

**DEVELOPING A SUSTAINABLE FUTURE
FOR FEDERALLY FUNDED RESEARCH AND
DEVELOPMENT CENTERS**

by

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ABSTRACT

Federally Funded Research and Development Centers (FFRDCs) were first established after World War II by the Department of Defense to provide technical expertise in areas of research and development that were not then available from the private sector. Since then, industry has expanded its capabilities in R&D and in the management of R&D to levels comparable to those offered by FFRDCs. Private industry and the Congress have questioned whether the work, given directly to FFRDCs without competition, should instead be openly competed among commercial contractors. Some critics of FFRDCs would eliminate them entirely, so as to compel the government to outsource this work to the private sector.

This thesis focuses on the eleven FFRDCs currently supported by the Department of Defense, and begins with a review of the policies and principles that underlie their existence. A survey of the somewhat antagonistic environment in which FFRDCs must function explores the criticism voiced by the private sector to limit the growth and the scope of FFRDCs. Attempting to remain important sources of innovation and technology transfer, FFRDCs have responded in different ways to this criticism. Although the Congress and Department of Defense have tightened the rules on FFRDCs, there nevertheless are ways for FFRDCs to interact with industry, and to diversify internally, so as to increase their value to both the private sector and to the government. FFRDCs offer both tangible and intangible sources of value.

There is a continuing need for FFRDCs, even though the global environment has significantly changed over the past 50 years. Through the use of legal mechanisms that encourage technical collaboration and cooperation, it is possible to balance the needs of the Department of Defense, the concerns of the private sector, and the mission of the FFRDCs in the national interest.

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1.0 INTRODUCTION

1.1 Objectives

Since the early 1990's, the research and development (R&D) budget of the Department of Defense (DoD) has been decreasing. As a result, the future of Federally Funded Research and Development Centers (FFRDCs) has become more uncertain, especially in the light of criticisms from the private sector that the work given directly to FFRDCs should instead be bid in open competition. Industrial lobbies and influential members of the Congress favor the further reduction, and even the elimination, of FFRDCs. In this way, the government becomes compelled to outsource more work to private industry.

In order to remain viable as centers of technical innovation and important sources of technology transfer, FFRDCs must develop a proactive strategy in which their mission is well understood and their value to the national interest is clear. The first objective of this thesis is to understand the policies which underlie the existence of FFRDCs, yet which also constrain their growth. In following these guidelines, an FFRDC's mission statement differentiates it from its peers and its competitors, defining its scope of operations and responsibilities to the DoD. Mission statements can change over the years, but they must comply with government policy.

A second objective is a survey of the competitive environment in which FFRDCs function. In the private sector, the recent consolidation of the defense industry and the emergence of a few large defense contractors present a new phenomenon. The relationships involving the government, private industry, and FFRDCs are very different today compared to the decade following World War II when FFRDCs (then called FCRCs) were first created. What are the new working relationships, and how can they be managed in a mutually beneficial way? What might be the future business model for an FFRDC?

A third objective considers the options for diversification available to FFRDCs. In reacting to government guidelines and to the competitive environment, the three largest FFRDCs funded by the DoD (M.I.T.-Lincoln Laboratory, the MITRE Corporation, and the Aerospace Corporation) have responded differently in order to remain viable and to maximize their value to the government. What are these options? If the government regulations eased or were redefined, do new options emerge?

The fourth objective addresses value. FFRDCs must be able to demonstrate that their mission is still needed by the government, and that situations exist in which they can provide a greater benefit, or can perform with a greater efficiency, than can any alternative to which the government might turn. An FFRDC's mission statement must be structured accordingly, so as to provide flexibility and to ensure that the government receives the optimum benefit from its investment. What are the tangible and intangible elements of value that the government should consider when deciding whether to place work directly with an FFRDC, or to put it out for bid in an open competition?

In short, the thesis intends to survey the setting in which an FFRDC functions, and to synthesize those conditions and policies under which it can continue to provide value in the national interest. It is upon this basis that the mission of FFRDCs is defensible and their future is sustainable.

1.2 Hypotheses and Methodology

The thesis considers three hypotheses in order to demonstrate that there can be a balance among the interests of the government, FFRDCs, and private industry:

- H1. There is a continuing need for FFRDCs to do R&D and R&D management for the federal government.

- H2. A self-consistent set of policies and procedures can be configured according to which FFRDCs can perform their function without incurring criticisms from the private sector or encroaching upon commercial enterprise.
- H3. There are identifiable measures of tangible and intangible value with which the government can assess placing work with an FFRDC.

In evaluating these hypotheses, this research includes an investigation into public documents and the open press in order to ascertain the current thinking about the role and responsibilities of FFRDCs. Documents published by the General Accounting Office, testimony cited in the Congressional Record, and policy statements issued by agencies within the Department of Defense are a primary source of information. The news and business media also contain many citations about the reaction of the private sector to attempts by FFRDCs to strengthen or realign their position with the government.

Personal interviews with executives at several FFRDCs have provided a view of the issues from the inside. Similarly, communications with the office of the Director of Defense Research and Engineering (DDR&E) at the Pentagon, which has the responsibility of overseeing DoD's eleven FFRDCs, have provided insight into management policy and long-range planning for FFRDCs. In addition, interviews with several government project managers who deal directly with FFRDCs have provided first-hand information about what they value most in their working relationship with FFRDCs.

A number of lobby groups in Washington, D.C. represent the interests of the private sector. In particular, the Professional Services Council (PSC) and ACIL are lobbies attempting to influence legislation that would reduce the funding of federal laboratories and FFRDCs, and would require the government to contract most of its testing and R&D with commercial organizations. Literature provided by these lobby groups and

personal conversations with their staff have been useful in understanding the position of private industry.

Thus, the collection of information spans all three parties--the government, the FFRDCs, and the private sector--so that all points of view can be equitably presented.

2.0 Background on FFRDCs

2.1 The Origins of FFRDCs

During World War II and in the years following, the DoD began to create FFRDCs to address specialized needs in research and development that could not readily be satisfied by the civil service, government laboratories, or commercial contractors. Industry had been geared for wartime production and lacked the capacity to conduct the long-term basic R&D wanted by the federal government. Industry was also starting to focus on the booming post-war markets for consumer goods and services, with less of an emphasis on military research.

In the 1940's and 1950's, the government needed research organizations that were not biased toward particular product lines or technologies. At that time, companies that provided independent, diversified, and highly technical services simply did not exist. (In contrast, today there are numerous companies in the private sector that fit that description.) In addition, the limits on federal hiring and the lower salary scales in the civil service dissuaded highly trained scientists and engineers from joining government laboratories. DoD's alternative was to create a non-government entity that could attract skilled researchers and perform the R&D that it wanted to conduct. Thus, in the post-war era, much of the capability to do the basic R&D for military applications became resident in the FFRDCs. DoD, however, continued to procure the equipment and large systems for its inventory by competing bids in the open market and awarding contracts to commercial industry.

FFRDCs grew out of the semi-academic laboratories and research efforts established by the federal government during World War II, and many can trace their lineage directly back to wartime activities. The first entity of this type was the Applied Physics Laboratory, established in 1942 at the Johns Hopkins University by the Navy to work in the area of radio proximity fuses for fleet anti-aircraft defense. (For a time, APL

was an FFRDC but is now a University Associated Research Center (UARC), which closely resembles an FFRDC in its role and function.) The Radiation Laboratory at the Massachusetts Institute of Technology led to the 1951 founding of Lincoln Laboratory. The Navy's 1942 Operations Research Group became the peacetime Center for Naval Analyses.

This paradigm worked well, and DoD's expanding need for specialized services led to an increase in the size and number of its FFRDCs. DoD continued to create other FFRDCs after the war in order to obtain objective assessments of military problems that involved complex technical issues. The RAND Corporation, the Institute for Defense Analysis, the MITRE Corporation, the Logistics Management Institute, and the Aerospace Corporation were all established prior to 1962.

Other agencies and departments of government also began to create their own FFRDCs. By 1969, the total number of FFRDCs throughout the government peaked at 74. Today, there are 39 FFRDCs, 11 managed by DoD and 28 managed by seven other federal agencies that include the Department of Energy, the Federal Aviation Administration, the National Science Foundation, the National Institutes for Health, the National Aeronautics and Space Administration, the Nuclear Regulatory Commission, and the Internal Revenue Service.

Apparently, the FFRDC concept must be a useful one, if such a diversity of government agencies has adopted the model. Actually, there have been approximately 150 FFRDCs certified, chartered, or funded by the government since World War II, although there have not been more than 74 in existence at any one time. As explained later, the flexibility and the characteristics of the "special relationship" (a term coined by the DoD to describe the arrangement between an FFRDC and its sponsoring federal agency) can be of great value and operational convenience to the government in conducting its business.

2.2 Criteria for Establishing an FFRDC

The Office of Federal Procurement Policy (OFPP) specifies that a federal agency may establish an FFRDC if the agency can show that “...existing alternative sources for satisfying agency requirements cannot effectively meet the sponsor’s special research and development needs [1].” The establishing agency must apply two tests:

- (1) Can the FFRDC meet the agency’s needs?
- (2) Does the FFRDC meet these needs more effectively than any alternative source that is not an FFRDC?

What does it mean for an FFRDC to be able to perform R&D “more effectively” than the private sector? In what way can an FFRDC have more power to achieve the desired result than private industry? The comparison was clearer in 1950 when industry was not prepared or inclined to embark on long-term R&D for military applications. Today, there are many commercial companies with considerable R&D capability and technical expertise. The answer is a subtle one: Effectiveness lies not only in the basic ability to do the work, but also in the circumstances in which the work is done. It is not enough merely to have capability; the performing organization must also be free of the conflicts of interest that would turn a success into an impasse. The “special relationship” between an FFRDC and its sponsor is a perimeter within which an FFRDC can function more effectively because of the elements of access and privilege that cannot be shared with private industry. This relationship is described more fully in section 3.2 of this thesis.

If the two tests are satisfied, such that it is clear that private industry cannot as effectively do the work, then the agency can establish a new FFRDC with the following characteristics [2,3]:

- (1) The FFRDC's primary activities must include basic research, applied research, development, or the management of research and development;
- (2) It performs R&D or R&D management under the direct monitoring of the federal government per the government's specific request, or under a broad charter;
- (3) It is a separate operational unit within the parent organization, or is an independently incorporated entity;
- (4) At least 70 per cent of its financial support comes from the federal government, usually from a single agency;
- (5) A long-term relationship of at least 5 years is anticipated to exist between the FFRDC and its sponsor;
- (6) The government owns, or funds under contract, the facilities and fixed assets of the FFRDC; and
- (7) The average annual budget, including operating funds and capital equipment, is at least \$500,000.

These largely administrative restrictions define an FFRDC's funding structure and mode of operation.

2.3 Other Restrictions on FFRDCs

FFRDCs agree to terms and conditions that are much more restrictive than those accepted by commercial organizations that do business with the federal government. These agreements do not allow an FFRDC to make a profit or to compete with private industry for government work. Instead, funding comes directly from the government either as an explicit line item in the DoD Budget, or it is channeled through the FFRDC's sponsor as part of the appropriations for the DoD programs on which an FFRDC is working (a procedure known as a Military Interdepartmental Purchase Request, or MIPR).

Furthermore, an FFRDC cannot manufacture goods and products for sale in the marketplace. Doing so would give an FFRDC an unfair competitive advantage because the direct funding would amount to a government subsidy that is not available to private industry.

Likewise, an FFRDC may not work directly for or with a commercial company in a profit-making venture because the use of government resources and the access to sensitive information would favor the private partner over its own competitors , who would certainly complain about such exclusive joint ventures.

3.0 The Special Relationship Between an FFRDC and Its Sponsor

3.1 A Special Paradox

Government sponsors who place work with FFRDCs generally view them as flexible, convenient, and exceptionally competent in doing long-term R&D and management of R&D. Some critics argue, however, that because the work was not awarded competitively, sponsors cannot know absolutely whether a non-FFRDC could have done the work better or at less cost. (This latter position naively assumes that an open competition will always find the optimal combination of quality and cost.)

An apparent dilemma for an FFRDC is how to strike a balance between doing the kind of work that will demonstrate and strengthen its own core competencies, and yet minimize the sponsor's uncertainty about placing the work with the FFRDC without competition. This paradox is dispelled through the working relationship that develops between the sponsor and the FFRDC, which adds value beyond the considerations of cost and quality.

3.2 Characteristics of the Special Relationship

The nature and purpose of FFRDCs have changed over the years; their origins reach back to World War II and to the tense Cold War environment in the following four decades. These centers have evolved; some have dissolved because their FFRDC function was no longer needed by the government. The characteristics of the special relationship are largely intangible, but they establish a sharp contrast in comparison to commercial organizations. In 1995, the Defense Science Board studied and clarified this relationship as part of its review of FFRDCs [4,5]. The following features describe a relationship that is successful and allows an FFRDC to perform research, development, and analytical tasks integral to the mission and operation of the sponsoring agency.

(1) An FFRDC is an embodiment of scientific and technical expertise that cannot be recruited, sustained, or managed within the civil service itself. The R&D is objective, high-quality, and state-of-the-art. The sponsor can be confident that the analyses and results will be comprehensive and far-sighted, and involve complex technical problems that have not been previously solved.

(2) An FFRDC is free from real or perceived conflicts of interest. There is an independence of commercial and shareholder interests. In its role as an “honest broker,” the FFRDC is committed to the objectives of the sponsor, but it must be independent even of the sponsor’s policies if such should involve political or partisan elements.

(3) A key factor is the long-term continuity and corporate memory of an FFRDC. An uninterrupted and consistent level of support is part of the relationship. In contrast, the involvement and interest of a commercial contractor can come and go, depending on whether the company wins a bid or changes its business strategy and goals. Because of the fiduciary responsibility that a corporation holds for stockholders, any unprofitable work, however critical to the national interest, can be abandoned simply by not bidding. Mergers, acquisitions, and economic turbulence can dramatically alter a company’s priorities. If skilled staff and other resources are redirected by the commercial corporation toward more profitable pursuits, then the quality of the work done for the government will deteriorate. This will not be the case with an FFRDC.

(4) An FFRDC accumulates a comprehensive knowledge about the sponsor’s needs and requirements, and anticipates these needs even before they are expressed. Institutional memory and a sensitivity to the enduring concerns of the sponsor establish a partnership in action in which both parties are committed to success and expect the interaction to last for a long time.

(5) The freedom from conflict of interest allows a broad access to sensitive information about acquisitions planned by the government, and to classified information

about foreign and domestic military systems and policy. The FFRDC frequently works out the specifications for a procurement before the government presents it to industry for open bid. An FFRDC therefore performs an important pre-competitive function in limiting the need to disseminate classified information widely to industry, because it can provide the requirements for a defense system development without having to reveal the issues that drove the specifications.

An FFRDC is frequently involved in the process of evaluating the bids from many contractors. Using its in-depth knowledge about how the specifications were derived, the FFRDC can make recommendations to the government about the technical content and feasibility of the proposals. In this way, the quality of the acquisition will be assured. (Typically an FFRDC does not have access to the financial and costing sections of a proposal, so that the FFRDC's evaluation is done only on the proposal's technical merit.)

The contractor who wins the bid also benefits from the FFRDC's position of privacy and confidentiality. It can subsequently share its own proprietary information with the FFRDC with impunity, not having to worry that the information may somehow find its way into the hands of a competitor. The FFRDC essentially is a neutral participant and liaison between government and industry, and occasionally between the competitors themselves when the government needs a means to integrate and protect proprietary information provided by several for-profit companies.

(6) An FFRDC is adaptable to the emerging needs of the sponsor. The institutional knowledge, resident expertise, and long-term familiarity with the sponsor's concerns engender a flexibility that can respond to redirection. In contrast, there are usually many legal and contractual items that must be renegotiated with a commercial contractor whenever a sponsor wants to change direction. Changes can become obstacles because they cost both time and money. The tedium and level of detail may dissuade the sponsor from considering fruitful alternatives because of the trouble involved in making changes to

an existing contract. Administratively, an FFRDC can act on brief communications from a sponsor (a letter or telephone call) in modifying an existing program plan or in initiating a new piece of research.

(7) An FFRDC responds quickly when the sponsor needs short-term assistance in making urgent decisions. When world events happen unexpectedly, the government needs educated answers and unbiased recommendations quickly. For the reasons cited above, a commercial contractor is not always able to drop one effort and assume a new one unless the requirement for such responsivity is explicit in the wording of the existing contract. Profitable business planning requires a balanced and deterministic allocation of resources. Sudden shifts can disrupt a contractor's assignment of personnel and resources to other projects that are being done for the government or for other non-government clients. Understandably, commercial contractors are uncomfortable with contractual language that is broad and general. Their profits and fees are awarded on the basis of providing specific items and satisfying quantitative measures of performance on behalf of all their clients. An FFRDC, on the other hand, can respond quickly in a volatile environment because its charter and mission statement encourage flexibility without imposing a penalty that might impact the revenues shown on an income statement.

3.3 Justifying an FFRDC's Work

As noted in section 2.2, the application of tests of relative "effectiveness," as described in the OFPP letter of 1984 [3], differentiates an FFRDC from other organizations that might be able to do the same work. Effectiveness is not explicitly defined, but can be interpreted in the terms of the special working relationship described above that exists between an FFRDC and its sponsoring agency. In many cases, an FFRDC can be more effective than a commercial organization, not just because it has the

expertise to perform the work, but because of the environment in which the work is performed.

An FFRDC is effective because its flexibility and familiarity with respect to the sponsor's needs make it easier for the FFRDC to perform the job, thereby increasing the probability that the sponsor's goals and milestones will be achieved. The long-term relationship maintains a predictable level of activity that allows the retention of technical expertise and reduces the risk to the government.

While industry may have the expertise to do the R&D work, it operates in a less certain environment and responds to the vicissitudes of the national and global marketplaces. In general, the industrial time horizon is much closer; short-term profits are more critical to stockholders than is long-term research that is supported by the government and therefore may not offer the gains of proprietary ownership. To the corporation, the opportunity costs of doing government R&D may be too great; there may be more profit in doing something else.

An R&D operation is typically a cost center, for which the ultimate payoff is uncertain and speculative. A commercial corporation, which is funding its own internal basic research and development, does not ordinarily place the effort into one of its business units or profit centers. Commonly, the effort is centralized at the corporate level in order to protect it from the short-term interests of subsidiaries or divisions in which performance is measured by profitability. In an analogous way, DoD should consider centralizing some basic R&D and R&D management functions in an FFRDC, which is a cost center by definition since it does not return a profit in terms of dollars and cents. This action, akin to a decision by a board of directors, is appropriate when the "special relationship" affords a long-term perspective, a detachment from concerns of ownership and profitability, and an insulation from conflicts of interest. Clearly, there is a role for FFRDCs to play in DoD's portfolio of support. The question is how to balance and manage that portfolio for the

greatest benefit to the taxpayer in the interests of the national security and the national economy.

4.0 Types of DoD FFRDCs

4.1 FFRDC Nomenclature and Documentation

As described earlier, the modern day FFRDCs have their roots in the operations research and technical R&D done for the military by civilian scientists and engineers during and following World War II. The federal government had established these centers to harness independent scientific inquiry into problems of interest to the military. A second motivation was the need for support with an objectivity strengthened by an independence from commercial industry. First simply called “research centers,” they became known as Federal Contract Research Centers (FCRCs) until 1967 when the Federal Council for Science and Technology formalized the FFRDC nameplate.

The National Science Foundation maintains an authoritative master list of FFRDCs by mandate of the Federal Acquisition Rules [6,7]. The federal agencies themselves determine which contracts will be written as FFRDCs, and report this information annually to the NSF. Today there are 11 DoD FFRDCs, with an additional 28 managed by other government agencies. Within DoD, the Director of Defense Research and Engineering (DDR&E) develops the overall policy of management, and determines the funding levels based on the congressional ceiling for FFRDC funding and on the various sponsors’ funding requirements.

The DoD military services and defense agencies individually sponsor the 11 FFRDCs. They award and administer 5-year contracts that are re-negotiated non-competitively after the continuing need for the FFRDC is established by DDR&E. The FFRDCs are governed by a long list of documents and legislation:

- (1) The OFPP Policy Letter 84-1; [3]
- (2) The Federal Acquisition Regulations;
- (3) FFRDC Defense Management Plan; [8]
- (4) The individual agreement and contract between the FFRDC and its sponsor;

- (5) The Internal Revenue Service regulations for tax-exempt organizations;
- (6) Appropriate state laws for non-profit organizations;
- (7) Specific provisions in the annual DoD Authorization and Appropriations Acts.

Clearly, the FFRDCs have been heavily scrutinized, examined, legislated, and regulated. Indeed, their size, scope, and oversight have been recurring areas of concern to the Congress, federal officials, and the private sector since 1960. In 1991, the Congress reduced their funding, set personnel ceilings, capped executives' salaries, and prohibited the formation of any new DoD FFRDCs. An account of the government's response to the criticisms of FFRDCs is discussed in Chapter 5 of this thesis.

4.2 Categories of DoD FFRDCs

There are three types of FFRDCs within DoD, each with a different function.

These are the

- Research and Development Laboratories
- Study and Analysis Centers
- System Engineering and Integration Centers

Table 4-1 shows the parent organizations and primary sponsors of the FFRDCs in these categories.

4.2.1 Research and Development Laboratories

These centers were founded as scientific research laboratories working in the traditional sense on challenging technical problems. They include M.I.T.-Lincoln Laboratory, the Software Engineering Institute, and the Institute for Defense Analysis--Communications and Computing Center. They were created to fill voids in which federal laboratories and private sector research could not meet DoD's needs. They engage in projects that emphasize advanced concepts and technology. A key role of these laboratories

FFRDC	PARENT ORGANIZATION	PRIMARY SPONSOR
Systems Engineering and Integration Centers		
Aerospace	The Aerospace Corporation	Air Force
MITRE	The MITRE Corporation	Assistant Secretary of Defense
Studies and Analysis Centers		
Arroyo Center	RAND	Army
Project Air Force	RAND	Air Force
National Defense Research Institute	RAND	Office of the Secretary of Defense
Center for Naval Analyses	The CNA Corporation	Navy
IDA-Studies and Operational Test and Evaluation	IDA	Office of the Secretary of Defense
Logistics Management Institute	Logistics Management Institute	Office of the Secretary of Defense
Research and Development Laboratories		
Lincoln Laboratory	Massachusetts Institute of Technology	Air Force
Software Engineering Institute (SEI)	Carnegie Mellon University	Defense Advanced Research Projects Agency
IDA-Communications and Computing	IDA	National Security Agency

TABLE 4-1. DoD Federally Funded Research and Development Centers

is the development and transfer of technology to the private sector, so that the government will benefit from having a broader base of expertise and more choice among competitors when acquiring goods and services.

Lincoln Laboratory was established in 1951 under the sponsorship of the Air Force, Army, and Navy. The Defense Advanced Research Projects Agency (DARPA) became a sponsor in 1958. Its research is pertinent to the national defense, with a particular emphasis on advanced electronics, ballistic missile defense, communication systems, air defense, and space and ground surveillance techniques. Current work includes some non-DoD activities sponsored by the Federal Aviation Administration, NOAA, and NASA.

The Software Engineering Institute was established in 1984 at Carnegie-Mellon University. SEI provides leadership in advancing state-of-the-art software designs and improving systems that depend heavily on software control. SEI is instrumental in setting standards for software development, and has a great influence on the software engineering curricula throughout the educational community, industry, and government.

IDA--Communications and Computing Center began in 1956 to promote national security, the public welfare, and the general advancement of science. Its analyses and evaluations are used by the National Security Agency in the specialized fields of crypto-mathematics and crypto-computing, speech research, and applied signal processing.

4.2.2 Studies and Analysis Centers

These centers pioneered the development of the discipline of operations research, an analytical tool applied to the process of making decisions, formulating policy, and evaluating alternatives. Because their range of analysis has expanded greatly into many esoteric areas, these centers have become popularly known as “think tanks.”

The Arroyo Center was founded in 1984 and moved to the RAND Corporation in 1985. It provides the Army with objective analyses about developing ground forces, manpower and training, strategy and doctrine, and logistics. Arroyo is currently working on structures and alternatives for the post Cold War army.

Project AIR FORCE was created by the Air Force in 1946 at Douglas Aircraft Corporation, and transferred to RAND in 1948. It provides studies and analyses about the development, deployment, and instrumentalities of aerospace power. PAF maintains a wide perspective and deals with difficult multi-disciplinary problems that cross organizational boundaries and involve many commercial contractors.

The National Defense Research Institute was established in 1984 to consolidate RAND's support of the Office of the Secretary of Defense (OSD), the Joint Staff, and the defense agencies. NDRI analyzes and recommends positions of policy that concern international security and economics, forces and resources for the military, and technology acquisition and transfers.

The Center for Naval Analysis has existed since 1942 and is the oldest DoD FFRDC. CNA advises the Navy and Marine Corps on fleet operations, system requirements for major acquisitions, and program planning. In 1993 CNA restructured to include a new operating unit, the Institute for Public Research, which functions outside of the FFRDC umbrella but nevertheless works for a number of federal agencies.

As part of IDA, the Studies and Analyses/Operational Test and Evaluation FFRDC performs analyses and evaluations relating to national security, public welfare, and the advancement of scientific learning. It develops computer software prototypes and simulations that are used in developing policy and management models for OSD, the Joint Staff, Unified and Specified Commands, and the various defense agencies.

In 1961 the Logistics Management Institute was founded to work on issues of materiel management, acquisition policy, operational logistics, facilities management, and

force management. The primary sponsors are OSD, the military services, and the defense agencies.

4.2.3 Systems Engineering and Integration Centers

These centers provide technical support in defining, developing, procuring, deploying, and operating complex systems for DoD and other federal agencies. They provide the technical understanding and systems engineering needed for the federal government to manage and deal effectively with the commercial contractors who actually build the large systems. These centers also assist their sponsors in evaluating the performance and activities of for-profit firms.

The Aerospace Corporation was established in 1961 to support the Space and Missile Systems Center of the Air Force Materiel Command. It functions as an architect-engineer for space systems, addressing R&D tasks from initial concept to deployment and operation. Aerospace oversees the technical planning and management of military satellites, while protecting the proprietary space technologies of the participating defense contractors. It seeks to minimize system development schedules and operational risks to the Air Force in the acquisition and certification of launchers and boosters. The evaluation of the space programs and activities of commercial firms is an important role in the integration of common efforts in the interest of national security.

The MITRE Corporation was a spin off from Lincoln Laboratory in 1958. Lincoln Laboratory's role did not extend to the implementation and acquisition of defense systems. That part of the Laboratory that was working on the Semi-Automatic Ground Environment (SAGE) radar system was transferred by the Air Force to the newly created MITRE to complete the engineering tasks of acquisition and deployment. MITRE became a separate FFRDC to serve as a link between the government and the commercial defense contractors while SAGE was being built. Since 1958, MITRE expanded into many areas, including

DoD work in command, control, communications, computers, and intelligence (C⁴I) systems. It also does work for the Federal Aviation Administration in designing and testing the components for future air traffic control systems.

4.3 FFRDC Mission Statements and Opportunity Costs

All three types of DoD FFRDCs---the research and development laboratories, the studies and analysis centers, and the system engineering and integration centers---provide a variety of services to the DoD under mission statements and charters that have some flexibility and diversity, but within limits which some critics of FFRDCs maintain are not restrictive enough.

The mission of a commercial organization is a broadly defined statement of purpose that differentiates the organization from similar firms in terms of the scope of work, the customers and the customer needs that will be served, the technology and means used in the delivery of products and services, and the long-term desire for sustained success through growth and profitability [9]. It is an articulation of long-term corporate intentions and goals, which serve as a basis for shared expectations, planning, and evaluation of performance. In understanding the mission, both employees and customers of the company develop shared values, a positive attitude, and a sense of purpose.

These same principles apply to FFRDCs. However, there is one major difference: the goals of growth and profitability do not apply to FFRDCs in the conventional business sense. As mentioned earlier, FFRDCs are not allowed to make a profit or to offer goods and services in the open market. Their growth is constrained by ceilings on funding and personnel that are imposed by the Congress explicitly to contain their expansion.

It may seem that the mission statement of an FFRDC is incomplete and open-ended in comparison to the well composed mission statement of a for-profit organization. However, "success" does not have to be defined in terms of growth and profitability,

which ultimately focus upon the satisfaction of the owners and creditors of a commercial organization. In the case of the FFRDC, the satisfaction of the government sponsor is the measure of success.

In a basic sense, the sponsor is like the shareholder who has made an investment (has funded an FFRDC to do work), and expects a monetary return (a result that supports the goals of the agency). A government sponsor must certainly be cognizant of the accounting costs---the wages, salaries, price of materials, property rentals, cost of utilities, etc., that are the explicit outlays of cash needed to do the work itself, whether it is done by an FFRDC or by a commercial contractor. Critics of FFRDCs tend to focus on the accounting costs when drawing comparisons between FFRDCs and commercial organizations. This is a myopic point of view that often disregards other sources of value to the sponsor.

Beyond the explicit costs are economic costs that farsighted managers should consider [10, 11]. Economists do not ask: “What does it cost me, and how much do I have to pay for it?” Instead, they ask: “What do I give up in order to get it?” Managers must also examine the opportunity cost, which is the return not realized because the investment was not placed elsewhere. In a simple example, if one savings account offers a 10% return, and another offers 8%, then the opportunity cost of investing in the second account is 2%. It is the value foregone for not having put resources in another instrument. All true costs are lost opportunities of some sort, but not all lost opportunities show up in the accounting sheets. Opportunity costs are hidden, yet they are real.

This economic principle as applied to FFRDCs is the subject of Chapter 9 of this thesis. As it relates to an FFRDC’s mission statement, however, the consideration of opportunity costs must be included in order to give a sponsor the license to weigh them in deciding whether to place work with an FFRDC, or to compete it in the open market. It

may be the case that the accounting costs favor the commercial contractor, but when the opportunity costs are included, the FFRDC becomes the better choice.

5.0 Government Concerns About FFRDCs

For many years, FFRDCs have attracted the attention of the Congress. In the late 1950's and the 1960's, the primary questions regarded the growing number of FFRDCs, their increasing cost to the government, the level of control exerted by the sponsoring agencies, and the quality of the work. More recently, the concerns address the non-competitive award of contracts to FFRDCs and their diversification into areas beyond the centers' original missions.

5.1 The Early Years of Conflict and Transition: The 1960's

During the 1960's, Congress was influenced by many societal forces and by changes in the attitude of the public toward the use and power of science, and toward the military services in general. The tenor of the nation following World War II and the Korean War generally had favored the contributions of the FFRDC "think tanks" and special R&D laboratories. During the 1960's, however, there was a widespread shift that was apparent in the news media and entertainment industries, and in the educational community.

The RAND Corporation, which was running several FFRDCs (then called FCRCs, or simply federal research centers) was a well-known "think tank" during the 1960's. It became the object of a popular protest-style folk song called "The RAND Hymn" written by songwriter Malvina Reynolds in 1961 and made popular by singer Pete Seeger [12]:

Oh, the RAND Corporation is the boon of the world,
They think all day for a fee.
They sit and play games about going up in flames;
For the counters, they use you and me, Honey Bee,
For the counters, they use you and me.

They will rescue us all from a fate worse than death
With the touch of a push-button hand.
We'll be saved at one blow from the designated foe.
Who's going to save us from RAND?

In a similar vein, in Stanley Kubric's 1965 movie "Dr. Strangelove," the protagonist of the same name was a caricature of an advisor for nuclear strategy who worked for the "BLAND Corporation."

The war in Vietnam and the vigorous opposition to it had a profound impact upon the public, the military, and the political arena that is still felt today. FFRDCs that had connections to universities found the relationship to be a liability. As examples [13], in the fall of 1967, the Students for a Democratic Society (SDS) protested that Princeton University should sever its ties with IDA. Similar demonstrations occurred at the University of Michigan, and prompted an eight-day student revolt at Columbia University. On August 24, 1970, the Army Mathematics Center, then an FFRDC at the University of Wisconsin, was bombed. One researcher was killed, three were injured, and the building was severely damaged. A letter to the news media from the bombers accused this FFRDC of being a "vital cog in the machinery of U.S. imperialism." There were demonstrations at the University of Rochester, which had connections with the Center for Naval Analyses. In 1961, there were 43 DoD FFRDCs (the largest number ever). In 1968, 10 of the 16 FFRDCs were administered by universities. Today, the number is 2 out of 11.

Clearly, forces outside the walls of Congress had had an impact. However, criticisms of FFRDCs within those walls began as early as 1961. President John F. Kennedy convened a study group headed by David E. Bell, Director of the Bureau of the Budget, to review the subject of how the government awards contracts for research and development. The "Bell Report" [14] investigated federal contracting procedures and policies for scientific evaluations and advice, research engineering services, and technical and administrative management services. It was the first comprehensive attempt to address issues relating to the government's contracting for technical services and expertise. The

report discussed the differentiation between FFRDCs and the private sector, stating that [14]:

In selecting recipients, whether public or private, for research and development assignments, the basic rule should be to assign the job where it can be done most effectively and efficiently, with due regard to the strengthening of institutional resources as well as to the immediate execution of projects.

Not-for-profit organizations (other than universities and contractor-operated government facilities), if strongly led, can provide a degree of independence both from government and from the commercial market, which may make them particularly useful as a source of objective analytical advice and technical services.

However, the Bell Report recognized that the professional and technical services industry was growing and endorsed meeting the government's needs for scientific expertise in all of its forms, including private industry [14]:

We believe that the present intermingling of the public and private sectors is in the national interest because it affords the largest opportunity for initiative and the competition of ideas from all elements of the technical community. Consequently, it is our judgment that the present complex partnership between government and private institutions should continue. On these assumptions, the present report is intended to deal with the practical question: What should the government do to make the partnership work better in the public interest and with maximum effectiveness and economy?

The Bell Report documented the controversy over the relatively high salaries being paid to the employees of newly formed Aerospace Corporation, about which the 1961 House Appropriations Committee had criticized that [14]:

To a considerable extent, the use of contracts with not-for-profit organizations is merely a subterfuge to avoid the restrictions of civil service salary scales. The buildup of these organizations has not been accompanied by corresponding reductions in the number of civilian and military personnel on the government rolls...Military and civilian personnel should be competent to do the jobs assigned to them, or they should be removed from the payroll.

This may not have been a valid basis for criticism, since FFRDCs were created specifically to attract the best and brightest people to do work for the government with higher salaries as an incentive. The space program initiated by President Kennedy was

expanding rapidly, so any reduction in personnel was not practical. Nevertheless, the seeds of congressional discontent had been planted.

In 1964, the Congress placed a ceiling on the total funds for all FFRDCs. Specific ceilings on funding for Aerospace and MITRE occurred in 1964 and 1968. From 1965 to 1972, the Army and Air Force reduced their support for FFRDCs, so that by 1972 the Army had no FFRDCs of its own. In responding to these ceilings, MITRE's board of directors amended its certificate of incorporation in 1968 to allow MITRE to do work outside of the federal government. At that time, DoD allowed this action because its policy encouraged diversification outside of DoD [15]. (As will be seen, however, diversification caused MITRE problems in the 1990's.) In 1969, for example, Secretary of Defense Melvin Laird encouraged Aerospace and the other FFRDCs to increase work in non-defense programs, even though the defense funding was stable. Secretary Laird wanted the technology and knowledge developed for military purposes and for the space program to be applied in the civilian economy for domestic problems [16].

5.2 Development of a Unified Policy for FFRDCs

Since the 1970's, significant changes in world politics have influenced the mission of FFRDCs. The Anti-Ballistic Missile Treaty and the Strategic Arms Limitation Talks in 1972 helped to defuse nuclear tensions between the United States and the Soviet Union. The involvement in Vietnam ended in 1973 with a total withdrawal in 1975. Conscription into the military, which had become a sensitive issue with the public, ended in 1973. During this period, defense budgets declined. The Director of Defense Research and Engineering (DDR&E), Dr. Malcom Currie, authorized an extensive study of FFRDCs, out of which the Task Force published a report in 1976 that endorsed FFRDCs, stated that the congressional ceilings were outdated, and that further controls were not needed [17]. The report stated that FFRDCs

...are so valuable a resource, because of their perspective, the quality of their work, and the responsiveness they can exhibit, that they should be retained and protected in essentially their present roles. This recommendation is meant to be read as a strong endorsement of the current defense policy in use of the FFRDCs.

DDR&E proceeded to execute its management plan [18] and reduced the number of FFRDCs from nine to six through decertifications of the Applied Physics Laboratory at Johns Hopkins University, the Applied Research Laboratory, and Analytic Services, Inc. (ANSER). (The DoD continued to contract with these organizations, although without the FFRDC relationship.) MITRE was reorganized into two FFRDCs, one in Bedford, MA, to do the DoD work, and another in McLean, VA, to do non-DoD work. Aerospace was encouraged to take on no more work outside of defense, and to divest itself of its non-DoD activities. In this period of consolidation and reduction, DDR&E maintained that, while the industrial base had grown that was capable of performing some of the work being done by FFRDCs, the need for FFRDCs remained and that they provided “high quality and essential services [18].”

5.3 Transition to the Present

The status of FFRDCs remained stable until 1984 when four were reconfigured. Three were actually reorganizations of existing efforts (LMI, NDRI, and the Arroyo Center), and one was a new entity (SEI). The passage of the Competition in Contracting Act (CICA) in 1984 [19] clarified the procedures for awarding contracts to FFRDCs non-competitively. This Act made the use of FFRDCs by federal managers more attractive because it simplified administrative procedures, but also the Act made it more difficult for an FFRDC to take on non-DoD work. The OFPP Policy Letter of 1984 [3] codified the rules to establish FFRDCs, and the Federal Acquisition Regulations were modified in 1990 to bring them more into conformity with the OFPP Letter.

Over the past 10 years, various types of ceilings have been applied to limit expenditures by DoD on FFRDCs. Before 1991, the sponsoring agencies themselves set the limits. In 1991 and 1992, Congress intervened and imposed limits on a center-by-center basis. In 1993, DDR&E determined individual ceilings and Congress passed legislation that prohibited DoD from forming any new FFRDCs. Since 1994, Congress has placed a cap on the total funding for FFRDCs, and DDR&E apportions the funding among the centers according to its own discretion. In one variation, DDR&E can place a limit on the number of the members of the technical staff (MTS) when a large amount of money is passing through an FFRDC on its way to private industry in the process of an acquisition.

Beginning in 1991, however, the total funding for FFRDCs has been on the decline, as shown in Fig. 5-1. The reduction is partly the result of Congress's response to the more vocal criticisms of FFRDCs coming from the private sector, to overall cutbacks in the DoD budget, and to the irregular use of management fees by two of the FFRDCs (MITRE C³I and Aerospace). For example, the 1995 budgets by FFRDC category, expressed as a percentage of the 1991 budget in constant 1995 dollars, are shown below.

<u>TYPE OF DoD FFRDC</u>	<u>1995 \$ / 1991 \$</u>	<u>1995 MTS / 1991 MTS</u>	<u>1995 \$ M</u>
R&D Laboratories	64%	76%	337
Systems Engineering and Integration Centers	76%	18%	722
Studies and Analysis Centers	93%	91%	194

All DoD FFRDCs	74%	82%	1,253

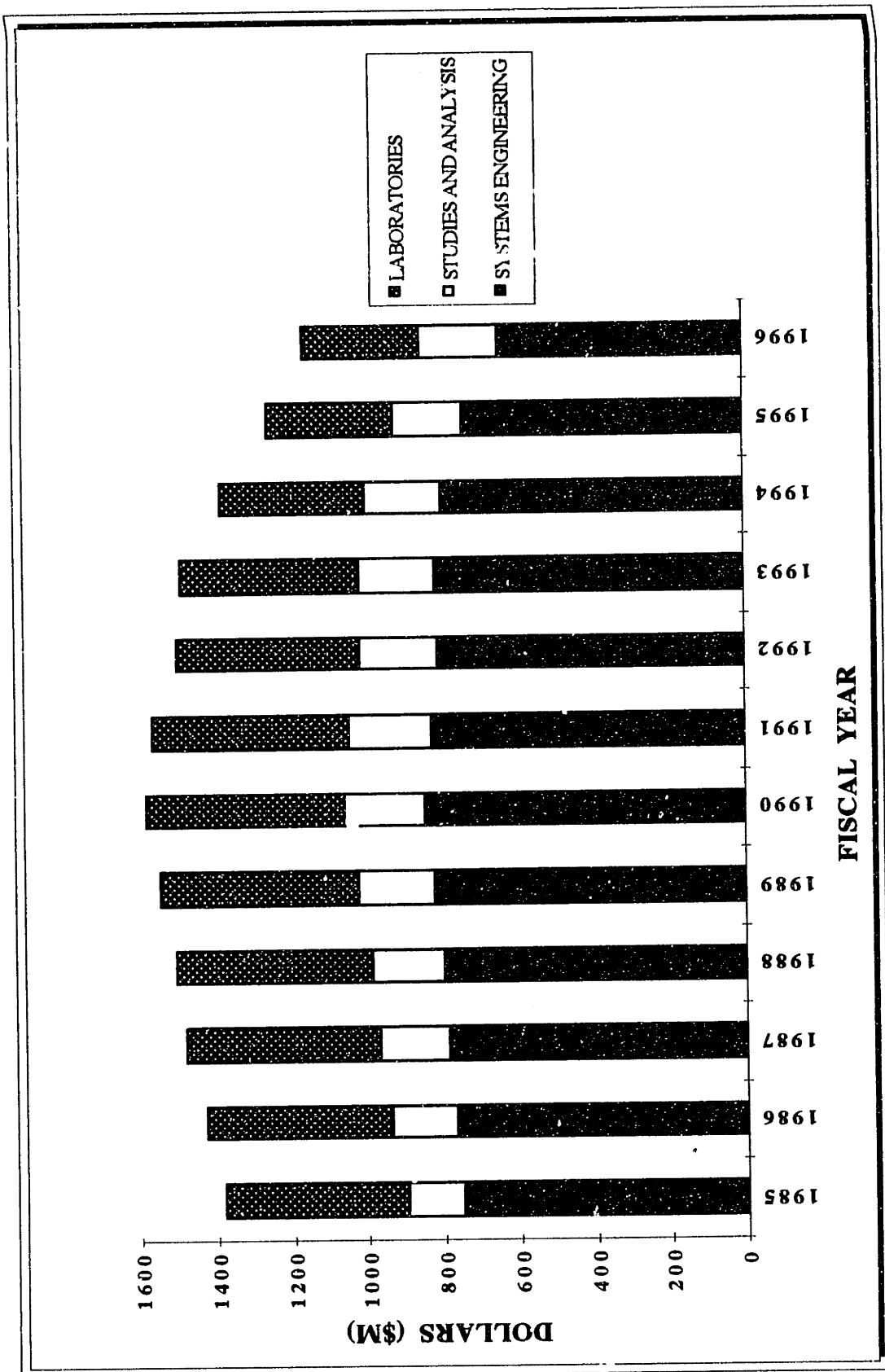


Fig. 5-1. DoD FFRDC Budgets (1996 Dollars)

These budget reductions were accompanied by a decrease in the number of members of the technical staff (MTS) in each of the three categories. Thus, over the 5-year period, the Congress reduced the total FFRDC budget by 26% down to \$1,253 million. The total number of professional staff was reduced by 18% down to 6,446 MTS [20].

In 1995, the majority of the resources--about 57% of the funding and 62% of the MTS--were used by only two of the 11 FFRDCs, the systems engineering and integration centers (MITRE C³ I and Aerospace). Such a large share of resources consumed by just two FFRDCs focused congressional scrutiny on them in particular, unearthing some controversial results described below.

5.4 Guidelines for the Use of Management Fees

Management fees are discretionary funds provided to some FFRDCs in addition to reimbursement for incurred costs. Both MITRE C³I and Aerospace receive a management fee. Lincoln Laboratory does not. Two issues have remained unresolved for many years:

- For what purposes should a management fee be provided?
- How should FFRDCs use a management fee?

In 1969, the Government Accounting Office (GAO) had recognized that non-profit organizations such as FFRDCs can incur necessary costs in their operations for which the procurement regulations do not explicitly allow a reimbursement [21]. Since 1969, however, little guidance has been given and questions continue to surface concerning these fees. Unfortunately, this ambiguity has made for misunderstandings over the uses of fees, some of which were deemed inappropriate after the fact..

In 1994, the DoD Inspector General concluded that an audit of all FY 1992 FFRDC accounts showed that \$43 million of the \$46.9 million of fees had been used for items that were improper [22]. The bulk of the \$43 million had funded independent research projects, which should have been charged to overhead instead. The rest was ascribed to

unallowable costs that were not necessary to the operation of those FFRDCs receiving a management fee.

The GAO audited the FY 1993 fee expenditures at MITRE C³I and concluded that only 11% were ordinary and necessary. MITRE had used most of the fees to pay for such items as entertainment, personal expenses for company officers, and generous employee benefits [23].

A GAO audit of Aerospace showed that \$11.5 million of its 1993 \$15.5 million in management fees had been improperly used for internally sponsored research. The remainder was spent on purchases of capital equipment, real and leasehold property improvements, contributions, personal use of company cars, conference meals, trustee expenses, and new business development [24].

These revelations about the two largest DoD FFRDCs merely added ammunition to the criticism and concern in both the Congress and the private sector about the management of FFRDCs. DoD recognizes the need to define which expenses are ordinary and necessary, and which can therefore be covered by a management fee. However, without such guidance, the confusion and disgruntlement will continue. Congress is concerned that the fee issue is symptomatic of a general lack of oversight of FFRDCs by DoD [25].

5.5 Concerns Over Objectivity and Diversification

FFRDCs strive to maintain objectivity and to avoid conflicts of interest. Advocates contend that they have fewer self-serving motivations than do commercial companies or other non-profit research organizations. However, Congress questions whether FFRDCs should have an exclusive niche, and suggests that many private sector organizations can also meet high standards of objectivity and freedom from bias. Critics point out that organizations that run more than one FFRDC, such as RAND, IDA, and MITRE, may

actually have internal organizational conflicts of interest themselves when the objectives of their separate sponsors may differ.

Indeed, diversification, as a response by FFRDCs to the end of the Cold War and to the decline in DoD R&D budgets, is a controversial issue. FFRDCs should not encroach into work already being done by private industry, yet they need to refocus their efforts on current problems to maintain their technological expertise and acumen. As part of the FY 1993 Defense Authorization Act, Congress gave the right to establish Cooperative Research and Development Agreements (CRADAs) with industry in order to effect technology transfers. Properly structured, CRADAs may provide diversification and at the same time function within the charter of an FFRDC. (CRADAs are described in section 8.3 of this thesis.)

5.6 Summary

Over the past 40 years, FFRDCs have experienced an uncertain and turbulent environment that has reacted to powerful societal forces, a distrust of the “military-industrial complex,” changing world tensions, pressures from the private sector, and unsettled administrative policies. On the one hand, the role of FFRDCs has been reaffirmed several times, even as the reasons for having them have changed. On the other hand, this support has been recently coupled with major budget cutbacks, ceilings on funding, and limits on the number of personnel imposed by the Congress.

Since 1991, DDR&E and the Congress have been searching for the optimal recipe to allocate funds and to demarcate the scope of work for FFRDCs. The formula has changed every year or two, and seems to be converging to a stable point where DDR&E uses its own discretion to allocate the total funding that the Congress provides. In this way, Congress does not need to micro-manage the details with which DDR&E is more

familiar, and which it can more effectively evaluate in terms of its own goals and objectives.

After almost 30 years of ambiguity, DoD needs to resolve the controversy over the use of management fees, which some critics view as an “untaxed profit.” This item is a recurring source of irritation to the Congress, which it may take into its own hands if DoD does not take the initiative. Even a list of expenses, for which management fees cannot be used, would add more clarification than the trial-by-error approach that has more recently been the case.

The Congress is mindful of the concerns about FFRDCs from private industry, which are the subject of Chapter 6 of this thesis. As will be seen, the external forces from commercial rivals can be as zealous as the political forces within the government itself.

6.0 Concerns of Private Industry

After World War II, the private sector began to develop its own capability to meet the growing demand for technical products and services. Industry gradually entered into basic R&D that had been the domain of the FFRDCs. Today, the roles are somewhat reversed. Private industry complains that FFRDCs divert federal R&D funds away from the marketplace, and do work in areas that are equally well or better served by commercial organizations. When the disciplines developed in the research centers were published in the open literature and became established in the standard curricula of academia, then the well educated staff working in industry were able to offer services similar to those of the FFRDCs.

Antagonists view FFRDCs as dinosaurs that encumber making a profit. They cast doubt on the position that the government's need for non-traditional providers of services is the same as it was following World War II. Protagonists view FFRDCs in an entirely new role, no longer as monopolists in the research they pioneered, but as stable intellectual capital in the chaos of short-term, year-to-year contracting.

6.1 The Antagonist Position of the Private Sector

The spectrum of commercial industry that challenges FFRDCs ranges from small engineering firms to the emergent defense contracting giants. The world of Washington consultants, humorously associated with the interstate highway encircling the nation's capital as "Beltway Bandits" or "Highway Helpers," contend that they can do much of the work of the FFRDC Studies and Analysis Centers. After all, both are knowledge-based providers of service to the government.

Modern computing workstations are orders of magnitude more compact, more capable, and less expensive than the mainframes of the 1960's and 1970's used by the FFRDCs in research at that time. Since the tools and the talents have become equivalent,

why not compete the special studies, the analyses of data, the development of algorithms, and the delivery of educated advice in order to maximize quality and minimize cost?

The engineering and integration of large systems may require more than individuals or a small group of people to accomplish. However, mid-to-large sized commercial firms can do this work by assembling a technical team to act as a “general contractor” while a large system is being designed, procured, and deployed by a sub-contracting work force.

Many large organizations support central laboratories that do basic R&D for the company and its clients. Advanced electronics, hardware and software development, and device technology are commonplace in the commercial world. Many companies are experienced in the integration of large systems and the management of large projects. If the board of directors is willing to forego proprietary ownership in order to secure a government contract, then perhaps the opportunity should be available to bid for the work.

As early as 1962 [14] these concerns were expressed by the Congress. As a 1971 DDR&E report [26] suggested, “It is pointless to say that the FFRDCs’ function could not be provided by another instrumentality.” It was in the early 1970’s that the Professional Services Council (PSC) formed for the single purpose of containing and restricting the growth of FFRDCs. The PSC is a lobby group in Washington, D.C., that testifies to Congress and represents the interests of large and small technical firms who would do the work given directly to FFRDCs. The PSC attempts to influence legislation and seeks “ultimately to eliminate the secure and special sole-source relationships that FFRDCs have enjoyed for years [27].” PSC maintains that the pattern of abuse involves three elements:

- (1) FFRDCs are assigned work on a sole-source basis, absent from any real market research that determines whether capability exists in the government or in private industry;
- (2) DoD and civilian agency sponsors often assign work to FFRDCs to avoid competitive procurements or budget constraints;
- (3) FFRDCs have moved aggressively outside their charters and into markets now occupied by private industry [28].

In testifying before the 1995 Defense Science Board Task Force examining the role of FFRDCs, the Information Technology Association of America (ITAA), another Washington lobby group that represents the information technology industry, stated:

FFRDCs have a negative impact on the systems integration community by removing important systems application work from the competitive marketplace. For industry, these lost opportunities involve work performed at the leading edge of information technology. Lost along with the program opportunities themselves are the by-products of federal contracting: insight, innovations, applied research, and experimentation. These are technology advancements which might otherwise lead to profitable commercial applications, market expansion, business growth, and job creation [29].

ACIL, another Washington lobby affiliated with the PSC, represents a variety of smaller testing laboratories and research organizations across the U.S. In an advocacy statement for its more than 400 members, ACIL states:

ACIL supports current initiatives to privatize functions carried out in federal laboratories because we believe government should limit its activities to "inherently governmental" functions: policy, decision making, regulatory and other duties essential to the act of governing. It should not attempt to duplicate efforts of the private, competitive marketplace as a primary provider of services. As federal laboratories seek new missions in the post-Cold War world, ACIL believes fairness should be a governing principle. At the same time, we must not sacrifice the considerable capabilities of our private sector by converting federal laboratories from research to commercial testing [30].

ACIL is concerned that, in order to remain viable following the Cold War era, federal laboratories may look to new endeavors that encroach upon the private sector. By association, FFRDCs fall under similar criticisms. ACIL strongly supports legislation that mandates the government's use of, and reliance upon, the private sector when procuring laboratory and testing services.

While ACIL has not yet targeted FFRDCs with the same zeal as has the Professional Services Council or the ITAA, ACIL is concerned primarily with the civil service federal laboratories, which vary in size and number about 720. However, the ground swell of protectionism generated in Congress by these lobby groups may precipitate legislation in which the funding for the federal laboratories and for the FFRDCs will be further reduced.

6.2 A Favorable Response from the Private Sector

In contrast, there is recent evidence that private industry does recognize and realize a benefit from federally supported laboratories and FFRDCs. Several studies, reports, and congressional bills indicate an additional role for FFRDCs. The customer is private industry, and the new mission areas are technology transfer and joint R&D activities.

This work [31, 32] describes the results of 1988 and 1992 surveys of interactions that involved corporate members of the Industrial Research Institute (IRI) with federal laboratories and FFRDCs. The IRI membership consists of approximately 270 large, research-intensive companies that account for 85% of the total R&D performed by U.S. industry. They span a broad range of industrial sectors, including chemicals, pharmaceuticals, aerospace, defense, transportation, electronics, machinery, fabricated materials, and energy.

These surveys indicate that U.S. industry is looking for technical information, expertise, access to specialized equipment, and new technologies from outside sources. This need responds to greater market pressures, tighter company budgets, and global competition. The surveys indicate that federal laboratories and FFRDCs are an increasingly important source of technical interactions, which are surprisingly initiated by industry itself and are motivated more by long-term, less tangible payoffs than by expectations of immediate business opportunities. By far, the overwhelming incentive for an industry to approach a federally sponsored R&D organization is the access to intellectual resources and to unique facilities and equipment. These studies identified ten types of interactions between industry and FFRDCs:

- (1) Contract research in which the FFRDC hires industry to do work;
- (2) Cooperative research in which costs are shared;
- (3) Workshops and seminars sponsored by the FFRDC for industry;
- (4) Licensing of federally funded technology to industry;

- (5) Sponsored research in which industry reimburses the government for work done at an FFRDC (not typical of DoD FFRDCs);
- (6) Technical consulting with industry by FFRDC personnel;
- (7) Employee exchanges in which researchers trade assignments;
- (8) Use of FFRDC facilities where capabilities are not commercially available;
- (9) Individual visits by industry personnel to FFRDC for discussions;
- (10) Dissemination of information through FFRDC publications and reports.

The kinds of the interactions depend on the specific industry, but tend to favor contract research, cooperative research, and workshops. Access to technical resources, not the short-term expectation of a commercial payoff, was the primary stimulus for interaction reported by the chief technology officers of the IRI membership.

The surveys also indicated that industry's disincentives for interacting with federally-supported research centers included uncertainty about administrative requirements and procedures, intellectual property rights, protection of proprietary information, and possible conflicts of interest. Ironically, these are some of the very obstacles that FFRDCs were intended to circumvent. Over the past few years, the concerns about intellectual property have been clarified through legislation (described in the following section of this thesis). However, industry may not be totally aware about the flexibility and protection which FFRDCs afford them. It therefore behooves FFRDCs to make themselves better known to industry as places to do long-range problem-oriented research, especially if it is directed toward public missions and goals. In that way, industry will more actively seek out collaborations with federal research centers. Technology "pull" by industry will be much more effective in transferring knowledge than a technology "push" by FFRDCs.

6.2.1 Federal Incentives for Cooperation Between Industry and FFRDCs

Since 1980, several pieces of legislation and executive orders have enabled a greater utilization of the total \$70 to 75 billion that the federal government currently spends per year on research and development (of which \$1.2 billion goes to DoD FFRDCs). This is accomplished largely by the transfer of technology to the public and private sectors, so that commercialization can boost the economy and improve competitiveness on a global scale. The chronology for this legislation is shown in Table 6-1. These documents establish the legal mechanisms by which FFRDCs and private industry can work together, and help to craft the future mission of FFRDCs that is discussed in Chapter 10 of this thesis.

A very flexible arrangement for technology transfer from an FFRDC to private industry is the Cooperative Research and Development Agreement (CRADA), which was enabled by the 1986 Federal Technology Transfer Act. A CRADA is defined as

Any agreement between one or more federal laboratories and one or more non-federal parties under which the Government, through its laboratories, provides personnel, services, facilities, equipment, or other resources with or without reimbursement (but not funds to non-federal parties); and the non-federal parties provide funds, personnel, services, facilities, equipment, or other resources toward the conduct of specified research or development efforts that are consistent with the mission of the laboratory; except that such term does not include a procurement contract...and as such the Federal Acquisition Regulation (FAR) and the DoD FAR Supplement are not applicable to these agreements [33].

One of the most attractive features of a CRADA is its legal circumvention of the cumbersome Federal Acquisition Regulation (FAR) that applies only to an official government procurement, which a CRADA is not. However, as mentioned above, the perceived specter of administrative “red tape” may turn industry away from approaching federal resources.

DESCRIPTION

ACT

YEAR

YEAR	ACT	DESCRIPTION
1980	Stevenson-Wydler Technology Innovation Act	Established technology transfer as official policy, and directed laboratories to establish Offices of Research and Technology Applications to serve as links to the private sector
1980	Bayh-Dole University and Small Business Patent Procedure Act	Permits non-profits and small businesses to retain patent rights to technology developed under government R&D support
1984	Cooperative Research Act	Permits consortia of companies to enter joint ventures without violating anti-trust laws
1986	Federal Technology Transfer Act	Created legal basis on which all government-funded laboratories and R&D institutions can enter into joint R&D agreements with non-government partners. Cooperative Research and Development Agreements (CRADAs) permit joint ventures with universities, corporations, and local governments in which both partners retain intellectual property rights. The government receives a royalty, and the private partner retains licensing rights.
1987	National Defense Authorization Act	Encourages DoD to transfer its technology to the private sector to the extent it is consistent with national security
1987	Executive Order 12591 Facilitating Access to Science and Technology	Directs DoD to promote commercialization of science and technology, and to accelerate their transfer to potential domestic users
1988	Omnibus Trade and Competitiveness Act	Directs the National Institute of Standards and Technology to promote commercialization and transfer of federally funded technology to private industry, and state and local government
1989	Domenici National Competitiveness Transfer Act	Contractor-operated federal labs may form CRADAs
1989	National Defense Energy Technology Transfer Act	Emphasis placed on transfers from Department of Energy

Table 6-1. Chronology of Technology Transfer Legislation

6.2.2 Payoffs to Industry

Cooperative research between FFRDCs and private industry carries the greatest promise for the commercial partner who takes a farsighted view. After all, long-term continuity and institutional memory are familiar elements the “special relationship” between an FFRDC and its government sponsors. Table 6-1 lists government legislation and policy that enable a similar relationship to exist with a commercial organization that wants access to the knowledge capital and other assets of a federal R&D center.

A significant benefit to industry is the transfer of ideas, for which measures are not as readily defined as they are for the transfer of technology. The exchange of ideas is subtle and does not tabulate as easily as the number of patents or licensing agreements, invention disclosures, and publications. Leveraging ideas will lead to business opportunities and commercialization for industry, and to an additional source of relevance for the FFRDCs beyond their responsibilities to the government.

The business time horizon is usually short-term. Private R&D laboratories are more tightly focused on commercial products or processes, and introduce results when they can be useful in production. An affiliation with an FFRDC, which normally takes the long-term view, allows industry to explore futuristic concepts, share costs, and minimize investment in capital equipment that is already in place at the FFRDC. The government itself might orchestrate or sponsor the collaboration if it relates to the agency’s own goals, thereby gaining the synergism of both partners and avoiding the extra costs of redundancy.

6.3 A Reconciliation of Opposing Views

Private industry becomes very vocal when it feels it can do the work that is being given directly to FFRDCs. The Professional Services Council, ITAA, and ACIL are lobby groups whose purpose is to reduce or even extinguish the role of FFRDCs and other federally supported laboratories in performing R&D work for the government.

However, there is compelling evidence that industry benefits from its interactions with federal R&D centers, especially if the collaboration looks to the future and not just to the next balance sheet. Looking at FFRDCs as “national assets,” the private sector has access to the government’s 50-year investment into intellectual capital and equipment.

The issue here is collaboration, not competition. While the criticism of FFRDCs has some substance in light of the current R&D capabilities of private industry, it is one-sided and must not be so uncompromising as to ignore the value and service that FFRDCs provide to the government and to the economy. The advocates of FFRDCs must likewise acknowledge that their once exclusive role has evolved.

6.4 A Comment on Criticisms from the Private Sector

In FY1996, the DoD spending for research, development, testing and evaluation (RTD&E) was \$35.1 billion (about one half of the total federal R&D budget of \$71.1 billion, summed across all agencies and departments). Of this amount, 86% went to private industry by competitive means. Following this, 4.6% went to DoD FFRDCs and 1.3% went to DoD University Affiliated Research Centers by non-competitive means. (See section 8.5 of this thesis for a discussion of UARCs.) In-house DoD operations (federal laboratories and other activities) account for the remaining 9.4% [34].

These are not large targets. Together, FFRDCs and UARCs received less than 6% of the FY1996 DoD RDT&E budget, while private industry received 86%. Several FFRDC advocates have commented that the private sector is “after the last dollar on the table,” and speculated that much of the current controversy is “much ado about nothing, and merely generates cash flows for lobbies and lawyers.”

In attacking FFRDCs, private industry has discovered a new tactic of competition, a strategy not based upon technical merit or valuation, but based upon the manipulation of ideologies in a litigious arena. Under penalty of law, boards of directors are compelled to

make the largest possible profits for their shareholders, even if doing so is ironically not in the best interest of national defense. It is certainly appropriate for DoD to examine and correct past irregularities, and to align FFRDCs with a sound management plan that is unambiguous and clear. It is also appropriate for the private sector to accept its 86%, compete among themselves, and preserve the national assets that are the FFRDCs.

7.0 FFRDC Reactions to External Forces

Each FFRDC is run by a different kind of parent institution--by a university, by an independent non-profit corporation, or even by a subsidiary of a for-profit corporation (as is the case of some FFRDCs sponsored by the Department of Energy). In response to the reductions in defense funding and to the criticisms from the Congress and the private sector, FFRDCs have tried various strategies to remain viable and to generate some diversity. Here we consider the tact of several of the DoD FFRDCs in that effort.

7.1 M.I.T.--Lincoln Laboratory

By the end of the 1940s, the Soviet Union had developed nuclear bombs and the aircraft to deliver them to North America. The Truman Administration asked the Air Force to develop a system that could defend against that threat, and the Air Force called on the Massachusetts Institute of Technology for technical assistance. Drawing upon the experience and expertise of the Radiation Laboratory at M.I.T. that had developed radar systems during World War II, the Institute founded Lincoln Laboratory in 1951 as a "Laboratory for Air Defense" with a mission to develop an air defense system that could detect, identify, intercept, and direct resources against hostile aircraft. This effort produced the Semiautomatic Ground Environment (SAGE) system, which had an enormous impact upon scientific advancement in the United States and especially upon high-technology industry in eastern Massachusetts. SAGE effectively created the computer industry and digital communications industry, invigorated International Business Machines (IBM) as the prime computer contractor, and spawned the Digital Equipment Corporation (DEC) when much of the federally sponsored computer research was transferred to industry.

In 1952, Lincoln Laboratory conducted a study that led to the creation of the Distant Early Warning (DEW) Line, a string of radars from Greenland to Alaska for detecting incoming aircraft. This effort evolved into the Ballistic Missile Early Warning System (BMEWS) and the

Laboratory's involvement in the development of radar and infrared systems for ballistic missile defense and of satellites for military communications.

From those origins 45 years ago, the Laboratory has followed its mission statement to "carry out a program of research and development pertinent to national defense with particular emphasis on advanced electronics...and to provide technical advice and consultation in areas of its demonstrated competence to the military services and other defense and government agencies [35]." Lincoln Laboratory has always sought to transfer technology to industry, and since 1993 has participated in co-operative research and development agreements (CRADAs) to work jointly with industry before the government conducts a competition or procurement. After the research has been done or the prototype demonstrated, the Laboratory typically transfers the technology to the government for commercialization and moves on to a new task.

This model is perhaps the least objectionable mode of operation from the viewpoint of private industry (which has profited immensely from the technical work completed at Lincoln Laboratory without having to take on the risk and expense of the R&D or initial experimentation).

The core competencies and capabilities of Lincoln Laboratory, as identified by the Defense Science Board, are shown in Table 7-1. These follow Lincoln's charter to demonstrate the feasibility of, and to conduct R&D on, advanced systems concepts and technology.

Lincoln Laboratory is a bona fide R&D laboratory, one of the three categories of DoD FFRDCs described in Section 4.2.1 of this thesis. As such, its strategy has been to adhere closely to its original mission statement and not to attempt to venture from its terms, other than to accommodate the more recent federal legislation that allows CRADAs and encourages technology transfers. About 15% of the work is sponsored by non-DoD federal agencies such as the Department of Transportation, the FAA, and NASA, which is well within the 30% limit set by the guidelines. This very conservative approach was not without consequences. In the mid 1990's, when the Laboratory's budget dropped by almost \$100 million, there was a significant reduction in

FFRDC	CORE COMPETENCIES	CAPABILITIES
Lincoln Laboratory	<ul style="list-style-type: none"> • Ballistic missile defense • Communications • Space surveillance • Air defense • Surface surveillance • Advanced electronics technology 	<ul style="list-style-type: none"> • Independent advice on military technology issues and defense systems • High-quality interdisciplinary research staff recognized by their peers • Interaction with M.I.T. to produce technical advances and breakthroughs
MITRE C ³ I	<ul style="list-style-type: none"> • System of systems engineering • Systems development and acquisition • Process implementation • Technology application • Architectures and interoperability 	<ul style="list-style-type: none"> • Creation and choice of C³I systems • Specification of interfaces and system hardware and software • Provide on-site support to commanders during tests and experiments • Maintain a thorough understanding of all systems in wartime and peacetime
Aerospace	<ul style="list-style-type: none"> • Launch certification • System of systems engineering • Systems development and acquisition • Process implementation • Technology application 	<ul style="list-style-type: none"> • Creation and choice of space systems • Development and testing of space systems hardware and software • Technical review, monitoring, and steering of industry • Integration of subsystems in to overall national security space system

Table 7-1. FFRDC Core Competencies and Capabilities of the Three Largest DoD FFRDCs

personnel due to layoffs, early retirements, and accelerated attrition. By FY1996, the budget stabilized at \$250 million, and the work force is gradually being restored.

7.2 The MITRE Corporation (MITRE C³I)

Lincoln Laboratory's role and mission as part of M.I.T.'s R&D activity did not extend to the implementation and acquisition of defense systems. Therefore, in 1958 that part of Lincoln Laboratory working on SAGE was transferred by the Air Force to the newly created MITRE Corporation to complete the engineering task of deploying the SAGE system. MITRE became a separate FFRDC to serve as a link between the government and the science and engineering communities while SAGE was being procured and built [15].

Since 1958, MITRE's scope expanded and then contracted, such that in 1997 it manages two FFRDCs that perform systems integration and engineering work for Defense Department Command, Control, Communications, and Intelligence (C³I), and systems R&D work for the Federal Aviation Administration (FAA) and other civil aviation authorities. MITRE professes the special relationship with the government that permits its access to sensitive government information and a long-term perspective not characteristic of commercial contractors who compete for government business [36].

The Assistant Secretary of Defense for C³I is the primary sponsor of the first of MITRE's FFRDCs, which supports various Army and Air Force Commands to install battlefield digitization applications, the Navy to develop a capability to detect and clear mines, and the Defense Advanced Research Projects Agency (DARPA) and the Defense Information Systems Agency (DISA) to incorporate advanced information technology into operational military systems and equipment. The FAA FFRDC is helping to design a future air traffic control system and to promote the safe global management of air traffic.

MITRE is currently adhering to the traditional role of the FFRDC, but this has only recently been the case. With the criticisms of inappropriate use of management fees [37], and with the

scrutiny of the Congress and private industry, MITRE underwent a major transformation in early 1996 when it split into two separate and unrelated corporations: MITRE and MitreTek Systems. Over the past 10 years, MITRE had taken on work that was beyond the traditional FFRDC role, even daring to do work for state and local government agencies. (This is exactly the type of incursion to which ACIL and PSC vehemently object [30].) Like the biblical scapegoat [38], MitreTek carried away the transgressions of the corporation so that MITRE could refocus itself on its FFRDC mission as the FAA and DoD direct. MITRE has essentially reverted to its origins and, ideologically, is much like Lincoln Laboratory in that respect.

MitreTek itself is a non-profit company that assumed all of the contentious non-FFRDC work that had to be shed by MITRE. The two organizations are totally separate, and do not have any overlapping boards of trustees, officers, managers, or employees. MitreTek, which is not constrained by FFRDC rules, is free to diversify its work [39]. However, how MitreTek will deal with the commercial sector without the FFRDC umbrella remains to be seen.

The mitosis of MITRE demonstrates one way in which an FFRDC might respond to pressure from the Congress and from the private sector if its scope has noticeably extended beyond its charter or beyond federal guidelines. Spinning off the sources of criticism is one survival strategy. As discussed in the next example, being acquired by a private organization is another.

7.3 The Aerospace Corporation

The Aerospace Corporation is a private, non-profit corporation that was created in 1960. The purposes of the corporation are exclusively scientific: to provide research, development, and advisory services to its primary customer, the Space and Missile Systems Center (SMC) of the Air Force Materiel Command. Some work is performed for other federal agencies, international organizations, and foreign governments in the national interest.

The Aerospace FFRDC fulfills the functions of an architect-engineer for space systems; it assists with the engineering tasks required to develop space systems, from initial concept and

design to deployment and operation. Progress is monitored, alternatives and tests are analyzed, and problems are resolved in cooperation with industrial contractors and federal laboratories.

Aerospace oversees the technical planning and management of military satellites, while protecting the proprietary space technologies of the participating defense contractors. It seeks to minimize system development time and operational risks for the Air Force, which in turn protects acquisition schedules and aids in cost containment. About 93% of Aerospace's current revenues come from the DoD.

Partly because its budget and business with the Air Force had been declining over recent years (from \$350 million in 1995 to \$306 million in 1996 with a consequent 25% reduction in personnel from 4,000 to just under 3,000), Aerospace announced that it wanted to renounce its status as an FFRDC and to merge with the commercial Science Applications International Corporation (SAIC) [40]. Under this proposal, Aerospace would become a wholly owned subsidiary of SAIC, which would use Aerospace's resources to expand into the lucrative commercial markets of space applications. Aerospace would be free to compete for government contracts and for commercial work under this arrangement, with the potential of significantly broadening its business opportunities.

Aerospace officials further believed that the merger would safeguard the mix of its skilled personnel, maintain the organization's core competencies, ensure the organization's ability to apply its technical capabilities to national needs, and reduce costs to the government.

The proposed merger, which the Air Force would have to approve, ironically raised major concerns among other commercial contractors who believed that the acquisition would give SAIC too much of an edge. Aerospace, after all, had enjoyed a special relationship with the Air Force for 36 years that allowed access to sensitive government plans and to the proprietary information of all commercial organizations participating in the government's space efforts. SAIC's acquisition of this information and of the personnel who carry that knowledge would indeed create a competitive advantage.

On the other hand, the Professional Services Council, the lobbying group mentioned earlier that represents the interests of private industry, praised the merger as a signal of the demise of FFRDCs:

If this action, along with the breakup of the MITRE Corporation, are the examples of an emerging trend, we are pleased and will work to encourage, facilitate, and accelerate this movement [41].

After studying the proposal for several months, the Air Force disapproved the merger on November 18, 1996 and concluded that it would not be in the best interest of the U.S. government [42]. The Air Force stated that because of its unique knowledge and access to information about military launchers, reconnaissance, and communications satellites, Aerospace should remain an FFRDC. SAIC and Aerospace subsequently called off the merger.

The upside of these events is that the Air Force reaffirmed the value and status of its FFRDC. Aerospace became more fully appreciated, even in the light of decreasing budgets and personnel cutbacks. The Air Force stated that it is committed to ensure that Aerospace will continue to contribute to the needs of the national space program as an FFRDC.

Aerospace attempted to escape FFRDC status on its own and to enter the commercial world because it felt that its vitality was evaporating. Instead, it was forcibly brought back to conform to its original mission.

7.4 The Studies and Analysis Centers

The three FFRDCs described above together use 79% of the total DoD FFRDC funding, and employ 78% of all the technical staff [20]. Therefore, they are the most visible and the most scrutinized by Congress. In comparison, the six studies and analysis centers together use 17% of the funds, employ 16% of the technical staff, and therefore draw much less attention to themselves. (The remaining two of the eleven FFRDCs make up the rest.) As was shown in section 5.3, by 1995 the S&A centers had suffered the smallest cumulative reductions in funding (7%) and staffing (9%) compared to the 1991 numbers.

Perhaps there is some anonymity, or at least some safety, in having smaller a budget but a much needed mission. Since 1995, the S&A centers have experienced little change from the status quo and have maintained a stable level of effort. There have been no attempts to expand the scope defined by their primary sponsors, and no attempts to redefine or redirect the S&A centers.

7.5 FFRDCs: No Exit ?

In 1969, the number of FFRDCs throughout the government had peaked at 74. Today there are 39, 11 of which are run by DoD. An FFRDC can be redirected, decertified, or abolished only at the discretion of its government sponsor. An FFRDC cannot transform itself without permission from the sponsor, which is why the self-serving attempt by Aerospace to become commercial was a surprising and unprecedented move. Some FFRDC leaders believe that Aerospace's action was more than an attempt to call attention to the plight of FFRDCs. Perhaps it was a ploy to capitalize on the environment at a time when the Air Force might have been tempted to decertify Aerospace.

If the acquisition by SAIC had actually been approved, there would have been many unsettled issues: Who owns the fixed assets? How do you evaluate the purchase of a non-profit corporation that is intended to make a profit in the future? Since Aerospace is a knowledge-based service organization, what price is put on its knowledge capital? To whom would the purchase price be paid? In order to avoid serious conflicts of interest, is it proper for the current Aerospace executives to move over to the new enterprise and assume the lucrative equity positions they were expecting?

These are just a few difficult questions that fortunately did not have to be answered. No government sponsor would have been prepared on short notice to cope with such a legal quagmire, and the Air Force appropriately disallowed the acquisition. The incident,

however, points out how complicated an FFRDC has become as an entity, and how difficult any change of status will be.

The benefits of expanding scope beyond the traditional FFRDC role must be discharged (MITRE); attempts to invigorate and diversify through self-commercialization are impossible (Aerospace); efforts to adhere closely to the regulations confront budget cutbacks and reductions in personnel (all others). Ironically, the same special relationship, which affords an FFRDC some degree of protection and privilege, also limits its options for the future. The next chapter suggests ways for FFRDCs to do business that are less restrictive, provide diversity, and still retain the essential elements of freedom from conflict of interest and of commitment to the government sponsor over the long term.

8.0 Alternative Forms of Doing Business

In order to avoid actual or perceived conflicts of interest, DoD FFRDCs must accept stringent restrictions on their scope, size, method of operations, and the kinds of work they undertake for their sponsors or for other users. The primary sponsor has absolute authority over its FFRDC and may apply the policies and procedures according to its own discretion as long as the guidelines in the FFRDC Management Plan [8] issued by DDR&E are followed. Therefore, the limitations on the 11 FFRDCs and on the parent institutions that run them do not have to be absolutely uniform, and are determined on a case-by-case basis. Variations depend on the definition of the core work that is appropriate for each FFRDC, and on the criteria that permit the parent institution to accept non-core work outside of the domain of the FFRDC.

8.1 Core Work for an FFRDC

The DoD has adopted two criteria for identifying what constitutes core work for an FFRDC [8]:

- (1) The work must be consistent with the FFRDC's purpose, mission, capabilities, and core competencies.
- (2) The work must require the special relationship with the sponsor.

These criteria ensure that the FFRDC has the means and resources to do the work; that the work must be protected from conflicts of interest; that the work requires access to sensitive government, pre-competitive, or proprietary information; and that the work is consistent with the long-term plans of the sponsoring agency.

In 1995, the Defense Science Board Task Force, working with an internal DoD advisory group, estimated that the core work effort comprised only 3.4% of DoD's total research, development, and analytic effort [4]. The Task Force and advisory group also suggested that some FFRDCs were doing work that did not require the special relationship, and that such work should be transitioned out of the FFRDCs and acquired from the private sector competitively.

DoD recognizes that it is important to ensure that tasks given to FFRDCs meet the core work criteria. However, the Government Accounting Office conducted a review in 1996 and acknowledged that determining whether a piece of work meets these criteria will continue to be difficult because the FFRDC mission statements are broad and encompass very general areas [43]. Indeed, the GAO survey of FFRDC sponsors indicated that the sponsors themselves identified little, if any, work that was not core.

Clearly, there remains a spectrum of opinions concerning the kind of work that is "core." Partly in response to these issues, in 1996 the MITRE Corporation did divest itself of work that was questionable or controversial. Also, DDR&E's 1996 Management Plan [8] provided guidelines for primary sponsors and drew a clear distinction between the FFRDC work and non-FFRDC work which a parent organization may do. A parent institution or organization is the entity with which DoD contracts to operate an FFRDC. This can be a university or a non-profit corporation.

FFRDC work must be approved by the primary sponsor, and can be accepted only from DoD, other federal agencies, state and municipal governments, and not-for-profit activities. No commercial work can be accepted into the FFRDC domain.

A parent institution may do non-FFRDC work with the permission of the primary sponsor. Universities that run FFRDCs, for example, regularly do unrelated work. However, the DDR&E guidelines require that the non-FFRDC work must not undermine the independence, objectivity, or credibility of the FFRDC by posing an organizational

conflict of interest. The work must not be acquired by taking unfair advantage of the existence of the FFRDC, or of the information that is available to the parent institution only through its FFRDC.

The laboratory FFRDCs (Lincoln Laboratory and the Software Engineering Institute) may participate in technology transfer activities, such as CRADAs, when the sponsor feels it is appropriate. However, safeguards are installed to prevent conflicts of interest or preferential treatment of one commercial partner over another.

8.2 FFRDC Support of Government Functions

As advisory contractors, FFRDCs must be careful not to perform functions that are inherently the responsibility of the government. These are duties related to the public interest and welfare, such as commanding military forces, hiring federal employees, setting government policy, and awarding government contracts. Watchdogs of FFRDCs caution that DoD must not outsource or relegate government functions to its FFRDCs. FFRDCs should advise the government in making its decisions, which should be the result of informed judgments made by government officials. This support takes the form of

- analyses and feasibility studies to be used in developing strategy;
- support of planning acquisitions and procurements;
- technical evaluation of contract proposals;
- assistance in developing statements of work for commercial contracts; and
- work that involves access to sensitive government or proprietary data.

Sponsors have identified the objectivity of an FFRDC as one of the more important aspects of support. This is especially important because FFRDCs help DoD to develop and analyze policy and strategy options, and to assess alternative technologies. In many cases,

FFRDCs evaluate the performance of commercial contractors and participate in source selections for major procurements.

Within the perimeter of the special relationship, an FFRDC acts as advisor, confidant, evaluator, analyst, and innovator. However, an FFRDC needs options, too, in order to keep its activities stimulating and interesting to the technical staff. There is some flexibility within the restrictions and, with the approval of the primary sponsor, there are mechanisms by which to bring in work that offers some diversity and incentive.

8.3 Cooperative Research and Development Agreements (CRADAs)

CRADAs were mentioned in section 6.2.1 of this thesis as a means for the government to encourage technology transfer and scientific collaboration between FFRDCs and the private sector. Since 1993, the FFRDC R&D laboratories have participated in CRADAs with industry, mostly in the areas of semiconductors and advanced electronics. These have been relatively small efforts, however, typically under \$1 million and lasting for no more than 1 to 2 years.

CRADAs offer an additional way for FFRDCs to conduct research, and should be pursued more vigorously. The Executive Branch and the Congress encourage interactions between the government and the private sector [44], and the mutual benefits can be considerable. However, there are some barriers that may hinder the establishment of CRADAs.

Because of a smaller budget and a ceiling on the technical staff headcount, an FFRDC may be fully subscribed by its core work. Even if there is interest from industry, there may be few resources to direct toward the CRADA. An FFRDC's responsibility is to its primary sponsor, so that the latter would have to sanction the CRADA and permit a redirection of resources to support it.

There are legal issues that have to be resolved. The 1986 Federal Technology Transfer Act created the legal foundation on which FFRDC laboratories and industry can enter into joint R&D agreements. While private industry is likely to take the long-term perspective, it will nevertheless want to negotiate property rights, licensing, patent ownership, and royalties to favor its future business opportunities. This is a natural and understandable position that stems from a responsibility to the shareholders. The objective of the CRADA would have to fit into the corporation's technology strategy, filling in a missing capability or complementing technologies that already exist in house. There remains the clash between short and long term corporate goals. The current trend in the private sector is to decentralize R&D to be closer to the business units and profit centers. This puts control, clarity, and accountability into the effort. However, if the CRADA cannot be associated with future markets of new products or services, then the effort is less desirable from industry's point of view.

Cultural differences are also a barrier. Industry is used to dealing with the government on a very formal basis where military specifications, federal acquisition regulations, and formal contracts abound. A CRADA purposely circumvents much of the "red tape" and fosters the more flexible and less formal environment of an FFRDC. Industry may not be comfortable with the semi-academic role of FFRDCs as facilitators and conduits of technology. Consequently, industry may approach a CRADA with caution because it pre-supposes that FFRDCs have no real "business sense" and cannot relate to a business strategy.

In order to avoid an internal conflict of interest, the FFRDC must not co-mingle its other work with the CRADA. The two must be kept separate, so that the industrial partner does not inadvertently gain a competitive advantage through exposure to any proprietary or sensitive information from another activity within the FFRDC.

A further complication is the offering itself. If two or more private corporations can do the same work, which will join in the CRADA? Does a participant gain an unfair competitive advantage (real or perceived) over its commercial brethren by being involved early, even if the outcome of the research must be non-proprietary? The historical difficulties in dealing with the government on contractual rules and on intellectual property rights are still a source of aversion. However, an increased awareness about the CRADA mechanism by industry, FFRDC sponsors, and the staff working inside FFRDCs will lessen these concerns and promote the personal interactions that transfer technology.

8.4 Broad Agency Announcements (BAAs)

The government has several means by which to solicit bids from private industry. Commerce Business Daily is an official publication that announces and describes work that the government needs to be done. All agencies can advertise in the CBD. In addition, the three military services utilize Broad Agency Announcements (BAAs), which are issued frequently to identify specific areas of research interests, as well as to invite research proposals from universities, non-profits, and private industry. The Federal Acquisition Regulations define a BAA as an

...announcement that is general in nature identifying areas of research interest, including criteria for selecting proposals, and soliciting the participation of all offerors capable of satisfying the government's needs. [BAAs are to be used for] the acquisition of basic and applied research, and that part of development not related to the development of a specific system or hardware procurement.

Today, FFRDCs run by DoD may not respond to BAAs. (In the past, the MITRE Corporation had been allowed by the Air Force to respond to BAAs and to take on work. This expansion of MITRE's scope into areas that were traditionally not its domain brought severe criticism from the private sector, and contributed to the spin-off of MitreTek.) Some FFRDCs run by the Department of Energy have been allowed by DoE to respond to DoD

BAAs. (Sandia National Laboratory and Lawrence Livermore National Laboratory routinely respond to BAAs.) The policy is not uniform throughout the government, and seems to depend on the sponsoring agency. Any FFRDC response to a BAA will draw the attention of the Professional Services Council, ACIL, and others who closely watch all FFRDC activity.

However, there is an untried combination we propose here that includes a military service or government agency, an FFRDC, and private industry within the BAA construct. Simply put, the BAA would be configured as a solicitation to collaborate with an FFRDC to do a piece of research. To the issuing agency, such a “modified BAA” provides a means of imbedding FFRDC assets and expertise into the competitive bidding process. The winner enters into a joint activity with the FFRDC designated in the BAA. The FFRDC does not compete for the BAA, as its participation is actually part of the terms defined by the offering agency.

This would seem to be an all-win arrangement. The BAA program manager benefits from access to the FFRDC’s equipment and technical expertise; as we saw in section 6.2 of this thesis, these are the same factors that encourage private industry to interact with an FFRDC. This approach engages the private sector in a competitive procurement, and perhaps offers the same ownership and intellectual property rights to the commercial partner as would a regular BAA. The private sector should be pleased that a competition among peers did indeed take place, providing the opportunity to show its own technical capabilities and to join them with those of an FFRDC. The FFRDC continues to serve its sponsor in its traditional role.

In principle, any offering in the BAA, Commerce Business Daily, or other federal “want ad” such as the Federal Register, might include an explicit collaboration with an FFRDC or federal laboratory. In this way, the government can leverage FFRDC assets with the cash it uses to procure services from the commercial sector.

8.5 University Affiliated Research Centers (UARC)

University Affiliated Research Centers are a hybrid of academia and FFRDC. There are six UARCs that are funded directly by the Department of Defense without competition, much in the same way that FFRDCs are funded. Only within the past few years have UARCs attracted the attention of Congress and the private sector because of the funding mechanism, and DoD has found it necessary to begin defending its UARCs along with its FFRDCs.

How does a UARC differ from an FFRDC? The distinctions are subtle, and derive mainly from the parent institution. UARCS must be affiliated with a university, and there are very close administrative and departmental connections with the school's infrastructure. Many activities, resources, and administrative issues of the university and UARC are co-mingled. The education of students is one of the major goals; UARCs participate in both undergraduate and graduate programs of study, and are involved in the granting of degrees by the university. There is one major DoD sponsor, but there can be several minor sponsors that broaden the support base. The UARC is allowed to compete with private industry for other government work (such as Broad Area Announcements), and can receive contracts from private industry, as long as the work does not overlap with the work already being done for the major DoD sponsor as part of the UARC activity.

In the case of Johns Hopkins University-Applied Physics Laboratory, the largest UARC, all non-program specific equipment and real property (building, land, etc.) are owned by JHU. APL uses industrial financial practices, charges a management fee of 3.7% (part of which goes directly to the university), and has built up a \$45 million reserve fund which it can use for capitalizations that are not specific to any program.

The UARC model seems more flexible than does an FFRDC. It would seem logical for the two DoD FFRDCs (Lincoln Laboratory and the Software Engineering Institute), which are run by universities (M.I.T. and Carnegie-Mellon) to consider becoming UARCs. There would be a clear separation from FFRDCs, the opportunity for a new role not available to the other nine FFRDCs, and the possibility to diversify by responding to BAAs and other offerings, even from the private sector itself.

However, just as in the case of Aerospace's attempt to become commercial, the details of such a transition are uncertain and impeding. The re-assignment and reuse of government facilities and property are not clear. For example, Lincoln Laboratory does not own any assets, buildings, or equipment; all property belongs to the government. Its plant is leased from a private developer who may not be willing to continue the current lease if the Laboratory changes its category, because the same negotiated agreements about the lease may not carry over. A government agency would have to agree to become the major sponsor. New contracts would have to be negotiated with unfamiliar issues, such as a termination clauses, university overhead charges, and management fees. The work being done for non-DoD sponsors could also be impacted, especially if a new sponsor has different expectations or policies concerning the management of FFRDCs.

This is not to say that becoming a UARC is not desirable. There are many legalities that would have to be resolved. Menacingly, the period of transition provides a window of opportunity for the critics of FFRDCs and UARCs to act.

The Congress and the Professional Services Council have recently targeted UARCs because of the same direct funding issues that arose with FFRDCs. Table 8-1 lists the UARCs and FFRDCs with their FY 1996 budgets. Three of the UARCs used to be FFRDCs, but their status changed in the 1970s. It is notable that the second largest of all the budgets actually belongs to a UARC (Johns Hopkins-Applied Physics Laboratory), and that the rest of the UARC budgets are comparable to those of the FFRDCs. UARCs

Table 8-1 DoD UARCs and FFRDCs: FY 1996 Budgets

<u>UARCs</u>	<u>Established</u>	<u>FY96 Budget (\$M)</u>
Johns Hopkins Applied Physics Laboratory *	1942 / 1978	316
Pennsylvania State Applied Research Laboratory *	1945 / 1978	65
University of Texas Applied Research Laboratory	1945	43
University of Washington Applied Physics Laboratory *	1943 / 1975	16
Utah State Space Dynamics Laboratory	1982	13
Georgia Tech Research Institute	1934	10
Total Budget		463
<u>FFRDCs</u>		
MITRE C3I	1958	342
Aerospace	1960	306
MIT-Lincoln Laboratory	1951	250
Center for Naval Analysis	1942	46
IDA C3I	1956	31
Software Engineering Institute	1984	27
Logistics Management Institute	1984	27
RAND Project Air Force	1946	24
RAND NDRI	1983	22
RAND Arroyo	1984	20
IDA OT&E	1956	13
Total Budget		1,162

* Formerly an FFRDC: Year established as FFRDC / year became UARC

account for 28.5% of the total \$1.625 billion that the DoD ascribed to its non-profit organizations in FY1996. This significant percentage shows that DoD is underwriting the education of new technologists and the growth of an economy based in technology. There is long-term value in that action.

8.6 Conclusions

The options available to FFRDCs are limited, and the core work requires that the terms of the special relationship apply. FFRDCs support the functions of the government in an advisory role, but neither make important decisions nor set policy. Within this perimeter, the FFRDC can serve the government, but will do so in a rarefied atmosphere unless there is interaction with the private sector.

One mechanism to interface with industry is the CRADA, which provides a means for technical exchange and circumvents many of the cumbersome administrative rules that would otherwise suffocate the interaction. DoD FFRDCs have not historically used CRADAs to as great extent as have some other government agencies (such as the Department of Energy). A CRADA is an opportunity for an FFRDC to utilize its resources and to diversify its scope in a way that private industry will not find objectionable because it, too, is a participant.

Similarly, a BAA, which includes an FFRDC as an active participant but is competed in the usual way in the marketplace to obtain the commercial partner, is another mechanism to establish productive interactions with the private sector. This is a situation in which the government, FFRDC, and commercial partner can mutually benefit, and the concerns of private industry can be minimized. The use of BAAs in this manner does not seem to be a model of collaboration that has been fully explored.

Two DoD FFRDCs might consider becoming UARCs, although the transition is not well understood in the current environment. Similar to FFRDCs because they receive

direct funding without competition, UARCs seem to have more flexibility because of being imbedded in a university structure. However, UARCs have recently become targets of the same critics of FFRDCs. Converting to UARC status may not be advisable until the FFRDC situation has fully stabilized and the details of such a conversion can be resolved.

Because private industry already receives such a large share (86%) of the DoD RDT&E budget, the move to further constrain or eliminate FFRDCs and UARCs is excessive and shortsighted. Both contribute to the advancement of knowledge in their own ways, and both provide transfers of technology to the private sector. Industry must also realize that its fiduciary responsibility to shareholders and investors implicitly involves the military protection of the global markets in which real profits can be made. FFRDCs, as agents of the Department of Defense, are a part of that insurance.

9.0 The Value of an FFRDC

Estimating the payoff of research and development is a notoriously difficult task. In the commercial world, initiating an R&D activity is usually part of a technology strategy and a corporate strategy that together attempt to maximize profit and shareholder value. Commercial R&D is driven by the marketplace, to develop new products and services that produce income and enhance a corporation's competitive advantage. There have been many studies about valuing commercial R&D and posing metrics to track the impact it has on the firm [45], but value is ultimately measured in terms of the revenue it produces compared to what it costs to carry out.

In academia, profit is not as much of a motive, although the potential for patents, licensing fees, royalties, and spin-off companies are real considerations. Advancing knowledge, educating students, and gaining recognition from peers are strong incentives in the university setting. Initially, at least, academic researchers are more concerned with advancing a technology than with the commercialization of it.

Government has a very different focus. Government is not in the business of making profits; it is in the business of taxing profits. When government funds an R&D effort, the payoff comes on behalf of the national security, the national economy, and the public welfare. There is a mandate to encourage competition and to procure the best goods and services for the taxpayer's dollar. Federally funded R&D strengthens the economic position of the country on a global scale, and provides an environment in which capitalism and commerce can prevail, flourish, and produce gains that are taxable.

Forbidden to make a profit, to grow beyond a specified size, and to offer goods and services for sale in the marketplace, FFRDCs play an important role in this cycle. An FFRDC can provide a buffer between market forces and federal funding such that pre-competitive requirements and specifications can be settled before the bidding and procurement begin. Placing a value on this role cannot be done in a totally conventional

way, as it involves tangible and intangible elements that are not widely applicable to the commercial world, which has its own set of values.

A government sponsor can view giving R&D work to an FFRDC much in the same way as a chief executive or financial officer views the startup of an R&D activity within his own corporation. First we develop some terms and ideas that will help explain that analogy.

9.1 Value in the Private Sector

The “value of the firm” is derived from balance sheets and income statements, which variously cite assets, liabilities, equities, cash flows, retained earnings, and profits. The external shareholder values the stock price and dividends, and needs (and wants) little visibility into the internal workings of the company as long as the expected return on his investment is delivered. Within the company, managers must decide whether a purchase of real property or equipment, an acquisition of another company, or an investment in R&D will pay off. Frequently, the “net present value” (NPV) of financing a project is calculated to determine if a project will add wealth over its duration. NPV is the cumulative difference between all costs put into the project, and the estimated income coming out of the project. Cash flows have been adjusted (discounted) for the time cost of money, and include the obligatory payments to investors and creditors at the promised rates of return. If the NPV is positive, the project is worthwhile because it costs less than the value it will produce. If NPV is negative, then project is either abandoned or never begun. One simple principle guides the board of directors in making decisions; “Maximize NPV [46].”

There are many discernible parameters used to monitor R&D besides the NPV. A successful R&D project generates patents, publications, reports, citations, good will, and favorable peer reviews. While these metrics are applied after the fact, they form a basis for comparing a proposed project with similar projects completed in the past.

The placement of a basic R&D activity within a commercial organization is a strategic consideration. In a 1994 survey of the 30 largest aerospace and electronics systems companies in the United States, all had at least one large central corporate laboratory [47]. These companies organize their central laboratories according to technical disciplines or specialties, not according to the targeted markets. For example, there might be an advanced electronics R&D group in a central laboratory, but not a group specifically designated to develop a new video cassette recorder. Thereby, more than one business activity can benefit from the more generalized research.

Furthermore, the R&D groups in a central corporate laboratory do not usually report to business units, which are much closer to the consumer market. An R&D activity reporting to a business unit will have a shorter time horizon, and will have to limit its focus to the products being developed in that business unit. Technical synergy can get lost if the research is too narrowly managed.

There is a current trend to downsize corporate research laboratories in response to market pressures, outsourcing, and decentralization [48]. A survey from the Industrial Research Institute (IRI) indicated that, as a percentage of sales during 1988-1992

- basic research fell from 6% to 1.8%
- applied research fell from 21% to 17.8%
- new product development rose from 34% to 40.6%.

That is, industry is placing less emphasis upon doing research and more upon developing new products for the market that do not necessarily require technological breakthroughs. This is a position with shorter time horizons and an emphasis on revenues.

9.2 Categories of Research and Development

Both industry and government structure R&D into three general areas or tiers that are tracked and managed differently [49]. Table 9-1 lists these categories and some of their

INDUSTRY	DEPARTMENT OF DEFENSE	CHARACTERISTICS
BASIC RESEARCH EXPLORATIONS	6.1 BASIC RESEARCH	<ul style="list-style-type: none"> • Understanding basic phenomena that might have impact upon many applications or business units • Managed for high variability and for the long term
DEVELOPMENT PROGRAMS	6.2 APPLIED RESEARCH	<ul style="list-style-type: none"> • Matches research to the core competencies of the organization • Tracked with patents, citations, publications, peer review and with some market outcomes such as profits
APPLIED ENGINEERING PROJECTS	6.3 ADVANCED TECHNOLOGY DEVELOPMENT	<ul style="list-style-type: none"> • Usually funded by business units or agencies that will benefit directly • Closest to the customer or market and therefore is evaluated using market outcomes

Table 9-1. Categories of Research and Development

characteristics. While the correspondence between the industrial and DoD categories is not exact, they are similar and have commonalities. The 6.X designations relate to the subdivisions in the DoD Science and Technology (S&T) Budget.

In describing the S&T budget, the Director of Defense Research and Engineering (DDR&E) recently testified to the congressional Subcommittee on Military Research and Engineering:

Compared to the end of the Cold War, DoD basic and applied research, our technology base, is now at its lowest level since 1980. The Military Services' technology base investment is the lowest in 35 years. Unfortunately, the situation in the private sector is not much better. In the defense industry, independent research and development funding is down by 52%, in constant 1997 dollars, since 1989. World class commercial technology corporate research laboratories such as Bell Labs, IBM, Xerox, and General Motors are a shadow of their former strength. The industry research and development horizons are increasingly near term. For example, the horizon of the information technology industry sector is typically three years or less [50].

Both the government and the private sector are scaling down all three types of R&D, but for different reasons. The private sector is looking to find profitable markets for current and new products based on existing and maturing technologies--a short term view. DoD, in the national interest, must nevertheless sustain its long term view in spite of the decrease in its S&T budget imposed by the Congress. Where can DDR&E invest its limited research funds in order to produce the most value over the long term? One answer is clear: FFRDCs.

9.3 The Value of FFRDCs

The Honorable Paul G. Kaminski, Under Secretary of Defense for Acquisition and Technology, testified in March 1997 before the Acquisition and Technology Subcommittee of the Senate Committee on Armed Services. In responding to the criticisms from private industry about the direct funding to FFRDCs, he said

I am not arguing that competition is inappropriate. The Department of Defense uses competitive processes to obtain the overwhelming majority of the goods and services that we require. But there are some circumstances and some kinds of work for which the value provided by a strategic relationship with an FFRDC far outweighs the potential gains of competition [51].

A government sponsor must make a value judgment when deciding whether to place work with an FFRDC, or to compete it openly in the marketplace. The “potential gains of competition” are essentially a question of cost accounting. Could the government get the same item from the private sector at a lower price? This is certainly an appropriate guideline for DoD to follow when procuring a commodity, a system or set of components for which a dominant design has already emerged, or a service in which no conflicts of interest or collusion can occur. It is an appropriate guideline when the market is a perfectly competitive one, which firms can easily enter and exit, in which the service is homogeneous, and for which no one can control prices through either a monopoly of sellers or a monopsony of buyers.

However, FFRDCs do not provide a commodity service to the government. With only one buyer (DoD), the market is far from being perfectly competitive, and it abounds with possibilities for self-serving interests if left to itself without the not-for-profit objectivity of FFRDCs. As Paul Kaminski continued in his testimony:

My bottom line is that I believe --and this belief is widely held in the Department of Defense by both civilian and military leaders--that the FFRDCs are doing high-quality, high-value technical and analytic work that could not be provided as effectively by other means. The people who are complaining about FFRDCs are not the users of their services or the recipients of their products. FFRDCs are doing their jobs for DoD and they are doing them well [51].

The critics of FFRDCs use accounting arguments and ignore the economic value to DoD of its relationship with its FFRDCs. The question is not whether DoD can get the same services from private industry at a lower cost. The question is whether DoD can afford to incur the opportunity cost of not placing work with its FFRDCs.

9.3.1 Tangible Savings to the Government

There are identifiable ways in which DoD can save real money by involving an FFRDC in its R&D and R&D management processes. Interpreted as a financial investment made by DoD, they resemble call options that stay “in the money” from the moment they are established. That is, DoD can place work in an FFRDC knowing it does not have to make major expenditures in the future to correct errors, redirect an effort, or respond to the volatility of the marketplace or to unexpected business decisions from its contractors.

For example, if a commercial corporation decides not to continue an ongoing piece of government research, or if it loses the competition in the next scheduled round of mandatory rebidding, then the government incurs the burden of orienting and equipping the new contractor. There are many significant costs in transferring the effort to a new contractor, such as the cost of documentation, the relocation of people and real assets, and the negotiation of a new contract. The technical personnel of the new contractor are far behind on the learning curve, and it will take time for them to acquire the same level of performance as the former team. Lost time is lost money. If the R&D could have been appropriately done at an FFRDC, these transition costs would not be incurred.

DoD often needs specifications for a new sensor or system component that will be competitively procured in the future. An FFRDC can deal well with pre-competitive problems that are unstructured, ambiguous, and for which bounds and limitations are unknown. Otherwise, in dealing with the private sector, the government may first have to compete a feasibility study, then a design study, and then the procurement itself. This is an extended and expensive course of events that involves many contractors, bids, and evaluations--frequently without the assistance of an unbiased advisor to help in the decisions. The specifications that finally emerge may be wrong or incomplete, and the government must incur the additional cost of that repair (provided that the incorrect advice is detected before implementation begins). It would have been less expensive to have an

FFRDC study the problem thoroughly, build a prototype device if necessary to demonstrate feasibility, and then set the specifications for the larger effort on the basis of which a sound procurement could begin.

Administratively, an FFRDC can change direction quickly when the sponsor needs a fast response or a quick study. (This is a compelling reason to retain a broad mission statement.) Private industry is risk averse, especially when the contract is at a fixed price. Diversions and delays erode profits, and make resource allocation within the company more difficult to manage. Commercial organizations bind themselves to the details in their contracts, which may lack flexibility and require time and money to change. Redirecting a commercial contractor can incur costs that would not occur in redirecting an FFRDC.

These few examples show how the government can save money in the future by using an FFRDC in the present. If one calculates the net present value (NPV) of these potential savings (see 9.1 above), it is likely to be an amount that compensates for any additional costs that the private sector alleges will be incurred by the government when placing work in an FFRDC instead of competing it in the marketplace. These and other subtle considerations add even more value to the government's decision to use an FFRDC.

9.3.2 Intangible Value to the Government

Intangible value is not easily expressed in terms of dollars and cents. In the commercial world, the acquisition of one company by another may involve "good will." This is an additional amount paid by the acquiring company, over and above the total sum of the individual assets of the company being acquired, to purchase intangible but valuable economic resources. Good will includes such abstractions as reputation, image, brand name recognition, customer relationships, sound management practices, employee morale, and an established closeness to both suppliers and buyers. It is carried explicitly as an

asset on the balance sheet of the acquiring company [52], and represents the belief that future profits will exceed the purchase price of the intangible elements of value.

What does “good will” have to do with FFRDCs? From DoD’s point of view, FFRDCs possess equivalent elements of good will that derive from the special and strategic relationship that was detailed in section 3.2 of this thesis. These intangibles are as legitimate and as valuable to DoD as are those intangibles that a commercial company can offer to another in an acquisition or merger. To review, they include:

- an embodiment of scientific and technical expertise that is not found within the civil service;
- the freedom from real or perceived conflicts of interest;
- a long-term understanding and commitment to the needs of the sponsor;
- a corporate memory that spans many years of focused activity;
- the broad access to sensitive and proprietary information that has great commercial value if placed in the hands of a for-profit company;
- a responsiveness to the quickly changing needs of the sponsor; and
- the long-term maintenance of core competencies important to the mission and goals of the sponsor.

Because these intangible values are substantial, the tangible values cited earlier become even greater. As the DoD continues to downsize, and as the defense industry coalesces into a few large corporations, FFRDCs will become increasingly vital sources of independent support and candid advice. These values cannot be expected from private industry, which will evaluate its opportunity costs and turn to other pursuits where there is more profit to be made.

9.3.3 An Option Pricing Approach to FFRDC Value

On Wall Street, a call option gives its owner the right to buy stock at a specified exercise price (or striking price) on or before a specific date. The investor makes money if the exercise price, which was agreed to at the earlier time when the investor bought the option, is lower than the market price of the stock at the time he decides to cash in the option. In essence, he can force someone else to sell the stock to him at the lower exercise price, and then he can sell the same stock in the market at the higher market price. The difference between the market price and the exercise price is his gain. The investor who buys the call option is counting on volatility in the market price of the stock, so that the market will drive the stock price above the exercise price before the option expires. Also, the longer the period of the option, the higher is the probability that the volatility will drive up the market price of the stock at some time while the option is active. Therefore, a long time horizon can be beneficial, so that an option with a longer duration is more valuable and therefore costs more to purchase. (Of course, if the market price is less than the exercise price, the investor would be foolish to execute the option because he would lose money; why pay more for something at the higher option price when you can buy it in the open market for less?)

The purpose of the discussion above is to demonstrate the value of “keeping your options open” for as long as you can, so that you have the opportunity to benefit from the flexibility that is available to you. A good call option is therefore one that

- has a long time horizon over which to evaluate and act upon events; and
- engages an investment or project that implicitly contains a volatility or flexibility that has the potential to add value beyond what the project costs.

Financial analysts frequently use the Black-Scholes formula to price an option [46, 53].

Table 9-2 lists the five important variables in this formalism, and five corresponding analogues for the case when a government sponsor funds an R&D project at an FFRDC.

The arrows indicate the effect on the value of the option when there is an increase in each of

Black-Scholes Variable Stock Call Option FFRDC R&D Project Analogues

σ	↑ Variability	Standard deviation describing the fluctuations in the price of the stock in response to market forces	Flexibility of the project in response to unexpected events or redirection by the sponsor
S	↑ Stock Price	Market value of the stock in the investor's portfolio	Value of the R&D project to the sponsor's interests
X	↓ Exercise price	Predetermined price of stock paid by the investor if and when the option is executed	Total costs to the sponsor accrued during the life of the project
T	↑ Time	Period of the option	Time horizon of the project
R	↑ Risk Free Rate	Interest rate used to discount the exercise price to present value if there is no market risk	Interest rate used to discount total planned expenditures to present value when no programmatic changes are anticipated

↑ or ↓ = Effect on the value of the option if there is an increase in the corresponding variable

Table 9-2 Analogues Between A Stock Call Option and Placing R&D Work in an FFRDC

the parameters. We make the rough analogy that buying an option is like making the decision to fund an R&D project. The value of the option is to the investor, as the value of the project is to the mission of the sponsor.

In agreement with the points just made above, an increase in the period of the option increases the value of the option, because the fluctuations in the price of the stock caused by market forces have a chance to benefit the investor. Analogously, an increase in the time horizon of an R&D project allows the government sponsor to take advantage of the FFRDC's flexibility in responding to unexpected events or to a redirection of effort.

Also, an increase in the fluctuation of the stock price makes the option more valuable to the investor, just as an increase in the flexibility of the FFRDC creates more value for the government sponsor who can benefit from it.

While these analogies are approximate, they do point out the benefits of the long-term view and the flexibility offered by an FFRDC. These are features empowered by the strategic role of an FFRDC in supporting DoD in its research and development efforts. These are features that private industry cannot offer as easily or as efficiently, because that relationship is fundamentally short term and rigidly contractual

A consideration of the intangible values, which do not appear on a cost-accounting spreadsheet, demonstrates that the option to place R&D work with an FFRDC can be more valuable to a sponsor than the option to compete the same work in the private sector. These are indeed the circumstances described by Paul Kaminski, "for which the value provided by DoD's strategic relationship with an FFRDC far outweighs the potential gains of competition [51]."

10.0 The FFRDC Mission in the Future

The environment in which FFRDCs function has changed since the time of their inception, but their purpose has not. The Cold War is over, and the former Soviet Union has mutated toward a path of market-driven capitalism. Mainland China has abandoned the austerity of the Cultural Revolution in pursuit of economic power and an improved quality of life based on commerce and trade with the rest of the planet. Although the possibility of nuclear war on an intercontinental scale between “super powers” has eased politically, the military capability still remains intact. Moreover, the technology of weapons and delivery systems has enabled smaller countries to become a menace to their neighbors and to the allies of the United States. The current concern is less about the Soviet bomber or ICBM flying over the pole, and more about the tactical missile crossing close borders. The danger has not vanished; it has merely become more diverse.

The responsibility of the Department of Defense is still as complex as it was fifty years ago, and the assistance from FFRDCs is still as necessary. The DoD must continue to conduct R&D efforts and develop policies that will provide the means to deal with evolving threats. The question therefore becomes not whether FFRDCs should continue to exist, but what they should be doing. How should their mission statements read, especially in regard to the technical capability that has emerged in the private sector since FFRDCs first began?

10.1 Balanced Relationships with Government and with the Private Sector

Described in broad terms, an FFRDC mission statement enables the flexibility and responsibility that are highly valued by government sponsors for reasons discussed earlier. Any work given to an FFRDC must be consistent with the center’s facilities, capabilities, and core competencies. Core work is designated through the special relationship and requires a long term view, the protection of sensitive and proprietary information, and a freedom from conflicts of interest. These three facets,

- a mission statement responsive to the sponsor's changing needs,
- the assignment of work consistent with core competencies and capabilities, and
- the boundaries defined by the special relationship with the government,

are elements of a sound management plan for FFRDCs [8]. However, there is a fourth consideration that is new: the relationship between FFRDCs and private industry.

Private industry, because of the growth and maturation of its own capabilities in R&D and R&D management, criticizes the non-competitive means by which FFRDCs receive funding. It is not a controversy that disputes whether FFRDCs can do the work; it is a controversy that maintains that the private sector can do the work instead. In general, industry values its technical interactions with FFRDCs, participating in workshops and seminars, establishing CRADAs, gaining from the transfer of technology and knowledge, and sometimes performing under a contract for an FFRDC in support of a larger government project. The challenge is to reconcile the clash caused by funding issues with the mutual desire to benefit from technical collaborations.

The DoD has responded positively and responsibly over the past five years, conducting internal studies and developing management plans that clarify the role of FFRDCs and tighten the perimeter that constrains their activities [4, 8, 22]. These actions were prompted partly by the investigations of the Government Accounting Office (GAO), which identified areas in which the oversight and management of FFRDCs can be improved [20, 23, 24, 37, 43]. The published opinions of the lobby groups that represent the interests of the private sector have also motivated DoD to re-examine its use of FFRDCs [28, 29, 30].

In a response of good faith, the private sector now needs to reconsider its position and to negotiate a compromise. FFRDCs and other non-profit organizations that are currently serving the government simply cannot be dismantled, liquidated, or eliminated, just so that their funds can be redistributed to private corporations through competitive

bids. Such an action would not be in the best interest of the nation. The technical capabilities and personnel that would be dispersed would neither find their way easily into the private sector, nor re-establish themselves as effectively as in their earlier form. The loss of intangible values (discussed in section 9.3.2 of this thesis) would be permanent. Eliminating FFRDCs loses more value for the sponsor than would be gained by the private sector. Therefore, it is important that a balance be found and respected, so that both FFRDCs and the private sector can continue to support the government, each in its own way. Private industry and FFRDCs need to be on the same team, not on opposing ones.

A current trend in business is for the supplier to get closer to the buyer, and to avoid “transactional buying” that is impersonal, capricious, and commoditized. Transactional buying (a marketing concept) has low switching costs, low loyalty between participants, and a short time horizon. In contrast, “relationship buying” has high switching costs, a high degree of loyalty between participants, and a long time horizon. The government has been a relationship buyer with respect to FFRDCs for decades, but more a transactional buyer with respect to private industry. Private industry would like to enjoy a closer relationship with the government, similar to the close relationship already experienced by FFRDCs. Perhaps part of the contention between the private sector and FFRDCs originates in this transition.

10.2 Revision of the Mission Statement

When the FFRDCs were first established, their mission statements did not mention private industry. This was understandable, since the technical capability needed by government at that time resided primarily in the FFRDCs. Because that situation has changed, the mission statements of FFRDCs need to be updated. They should include explicit language that acknowledges the contributions of the private sector, and that encourages technical interactions and collaborations to the extent allowed by congressional

legislation and executive orders. If the mission of FFRDCs includes assisting industries in their technical dealings with the government, then the private sector will be more accepting of and receptive to the differentiated role of the FFRDCs. Such language also indicates that DoD expects the FFRDC leaders to seek out and participate in opportunities to interface with industry. A cooperative gesture is the placement of industry leaders on the FFRDC advisory boards to help set priorities and to exchange information at the executive level. An important factor in sustaining the future of FFRDCs is to get them more involved with the private sector, so as not to seem (and not to be) exclusive or privileged.

In the discussion of the mission statement in section 4.3 of this thesis, we suggested the replacement of “growth and profitability” with “value to the sponsor” as a factor in securing the long-term survival of an FFRDC. (If an organization is not allowed to make a profit or to grow in size, then it must deliver value to the stakeholders in some other way.) This language will give the FFRDC guidance in making decisions about the selection of the most important work to do with limited resources, about collaboration with private industry or other federally funded centers, and about the best mix of skills among the technical staff in order to be responsive to change.

FFRDCs are not generally visible to the public, but they do need to present a positive image to agencies throughout the government and to the commercial organizations with which they deal. The mission statement should include a directive to promote such visibility and communication. FFRDCs must inform Congress, other FFRDCs, federal laboratories, and the private sector about their expertise, facilities, and accomplishments. Within proper channels, which are often narrowed by national security considerations, the exchange of information will encourage FFRDCs to be less insular and more extrovert. This exposure will allow the government to leverage its projects, whether conducted at FFRDCs or at commercial organizations, and will create more value through the synergy of cooperation.

Critics of FFRDCs argue that the kinds of work described in the mission statements should be extremely precise and highly specific in order to contain FFRDCs and to prevent them from wandering into areas in which private industry can support the government. The intent is both justifiable and understandable, but the means is compulsive and can severely impair the flexibility and responsivity that are valuable to the sponsor. The same confinement is possible by invoking the administrative terms of the special relationship described in the DDR&E management plan [8]. Any work assigned to an FFRDC must require a protection from conflicts of interest, a high level of confidentiality, a compatibility with core competencies, and a long time horizon. As long as the work arguably needs to be done within the FFRDC domain because of these factors, then the details of the work are not at issue. Therefore, an FFRDC's mission statement should not be so limiting as to prevent initiating a new activity if that is what the sponsor desires and can justify. An FFRDC's growth is not in its size but in its diversity, and there is great value in that.

10.3 Conclusions

FFRDCs play a similar role as in the past, but in a very different global and national environment. The strategic military threats remain, and offensive technology has spread to smaller tactical arenas in many parts of the world. The DoD continues to need FFRDCs in designing systems and developing policy that can meet these threats. In contrast to the post World War II era of 50 years ago, private industry has an undeniable capability in R&D and R&D management that can address many DoD needs in a fundamental sense. FFRDCs need to team with the private sector, to recognize its capability, to exchange information, and to collaborate according to the desires of the federal sponsor.

The FFRDC mission statement should remain broadly defined in order to respond to change or redirection. It should also contain language that encourages interactions with industry and with other federally-funded organizations. The terms of the special

relationship will limit the activities of the FFRDC to the core work , thereby addressing the complaints from the private sector. At the same time, a broad mission statement will permit a diversity that will keep the FFRDC work force current and agile.

The new ingredient in the FFRDC mission equation is the private sector, which was not a consideration 50 years ago. The Congress has provided the legal means to establish technical collaborations, and DoD should take advantage of the opportunity to bring FFRDCs and industry closer together.

11.0 Summary: A Sustainable Future for DoD FFRDCs

This thesis set out to review the government policies that underlie the existence of FFRDCs, to survey the competitive and somewhat antagonistic environment in which they currently perform, to explore how they might diversify even under restrictions on growth and scope, and to demonstrate that they offer undeniable value to their DoD sponsors. The information base consists in public documents, citations in the news and business media, and personal interviews with government officials, FFRDC executives, and lobbyists who represent the interests of private industry. The three hypotheses posed in the introduction are treated individually below.

11.1 A Continuing Need for FFRDCs

Because the global military situation is different compared to 50 years ago and continues to change, the DoD still needs the support of FFRDCs in initiating pre-competitive R&D activities and in managing prolonged R&D programs. Figure 11-1 is a notional diagram that shows how universities, FFRDCs, and private industry compare in their areas of strength and responsibility in relation to the phases of a government project.

Universities deal mostly with academic pursuits, developing concepts and demonstrating feasibility. DoD funds much technical research at universities, as do the National Science Foundation, NASA, NIH, NOAA, and many other government agencies. Frequently, entrepreneurs at universities will join with industry, or spin off their own for-profit businesses, thereby jumping to the industry path on the figure in order to complete the project cycle.

DoD FFRDCs specialize in the earlier phases of a project that deal with concepts and feasibility. In some situations (viz., the two systems engineering and integration centers, MITRE and Aerospace), the role extends to overseeing the installation and

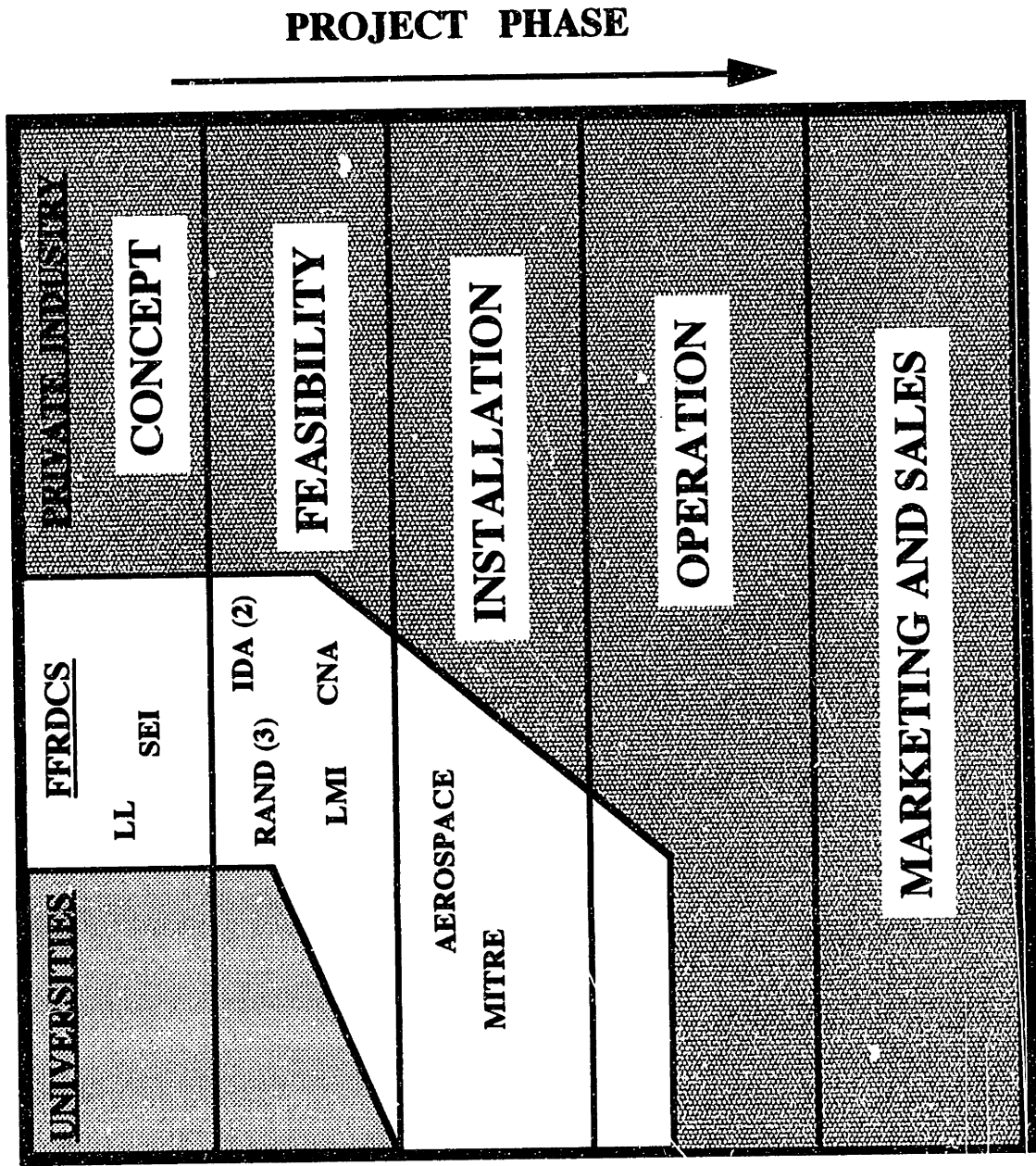


Fig. 11-1. Domains of Universities, FFRDCs, and Private Industry

operation of a large system, or “a system of systems,” that heavily involves the participation and coordination of many commercial organizations. (UARCs would find themselves in the FFRDC domain, perhaps spilling over into the universities.)

As shown in Fig. 11-1, the private sector can support all phases of an R&D project, whether it is sponsored by DoD or by internal corporate funds. This capability has developed significantly over the last 50 years. Obviously, industry can extend into marketing and sales, which an FFRDC cannot do, and can develop families of products that it can offer to the government or to other industries.

Some advocates of “competition at any cost” would see industry overrun the entire figure, closing out both universities and FFRDCs from DoD funding. Such a takeover is neither practical nor wise. It is not in the best interest of the nation to impair higher education, thwart university-based entrepreneurs, or to disperse FFRDC assets in a quest for profits and shareholder value.

Furthermore, during the life cycle of a government project, procurement rules may require re-competition along the way. The contractor may change from one phase to the next, which can disrupt continuity and add switching costs. There is definitely a need for FFRDCs to conduct innovative projects and to solve unstructured problems while providing prolonged support to the sponsor.

11.2 Cooperation and Collaboration Between FFRDCs and the Private Sector

The boundaries in Fig. 11-1 exist for obvious reasons, and yet can be very permeable to transfers of technology and knowledge if properly managed. As long as each party acknowledges and respects the domain and the value of the other, FFRDCs and commercial entities can co-exist and mutually benefit through the mechanisms that Congress has legislated. These include CRADAs, Broad Agency Announcements, and direct contracts let by an FFRDC to private industry. It behooves DDR&E, however, to

review its management plan for FFRDCs frequently to ensure that the boundaries are well defined. In controlling the size of FFRDCs, the current practice of placing a ceiling on the number of personnel, or “staff technical equivalents” (STEs), is an effective one. The amount of work done internally is limited because the number of people is restricted. The FFRDC can then manage its bounded resources to grow in diversity, but not in size. A dollar ceiling is less desirable because much of the money received by an FFRDC is actually passed along to industry in the form of contracts and purchases of equipment and services. In a cooperative environment, the personnel ceiling better addresses the concerns of the private sector about the size of FFRDCs. A dollar ceiling on FFRDCs is actually disadvantageous to industry, because it reduces the pass-through of funds. The ceiling on personnel implicitly limits dollars, as the two are correlated. A personnel ceiling allows latitude in the dollars that pass through to industry, but limits the dollars retained by the FFRDC for its own work in proportion to the authorized number of personnel.

A self-consistent set of policies and practices is configurable, according to which FFRDCs can serve the government and minimize any real or perceived trespass into the domain of commercial enterprise. The concepts of the “special relationship” and of “core work” define this boundary. In an equitable sense, the boundary also minimizes the involvement of private industry in the domain of the FFRDC. However, as mentioned above, the boundary can be infinitely permeable to transfers of knowledge and technology, but not to transfers of responsibility.

11.3 The Value of FFRDCs to Government Sponsors

Value can be tangible. The net present value of not having to spend money in the future can be considerable. The sponsor might have to pay for switching costs when a contractor loses a re-competition, for the education and orientation of a new contractor when the current one has decided not to rebid, or for the repair costs when specifications

were wrong and have to be redone. Involving an FFRDC early in a project can preclude many of these untimely costs.

During the course of a project, a re-negotiation of the terms of a contract can be so expensive as to dissuade the sponsor from making legitimate changes. FFRDCs by nature and by mission respond adaptively and without excessive “red tape.” A sponsor can frequently save costs by coordinating changes through an FFRDC rather than through a commercial contractor.

Value is also intangible. From the sponsor’s point of view, intangible value is like the “good will” for which a company receives credit when being evaluated by another in a merger or acquisition. The conditions of the special relationship between an FFRDC and its sponsor relate to such intangible values as the customized expertise focused on the needs of the sponsor over the long term, a freedom from conflicts of interest, and the knowledge that the FFRDC will not abandon a critical effort in order to pursue a more profitable one. Posed as a strategic option, placing R&D or R&D management responsibilities with an FFRDC offers a reassuring stability in the face of volatility in the business environment or in world politics. In short, in order to react to downstream events, funding an FFRDC creates valuable options for the sponsor that are not available when dealing with a commercial contractor.

This perspective helps to offset an institutional bias toward the short term, for which the unrelenting considerations of capital budgeting and return on investment (ROI) prevail. The government sponsor must be keenly aware of the consequences of not adding an FFRDC to his portfolio of support. A failure to position at least some activities in an FFRDC’s core technical areas may foreclose options that could have been of great value to the program in the future.

11.4 Concluding Remarks

The future of FFRDCs is sustainable through a partnership involving government, the private sector, and the FFRDCs themselves. Each has an important role to play in securing the national defense, in promoting the general welfare of the population, and in maintaining the global competitiveness of domestic enterprise. These three common goals are the basis for an integrative negotiation in which all parties can achieve their objectives.

The first step is to identify the problem. In this case, it is the contention of industry that it can objectively provide all the services that are provided by FFRDCs, and that the DoD should outsource these services to the private sector through competitive means. The DoD, however, maintains that FFRDCs provide a unique service that cannot as effectively be performed by any other source. There are many considerations, but the primary one is that FFRDCs are free from conflicts of interest when in possession of proprietary or sensitive information that would have economic value and produce an unfair competitive advantage if first placed in the hands of a for-profit organization.

The second step is to generate a number of possible solutions. For many years, the Congress, DoD, and lobby groups representing industry have struggled to find a workable scenario. Disbanding FFRDCs is not the answer because it violates all three of the common goals cited above; too much is lost by all, compared to what is gained by one. Certain long-term R&D activities and management functions must occur within the perimeter of the special relationship, and therefore the non-competitive funding of FFRDCs is justifiable.

Constraining the size of FFRDCs is necessary. They must not violate their charter by entering into the open marketplace offering services, or by preempting industry when industry could and should be doing the work. Similarly, containing the fanaticism and zeal of the private sector is necessary. Industry must withdraw its criticism when it distinguishes those pre-competitive and long-range situations that are appropriately handled

by FFRDCs because of the access to sensitive or proprietary information about government plans and programs.

The third and final step is to choose a specific solution. The personnel ceiling on FFRDCs is a viable way to limit size without precluding flexibility, and it serves in the best interest of the private sector because it allows funds to pass through the FFRDC to industry without a dollar limit. Congress has provided the legal means to establish meaningful interactions and technology transfers between FFRDCs and commercial organizations. Consequently, DoD should leverage its R&D funds by encouraging collaborations through the redesign of FFRDC mission statements and management plans, and through the wording of formal contracts with private vendors.

A sustainable future for FFRDCs is vital to the national interest and will require mutual cooperation among Congress, DoD, and the private sector. FFRDCs remain an effective means by which the government can attract the quality of scientists and engineers it requires for specialized tasks, while assuring a high degree of enduring loyalty and dedication to public goals. FFRDCs are incubators of ideas and arsenals of technology, and provide a stability and a long-term perspective that place them among our most valuable national assets.

GLOSSARY

BAA	Broad Agency Announcement
BMEWS	Ballistic Missile Early Warning System
CICA	Competition in Contracting Act of 1984
CNA	Center for Naval Analysis
CRADA	Cooperative Research and Development Agreement
DARPA	Defense Advanced Research Projects Agency
DDR&E	Director of Defense Research and Engineering
DEW	Distant Early Warning Line
DISA	Defense Information Systems Agency
DoD	Department of Defense
DoE	Department of Energy
DSB	Defense Science Board
FAA	Federal Aviation Administration
FAR	Federal Acquisition Regulation
FFRDC	Federally Funded Research and Development Center
FCRC	Federal Contract Research Center
GAO	Government Accounting Office
IDA	Institute for Defense Analysis
IRI	Industrial Research Institute
ITAA	Information Technology Association of America
LMI	Logistics Management Institute
MIPR	Military Interdepartmental Purchase Request
MTS	Member of the Technical Staff
NASA	National Aeronautics and Space Administration
NDRI	National Defense Research Institute
NIH	National Institutes of Health
NOAA	National Oceanographic and Atmospheric Administration
NPV	Net Present Value
PAF	Project Air Force
PSC	Professional Services Council
OFPP	Office of Federal Procurement Policy
OSD	Office of the Secretary of Defense
OT&E	Operational Test and Evaluation
R&D	Research and Development
RDT&E	Research, Development, Test, and Evaluation
SAGE	Semi-Automatic Ground Environment
SAIC	Science Applications International Corporation
SDS	Students for a Democratic Society
SEI	Software Engineering Institute
SMC	Space and Missile Systems Center
STE	Staff Technical Equivalent
UARC	University Affiliated Research Center

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