations.

Following the meeting, GM identified over 200 interesting cooperative projects. Realizing that it would be futile to submit so many proposals, GM whittled the projects down to about 25, which it submitted in the June, 1992 call for proposals. About half proposed to use DP facilities, and the other half various energy programs. None of GM's CRADAs had been signed by the end of calendar year 1992. By April 1993, 9 GM CRADAs had been executed.

DP Selection of Proposals

The process of initiating a CRADA is months long even under ideal circumstances, considering all the steps. The courtship phase—when industry and lab people get together, discuss their work, and develop ideas for joint R&D-often takes half a year or more. Once the idea passes muster in both the lab and the company (ies), the researchers prepare a proposal describing the proposed work, and submit it to DOE. If the proposal involves work done in Defense programs (as most do), the proposal must then go through the DP selection process, initiated in 1992.

The selection process precedes the negotiation of the actual work statement (called a joint work statement, or JWS) and the CRADA itself. DOE has delegated to its field offices the authority to approve JWSs and CRADAs, but the field offices

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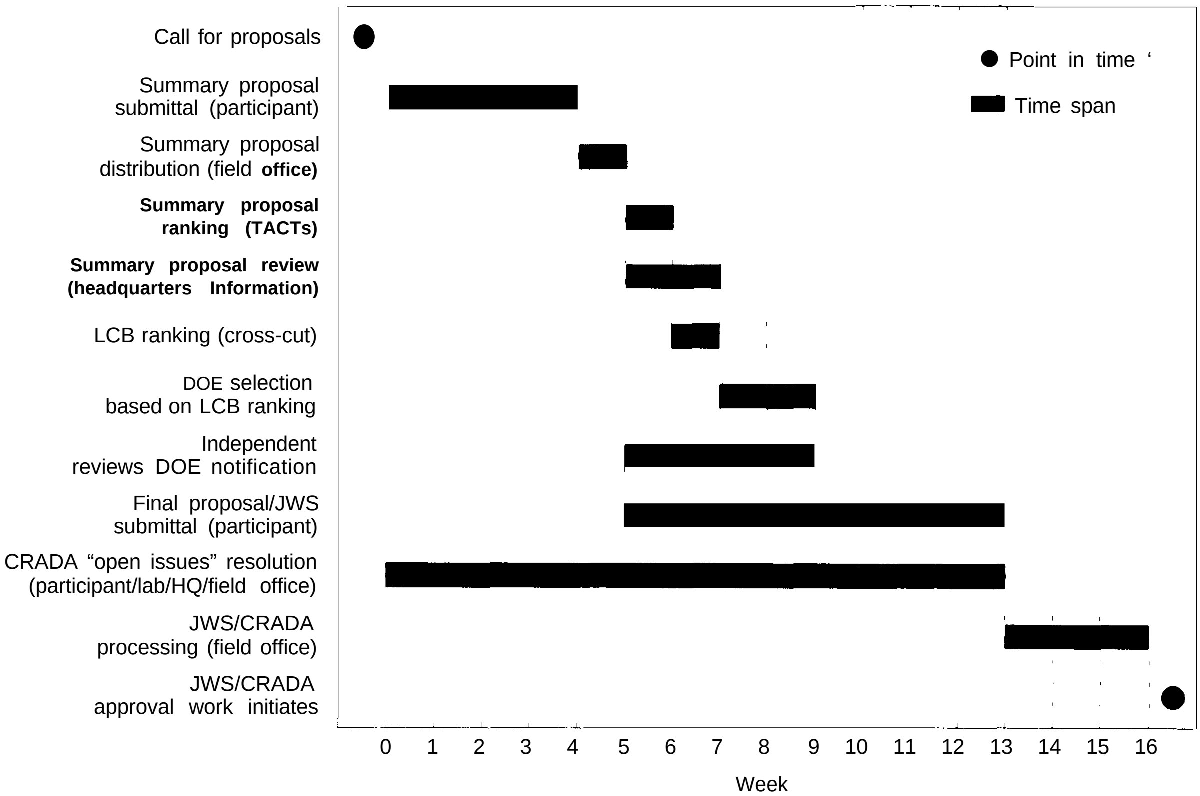
28 One bill currently before the Senate, the Department of Energy National Competitiveness Technology Partnership Act Of 1993, would make all program funds in DOE available to fund CRADAs.

29 The term ''inadequate'' is being used t. describe how many in industry and DOE feel about CRADA money so far. OTA has not weighed CRADA funding against other uses of public money.

Figure 4-1—The Call for Proposals Process of DOE Defense Programs

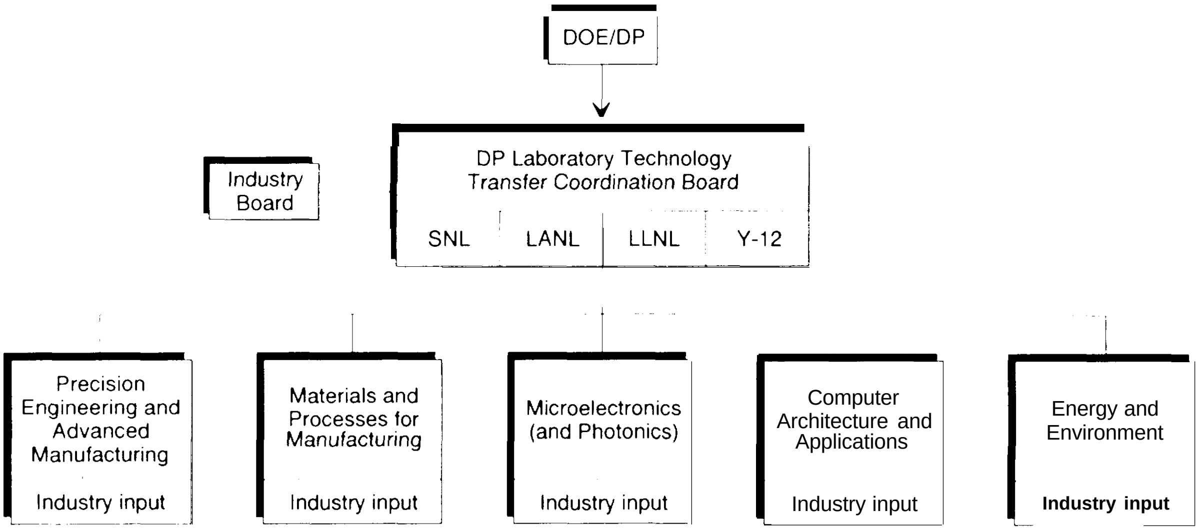


SOURCE: U.S. Department of Energy, Defense Programs, 1993.

cannot begin the approval process until DP has decided which proposals to fund. The process consists of several steps (figures 4-1 and 4-2). DP's call for proposals is the first step. The proposals are then reviewed by teams of technical experts, one from each weapons lab and one from the Y-12 Plant at Oak Ridge National lab. There are five such teams, called Technology Area Coordinating Teams (TACTs): 1) precision engineering and advanced manufacturing, 2) materials and processes for manufacturing, 3) microelectronics (and photonics), 4) computer architecture and applications, and 5) energy and environment. After the TACTs finish their reviews, the results are submitted to another review group, called the DP Laboratory Technology Transfer Coordination Board (LCB,). LCB consists of the directors of the ORTAs of each of the three weapons labs and the Oak Ridge Y-12 Plant. Using the TACTs' ranking as part of its own review, LCB then makes its own ranking, and forwards a list of ranked proposals to DP.[30] DP makes whatever adjustments deemed necessary, and announces which work. statements have been

30 Originally, the LCB was meant to have an industry advisory board to review the proposals. So far, the board has not been formed, and outside private sector review is lacking in the process. This has not proved a handicap, although both DOE and Congress have continued to express interest in forming an industry advisory board to review CRADAs.

Figure 4-2—The CRADA Proposal Review Process of DOE Defense Programs



SOURCE: U.S. Department of Energy, Defense Programs, 1993.

chosen. At that point, the lab and the company can prepare a JWS and negotiate a CRADA.[31]

DP's initial goal was for the proposal review process described above to take 13 weeks, and the approval of CRADAs following DP's selection to take another 3 weeks, for a total of 4 months from submission of a proposal to approval of a CRADA. Knowing that was optimistic, DP aimed initially for a 6-month turnaround, and hoped, as everyone gained experience with the process, to whittle it to 4.[32] Currently, some CRADAs may be meeting the 6-month target, but probably most are not. Nevertheless, the process of negotiating the agreements, which can begin only after DP has selected among the proposals, has become more predictable. For the June 1992 call for proposals, the LCB made its rankings by the end of August. DP made final selections at the beginning of November.[33] All the agreements approved from the June call have not been approved, but many have. From the time approvals are granted by DP until the final CRADA is signed usually takes, according to ORTA officials from Sandia and Livermore, 4 to 5 months.[34]

Things are moving no faster for proposals approved in the latest (November 1992) call, but under circumstances that are unlikely to be repeated. In early 1992, DOE planned to change

31 This negotiation process often consumes more than 4 months. The field offices, which have authority to approve both JWSs and CRADAs, have 90 days to approve the JWS and 30 to approve the CRADAs. There has been some friction between field offices and labs over whether the clock ticks continuously following the submission of the JWS to the field office (questions or problems with the proposed agreement might stop the clock); if it does not, as the field offices have maintained, then the process can take even longer than the maximum of 120 days. In practice, many JWSS and CRADAs are submitted to field offices simultaneously.

32 OTA staff interview with Warren P. Chernock, Deputy Science and Technology Advisor (Defense), May 4, 1992.

33 DP officials point out that not all the time it took to act on the LCB recommendations constituted delay. DP had already spent all the money it had set aside for CRADAs in FY 1992 by the time the proposals from the June call came in; DP had been turned down in its request to reprogram an additional $50 million in FY 1992 funds for technology transfer. There was no possibility of funding any of the proposals that came in June 1992 until the new fiscal year, or, more properly, until DOE's FY 1993 appropriation was signed.

34 Part of that time is taken by lab/industry negotiations, in which DOE offices do not participate. Also, not all the delay can be attributed to bureaucratic procedures at the labs or the field offices; company (or other cooperator) legal counsel can and do take time to review the provisions of the proposed agreement, and have proposed changes.

the review process at headquarters for DP proposals, to include staff in other divisions of the agency. Lab officials had expressed nervousness in 1992 about the distribution of proposals in DOE headquarters, because proposals often contain sensitive or proprietary information. DOE, unlike NIST, does not have an exemption from the Freedom of Information Act (FOIA) covering R&D proposals, and some in companies and labs feared that competitions could access information in the proposals through DOE (the labs do have an exemption from FOIA). With the expanded headquarters review in early 1993, the concerns deepened, and lab officials initially balked at sending proposals to DOE. The matter was eventually worked out, but only after a delay of a month or so. This problem is unlikely to come up again soon, mostly because DP plans no more calls for proposals in fiscal year 1993, even if it gets an additional $47 million for CRADAs.

Partly because of the time it has taken to get the DP selection process up and running, and partly because of funding bottlenecks, DOE officials have come close to admitting that their latest proposal call, combined with the publicity garnered from NTI, has been a bigger success than they can handle. In its June call for proposals, DP received 105 proposals from the LCB. It approved only 61 of them, not because the others weren't interesting but in order to set aside some money for other projects (such as automobile technology, lithography, and computer projects using the CSPP CRADA). Dan Arvizu, the head of the ORTA at Sandia, reports that the NTI campaign, begun in February 1992, has resulted in DOE receiving 460 proposals (120 from Sandia alone). The November 1992 call also received an overwhelming response; one lab reported receiving hundreds of proposals. The TACT's and LCB reduced the number considerably, but even so, DP was able to fund only one-eighth the dollar value of proposals forwarded to it by LCB (less than 30 proposals), for a total of $25 million. Unless DP is able to reprogram more money for CRADAs in fiscal year 1993 (in April, its request for authority to reprogram $47 million was pending), there will probably be no new proposals approved until fiscal year 1994, except those using program funds. Even with $250 million, which Warren Chernock thinks is the right amount of money to allocate to CRADAs for the foreseeable future, it is clear that there is far more work to do than money to do it with.

The Legal Terms of CRADAs: Intellectual Property Issues

There are inevitably conflicts between public and private interests in the terms of cooperative agreements. Even agencies that have been working cooperatively with private companies for years, such as NASA, still have occasional problems. For example, one NASA official said that it usually takes longer to negotiate the disposition of intellectual property rights than any other single item in a Space Act Agreement. A NIST official made the same observation about industry/government R&D projects under NIST's Advanced Technology Program, adding that the more companies involved in a single agreement, the longer the negotiation over intellectual property rights.

Protection of intellectual property can also be a source of disagreement. Firms sometimes bring some confidential technical, commercial, or financial information, developed wholly within the company, to a cooperative project with a government lab. This information is exempt from disclosure under the Freedom of Information Act, and by law is not disclosed to third parties. However, such information can, in some cases, be used in other government offices. This multiplies the chances for accidental leaks to competitors, especially considering the wide participation of government agencies in the NTI. NIST and NIH model CRADAs provide that such information will be used only within the CRADA, and for no other purpose. DOE's standard model,[35] and the NCMS and CSPP model CRADAs, provides that such proprietary information may be used by other government employees, who are in turn constrained in their ability to transfer the information. The CSPP model tries to minimize disclosures by requiring that they all take place at the lab site, and that DOE employees do not remove from the lab any notes or other items containing the fro's confidential information. These safeguards have partly assuaged industry's concerns about dissemination of proprietary information that companies bring to cooperative relationships, but some in the private sector are still wary.[36]

Judging by the amount of effort devoted to negotiations, the disposition of information developed in a cooperative arrangement may be an even greater concern than the disclosure of proprietary information that industry brings to the relationship. NCTTA permits agencies to preserve the confidentiality of information developed in a CRADA for up to 5 years, and the standard DOE model CRADA provides for up to 5 years of confidentiality. However, a firm can only designate as confidential information generated by its own employees; to so designate information developed by lab employees, the lab's permission is required. DOE *may use* information designated as confidential at other DOE sites, with confidentiality strictly preserved.[37] The CSPP model requires that the lab's permission to designate information generated by lab employees as confidential ''shall not be unreasonably withheld,'' but does not define what is reasonable. It also provides than an appendix will list subject areas in which all information generated will automatically be designated as confidential. The NCMS CRADA includes the same reasonableness requirement, sets the term of confidentiality at 30 months unless agreed to otherwise, and provides for disclosure to NCMS members on the same basis as to other DOE sites. DOE's models do not specify the treatment of information developed jointly; this is a matter to be settled in negotiations of the lab and the company. Negotiating these issues adds to the time and trouble of getting a CRADA approved.[38]

The division of patent rights for inventions that come from CRADAs is not constrained by the NCTTA, except that the U.S. Government must always retain a license "to practice the invention or have the invention practiced throughout the

35 The discussion below refers to several model CRADAs. DOE's standard model CRADA is found in a document titled 'Stevenson-Wydler (15 USC 3710) Cooperative Research and Development Agreement (hereinafter ''CRADA'')'' dated October 23, 1992. Accompanying this model is a document entitled ''Stevenson-Wydler Model GOCO CRADA Guidelines, ' which explains policies behind the model and discusses the extent to which certain changes will be permitted. (Both the standard model and the guidelines were distributed attached to an October 27, 1992 memorandum from ST-1, re: Issuance of Redline Model CRADA and Guidelines for GOCO Laboratories.) The DOE-CSPP model CRADA is found in a document with a similar title to that of the standard model, dated April 1, 1992, which accompanies a ''Letter of Agreement' between DOE and CSPP, executed on March 19 (DOE) and 20 (CSPP), 1992. The DOE-NCMS umbrella CRADA is found in a document entitled ''Stevenson-Wydler (1 5 USC 3710) Cooperative Research and development Agreement (hereinafter ' 'CRADA' No. DOE92-0077. The NIST model is found in a document entitled 'Cooperative Research and Development Agreement with the National Institute of Standards and Technology, ' version dated Oct. 15, 1991, which accompanies a memorandum of Oct. 2, 1991, from Bruce E. Matson, Chief, Technology Development and Small Business Programs, ''re: A Guide to the new NIST CRDA for NIST Staff. '' The NIH model is found in a document entitled "National Institutes of Health; Alcohol, Drug Abuse and Mental Health Administration: Cooperative Research and Development Agreement," dated April 24, 1989, at pages 143-159 of Office of Technology Transfer, National Institutes of Health, Bethesda, Maryland, 1991 *PHS Technology Transfer Directory;* policy guidelines are found at pages 137-142.

36 Some of this wariness has to do with the inherent conservatism of legal counsels, both in firms and in DOE. Legal departments have much to lose if they counsel corporate managers to take risks. If a major leak occurs, the potential damage is much greater, both to the firm and to the legal counselors' credibility, than the risk associated with not doing a partnership in the first place, where the losses are only in terms of what might have been.

37 Both NIH and NIST models specify that any information generated in the CRADA may be used for any government purpose (not limited to a particular agency).

38 The NIH model allows confidential status only for information developed solely by firm employees.

world by or on behalf of the Government," royalty-free.[39] Many arrangements are possible within the law. For example, a lab could own a patent and grant an exclusive license to the firm, which could then practice it free of commercial competition, except that it might face competition when the government is the customer. While many cooperators are interested in exclusive rights to inventions developed in CRADAs as a condition of entry, this kind of exclusivity can create problems for the labs and their parent agencies. Often, it is in the interest of the government to see inventions diffused widely, both on general principles of stepping up the rate of innovation and best practice for societal good, and especially to avoid potential accusations of unfairness of access. However, sometimes the promise of exclusive rights might be necessary to encourage a firm to invest in technology development and commercialization.

Another twist in the plot is the fear, expressed by one official of Livermore, that by agreeing to the industry taking title to the lion's share of intellectual property developed, the lab might sacrifice strength in later bargaining over U.S. preference. For example, if a lab is involved in trying to convince an industry partner to maintain substantial domestic manufacturing of products that developed from technologies produced in CRADAs, it could help to have the ability to deny the company an exclusive license if it decided to manufacture offshore.

DOE's standard model leaves allocation of patent rights to be worked out by the lab and the firm, subject to the government retaining at least a royalty-free nonexclusive license. However, accompanying guidelines imply that DOE's approval could be required for certain allocations. The NCMS CRADA spells out the rights in more detail. Each party takes title to inventions made solely by its employees; for joint inventions, the lab takes title. However, special rules apply for commercial applications in a field covered by the project's task statement. NCMS will have exclusive rights to license such applications for 30 months following the project's completion. After that, NCMS and the lab each have a nonexclusive right[40] to license commercial applications. Royalties on all licenses by either party for any application are shared according to a complex formula.

Like DOE's NCMS CRADA, the NIH and NIST model CRADAs spell out patent right in more detail than DOE's standard CRADA. With NIH, each party takes title to inventions developed solely by its employees; jointly developed inventions are jointly owned. For inventions owned jointly or by NIH, in some cases NIH will grant an exclusive license for specified fields of use. The model CRADA commits NIH to ' 'negotiate, in good faith, the terms of an exclusive or nonexclusive commercialization license that fairly reflect the relative contributions of the Parties to the invention and the CRADA, the risks incurred by the Collaborator and the costs of subsequent research and development needed to bring the invention to the marketplace. NIH is also willing at times to grant exclusive licenses in advance as a condition of signing the CRADA.[41] NIST's approach is more restrictive. Jointly developed inventions are owned by NIST alone; and NIST's model CRADA commits NIST to good faith negotiations on nonexclusive commercialization licenses.

Another intellectual property issue that has proven to be a sticking point in past DOE CRADA negotiations is software protection. Software can be protected by secrecy and/or copyright. Software written wholly or partly by government employees (which does *not* include employees of GOCO labs) cannot receive a U.S.

39 15 U.S.C. 3710a(b)(2).

40 Licenses by NCMS are subject to lab approval, which "shall not be unreasonably withheld if [the license] is royalty bearing."

41 NIH Policy Guidelines, Art. 9.

copyright, though it can be copyrighted in other nations.

DOE's standard model CRADA leaves the allocation of copyrights up to the lab and the firm, except for the provision that the U.S. Government must have a nonexclusive license free of charge for government use. For copyrighted software developed under a CRADA, the source code and documentation must be provided to DOE's Energy Science and Technology Software Center, where it will be publicly available. The copyright is also subject to DOE's march-in rights,[42] although the beginning of those rights can be set as late as 5 years after the software is produced.

The CSPP model CRADA, while retaining the basic approach of DOE's standard model, makes an important exception. Special rules[43] apply to software, listed in an Appendix E, which the lab and the firm agree is "being developed principally for commercialization" by the firm. The firm owns the copyright in appendix E of the model, software that it develops on its own. For appendix E software developed either jointly or solely by the lab, the lab may own the copyright but must offer the firm an exclusive or nonexclusive license at the firm's choosing, on reasonable terms. For all appendix E software, only *object* code and documentation are provided to DOE's Energy Science and Technology Software Center, and only for use on DOE contracts; the source code is kept secret.[44] For appendix E software, DOE has march-in rights only for software created solely by the lab. Also, if DOE ever exercises march-in rights (for any software, not just that covered in appendix E), DOE must leave the firm with at least a nonexclusive license.

March-in rights, more generally, are another instance of the divergence of public and private interests. Typically, the government's interest in publicly-funded R&D is for broad application; hence, DOE wants march-in rights in its CRADAs. However, inclusion of march-in rights can be a problem for firms; some worry that their own best efforts to commercialize technology might not be regarded as sufficient by the government, and that a long-term commercialization plan might be cut short if the government thinks the plan is taking too long. A firm might also not be willing to commit itself to justifying its progress to government officials over the years. The law requires march-in rights for patents,[45] and DOE's standard model, as well as the NCMS and CSPP model CRADAs, all provide for such rights according to standard DOE procedures.

The Legal Terms of CRADAs: U.S. Preference Issues

One of the aims of both the NTI and NCTTA is to improve U.S. competitiveness. Accordingly, there is a strong bias in public institutions (Congress included) to try to ensure that publicly-financed innovations are exploited in ways that benefit the U.S. economy directly. In the case of the FTTA, that means that labs are directed to "give preference to business units located in the United States which agree that products embodying inventions made under the [CRADA] or produced through the use of such inventions will

42 "March-in rights" refers t. a situation in which a firm has exclusive rights to technology developed with government funding, but is taking too long to commercialize the technology and make it widely available. In some cases, the government has the right to "march in" and take back the exclusive rights, and to license other firms to commercialize the technology. In the case of patents, march-in rights are required by law (35 U.S.C. 203), though the specific procedures are set by agency regulations.

43 The provisions giving these special rules (Article XIII, paragraphs E and F, of DOE's CSPP model CRADA) are difficult to understand; OTA'S tentative interpretation is given below.

44 Object code is far less useful t. potential competitors than source code. If DOE took possession of source code, company representatives maintain, then few companies would even be interested in co-developing software with the labs. While GOCO labs are likely not subject to the Freedom of Information Act, DOE is; after the period of FOIA exemption for information generated in a CRADA (at most 5 years), competitors could get the source code, and could use it to create their own commercial software.

45 35 U.S.C. § 203.

be manufactured substantially in the United States."[46] DOE's standard model, up until early 1993, took its cue from the statute, but made U.S. manufacturing a requirement rather than a preference. The model required that any ''products, processes, or services for use or sale in the United States" covered by a U.S. patent awarded for an invention arising under the CRADA's performance be "manufactured, practiced or provided substantially in the United States. '

Many of the firms most interested in CRADAs, like all the members of CSPP and many of the members of NCMS, are multinationals. They produce goods and services throughout the world, and, perhaps even more important, hold a growing portfolio of cross-licensing arrangements with foreign multinationals. For such fins, requiring domestic production of all goods and services using technologies developed in CRADAs is a significant discouragement to participation. As in several other cases, DOE, after encountering friction on this point in CRADA negotiations, made a compromise in early 1993. Now, the agency has declared itself willing to grant exceptions to the U.S. manufacturing stipulation on a case-by-case basis where substantial U.S. manufacture is demonstrably infeasible. In addition, the CRADA partners must commit themselves to provide appropriate alternative benefits to the American economy .47 This new flexibility is welcome, but unless additional guidelines can be established, allowing companies to anticipate how the department will decide in individual cases, this requirement may not shorten the negotiation of a CRADA.

Both the NCMS and CSPP CRADAs depart from the original, stricter requirements, and these departures, along with other feedback from industry, helped to establish the basis for DOE's compromise. The NCMS CRADA narrows the requirement to cover only products, not processes or services.[48] CSPP rewrites the requirement entirely to cover R&D, but not manufacturing. In the negotiations, CSPP argued that existing networks of manufacturing, R&D, and cross-licensing among computer companies of all nationalities made the domestic preference requirements impossible; if no compromise could be reached, argued CSPP, the CRADA would be useless. Moreover, CSPP maintained, in the computer industry the greatest benefit to the U.S. economy comes from domestic R&D, not from manufacturing. Accordingly, the CSPP model specifies that "all research and development under this CRADA shall be conducted in U. S.-based facilities, " and ''for a period of 2 years following the CRADA subsequent research and development. . . for the purpose of commercializing technologies arising from this CRADA, which are the primary focus of this CRADA, shall be performed substantially in U.S.-based facilities.

The U.S. preference issue may be a sleeper, even under DOE's new, more flexible requirements. It has been a major sticking point in several negotiations, but has not been a prominent part of the public debate over lab/industry R&D partnerships. However, some lab officials worry that DOE has been too willing to compromise, and that, by giving as much ground as the agency did in the CSPP CRADA, the labs lose some of their ability to enforce reasonable requirements for domestic manufacturing (such as requiring that products for the domestic market be substan-

46 15 U.S.C. 3710a(c)(4)(B). The same provision also directs that if a potential CRADA partner is a foreign-owned organization or a foreign citizen, the lab 'take into consideration whether or not such foreign government permits United States agencies, organizations, or other persons to enter into cooperative research and development agreements and licensing agreements.'

47 Memorandum from U.S. Department of Energy to Program Secretarial Officers and Field Office Managers, ' 'Restatement of Departmental Technology Transfer Policy on U.S. Competitiveness, ' Feb. 10, 1993.

48 By late 1992, NCMS was, according to one of its spokesmen, asking the Agency fOr additional loosening of the domestic manufacturing provisions of its CRADA. In initiating individual agreements, member companies found that they were uncomfortable with the provisions of its original CRADA requiring domestic manufacturing of products.

tially manufactured in the United States). The issue is likely come up again, especially in the event that a CRADA yields a technology that is commercially successful. Many American multinationals are bound by the terms of existing cross-licensing arrangements to license their patents to other companies, often foreign multinationals. Should a company grant a license to a technology developed partly with public money, it is likely, at the very least, to stir up a debate. There have already been analogous controversies. For example, some of the technology for GE's new aircraft engine, the GE-90, was developed through cooperative research and development with NASA. GE licensed the French aircraft engine company SNECMA to manufacture some high-pressure compressors for the GE-90. Any time foreign companies acquire American technology in a high-tech field, there are some who would take the view that this represents a failure of either public or private policies, but when the technology is at least partly publicly financed, the tendency to condemn is even stronger. This view, understandable though it is, is simplistic.

No nation, and no company, has ever been able to sequester technology for its own use. Even 200 years ago, when trade was minuscule and information flow glacial compared with today, knowledge of technology leaked abroad, often in the face of stiff personal penalties for transferring it. Now, with far more rapid communication and burgeoning trade and investment around the world, technology diffusion is wide, rapid, and to a great extent uncontrollable by governments. That is well understood; what is less well known is that, increasingly, American firms' ability to put access to technology on the bargaining table with foreign firms and foreign governments can give those U.S. companies powerful advantages, and that such advantages can work to the benefit of the U.S. economy and living standards just as domestic application of technology does. GE's ability to sell its engines to European airlines may well depend on its adding some value in Europe, which may, in turn, hinge on its licensing the technology to a European company. IBM's control of key patents gave it better access than other foreign companies had to the tightly regulated Japanese market in the 1960s; without the ability to negotiate with the Japanese Government on access to its patents, IBM would have faced even tougher restrictions than it did,[49] and it probably would not now be the force it is in Japan, the world's second largest economy.

DOE, NASA, and possibly other government agencies in the NTI are caught in a potentially fractious situation. Practicality dictates that their CRADA process will be less useful to industry if they insist on strong domestic preference in manufacturing and R&D. Yet Congress tends to favor even tighter restrictions on foreign transfers of technology financed partly by the taxpayers. So far, the issue is mostly confined to CRADA negotiations, but the more successful the NTI or other kinds of government-industry technology development partnerships are, the greater the likelihood of controversy.

The issue has yet to surface with respect to U.S. affiliates of foreign multinationals. Already, however, there are a few CRADAs with affiliates—Schlumberger and Philips Semiconductor are examples —and interest among Japanese firms in exploring CRADA opportunities is increasing. According to some reports, one Japanese transplant automaker was willing to sign up to the strict requirement requiring U.S. manufacture if it could join the U.S. Advanced Battery Consortium, but the consortium ended" up with only American members. DOE's new guidelines on U.S. preference may apply as well to affiliates of foreign firms as to U.S. fins, but this has not yet been tested.

49 Other companies were obliged to form joint ventures with Japanese companies, or denied access altogether.

The Legal Terms of CRADAs: Liability

Another issue that has been tricky to negotiate is liability for personal injury or property damage resulting from the commercial application of CRADA technology by: 1) a firm that participated in a CRADA, or 2) an entity that bought rights to the technology from such a participating firm. If someone sues the labor the government, the CRADA participant must reimburse the labor the government for any damages awarded. That, for most of 1992, was the position of the DOE model CRADA, with no qualification. Many potential CRADA partners objected to this complete indemnification of DOE. CSPP, for example, argued that participating firms should not have to pay for damages clue to labs' negligence. CSPP won the point; its model CRADA excludes liability "resulting from any negligent or intentional acts or omissions of" the lab.[50] (The NIH model has a similar exclusion.) There is still uneasiness on both sides. Like many other contentious issues in CRADA negotiations, liability provisions are most apt to become problems in CRADAs are successful in developing technology that succeeds commercially.

50 The CSPP model also specifies that if the lab licenses any third party, the license must include a provision requiring the third party to similarly reimburse the CRADA participant if the latter is sued for harm resulting from the third party's commercialization of the technology.