

Funded Research and Development Centers,” appears in the FY 1967-1969 report. “FFRDC” was simply a convenient label to apply to that heterogeneous collection of research centers that were clearly not federal government laboratories nor traditional free-market for-profit contractors. For the purposes of this background paper, the term “FFRDC” will only be used when referring to an organization that was officially considered an FFRDC after 1967. Otherwise organizations will be referred to as “federal research centers.” Since contractor-operated laboratories and “think tanks” existed before the term “FFRDC” came into use, the definition the federal government created in 1967 was more descriptive than prescriptive. It described the majority but not all of them and applied to organizations that were not considered FFRDCs.

At present 39 FFRDCs exist, according to the master federal government listing of the National Science Foundation for FY 1995. Of these, 10 are DoD-sponsored FFRDCs (53). A list of all current FFRDCs is provided in appendix A.

## ■ Categories

The federal research centers comprise three types of entities with different functions:

- laboratories,
- study and analysis centers, and
- system engineering and technical direction centers.

The first centers founded were scientific research laboratories working in the traditional sciences on technical issues. Some of these laboratories were large federal government-owned, contractor-operated facilities like Los Alamos National Scientific Laboratory and Oak Ridge National Laboratory. They included facilities funded by the Atomic Energy Commission (later the Department of Energy) as well as a number of pure science efforts. The laboratories provided considerable technical support and engineering services in addition to their research orientation.

The next centers founded were DoD study and analysis centers, which pioneered a new discipline called operations research to produce study and analysis of problems not traditionally addressed by scientists. Over time, the range of their work increased, and operations research became just one of many study and analysis tools they used. These centers became what people commonly refer to as “think tanks” such as RAND.

The system engineering and technical direction centers were later creations developed for systems integration. These centers did not grow directly out of organizations that functioned in World War II; the first emerged in 1958 from the need to integrate the complex technologies that were being used in modern defense systems. Representative of these centers are The Aerospace Corporation and the MITRE C<sup>3</sup>I center. The system engineering and technical direction centers were to provide technical support in defining, developing, procuring, deploying, and operating complex systems. In effect, they provided the technical depth, systems engineering approach, and corporate memory that the federal government needed to effectively deal with the industrial companies that actually developed and produced the systems.

The ownership of these varied centers is discussed in box 1-1.

## THE DEVELOPMENT OF THE RESEARCH CENTERS

At the start of World War II, virtually all of the scientific talent of the country resided in universities and private industry. The United States military did not have a large, research-oriented scientific establishment, but had a growing need for scientific knowledge. In the total-war environment of World War II, Allied nations harnessed the resources of their entire population and economy, including technical and scientific knowledge. Through arrangements with academia, the U.S. military established centers of excellence that developed radar, artillery fuses, atomic weapons, and a new and esoteric discipline of applied math-

## BOX 1-1: Federal Government Research Facilities: Discussion of Ownership

Research facilities available to the federal government can be categorized in terms of their ownership and operation. Facilities can be owned or operated by the federal government or the contractor as government-owned, government-operated (GOGO); government-owned, contractor-operated (GOCO); or contractor-owned, contractor-operated (COCO) facilities. A 1969 survey of 723 research and development installations showed that among the FFRDCs the facilities could be owned by the contractor or the federal government and the major items of equipment could be owned by the contractor or the federal government or leased.<sup>1</sup> FFRDCs cannot be GOGOs, some are GOCOs (especially those working for the Department of Energy), and some are entirely owned by the contractor organization. A 1982 search by the Executive Office Information Center found no statutory definitions of "GOCO" or "FFRDC." However, in the statutory definition of what constituted a federal agency, "GOCO" was specifically excluded.<sup>2</sup>

A 1982 letter from the Executive Office of the President, Office of Science and Technology Policy, referred to a 1978 congressional inventory of research, development, test and evaluation (RDT&E) facilities and compared them to the NSF list of FFRDCs. The 1978 congressional inventory classified 779 federal government research facilities as follows:

Government-owned, government-operated	608
Government-owned, contractor-operated	54
Contractor-owned, contractor-operated	18
Government-leased, government-operated	99

The letter compared the 35 FFRDCs on the NSF list, stating that 30 FFRDCs were also listed as GOCOs, with 26 GOCOs listed that were not considered FFRDCs (The mathematical discrepancy of 56 in the comparison versus 54 GOCOs as the total number on the inventory list was not explained, but is possibly related to some FFRDCs being defined as more than one facility). Only five FFRDCs were not GOCOs:<sup>3</sup> the Institute of Defense Analyses, the Center for Naval Analyses, The Aerospace Corporation, the C<sup>3</sup>I Division at MITRE Corporation and Project Air Force at the RAND Corporation.<sup>4</sup> None of these five are laboratories in the traditional sense and all are considered either study and analysis centers or systems integration organizations.

None of the 10 current DoD FFRDCs are considered GOCOs, although there are FFRDC GOCOs outside of the DoD. Nine of the 10 DoD FFRDCs operate principally in contractor-owned facilities. Lincoln Laboratory has been considered a GOCO and operates in government-owned and leased facilities.

SOURCE Office of Technology Assessment, 1995

<sup>1</sup>National Science Foundation, *Directory of Federal R&D Installations, for the Year Ending June 30, 1969* (Washington, DC: National Science Foundation, 1970).

<sup>2</sup>Joe Clark, "Memorandum for the File, Subject: GOCO and FFRDC Facilities" a letter from the Executive Office Of the President, Office of Science and Technology Policy, Washington, DC Jan. 22, 1982).

<sup>3</sup>Joe Clark, "Memorandum for the File, Subject: GOCO and FFRDC Facilities" a letter from the Executive Office Of the President, Office of Science and Technology Policy, Washington, DC Jan. 22, 1982).

<sup>4</sup>Identified in a "Diary Note," Subject: Federally Funded Research and Development Centers FFRDCs and government-owned contractor-operated facilities, Jan 12, 1982, signed by Norman W. Friedman of NSF and attached to the letter of Jan 22, 1982 by Joe Clark.

ematics, operations research. The desire by the defense establishment to maintain and expand operations research was one of the underlying reasons for the establishment of the first three study and analysis centers, RAND, the Operations Research Office (ORO), and the Operations Evaluation Group (OEG).

The organization that indirectly fostered operations research in the United States was the National Defense Research Committee (NDRC) established in June 1940. The NDRC, through the efforts of its chairman, Vannevar Bush, coordinated all scientific research among the different services during World War II. Several of its members traveled to England where they met with the new British operational research groups to discover how scientists were contributing to operations. This information was used to apply operations research to the problems of combating U-boats (78).

The U.S. military laboratories at this time were structured toward hardware development and testing. Pure science and new technologies were still the province of universities and some private companies. To integrate the efforts of scientists and the military in World War II, a civilian organization called the Office of Scientific Research and Development (OSRD) was set up with Bush, a respected scientist and engineer, as the head of the organization. The organization reported directly to the President of the United States, received its funds directly from congressional appropriations committees, and was relatively unrestricted in the manner in which it spent its budget. OSRD supported individual scientists and major research efforts through awarding them contracts (68). It established the pattern of contracting with civilian scientists to provide support to the military on technical and scientific questions and contracting out for scientific studies instead of developing in-house capabilities.

## ■ Establishment of Operations Research Centers at the End of World War II

At the end of World War II, operations research had proved to be of value to the British Royal Air Force and Navy and to a lesser extent the British

Army. It had also definitely proved useful to the U.S. Navy and Army Air Forces. Operations research establishments were in place in all three services in England. The U.S. military services, through the OSRD, contracted extensively with outside institutions and individuals to obtain operations research during the war (68). At the end of World War II, OSRD was closed down, as Bush, himself, had recommended. While it had accomplished its mission, he felt it was losing its flexibility with considerable time being spent on contractual concerns and procedures. Bush wanted to establish a new comprehensive civilian organization, the National Research Foundation, with scientific support for the military carried out by one division of this organization (77).

### *Navy*

At the end of World War II, the Naval Operations Research Group (ORG), originally ASWORG, had a staff of approximately 80 scientists and an annual budget of \$800,000. The Navy, under the strong encouragement of Fleet Admiral Ernest Joseph King, Chief of Naval Operations and Commander in Chief of the United States Fleet, did not want the organization dissolved. The Navy moved quickly to ensure its uninterrupted continuance and approached MIT to sponsor it. MIT was reluctant to sponsor this collection of unseen individuals located 500 miles away from campus, but did so nonetheless on November 1, 1945. The group's name was changed to the Operations Evaluation Group (OEG) to assuage the sensitivities of the Navy's Office of Naval Research, which had direct responsibility for the Navy's "research." OEG maintained its structure of a central office in the Pentagon and field teams among the major commands, but the entire staff was reduced to about 25 scientists and a budget of \$300,000. The contract was for three years. The Office of Naval Research, independent of OEG, commenced funding private contractors to conduct a wide array of small research projects to explore human behavior and many other promising areas.

OEG, in its first year of operation, tried to spend its time writing up what it had done during the war. It wrote and issued studies (some 55 is-

sued in 1946) and prepared basic methodology texts on operation research. But instead of being left alone to write about past glories, the office found itself with more new assignments and tasking than it could handle and began a slow and steady expansion. By the start of the Korean conflict, OEG had a staff of approximately 60 people, including almost 40 scientists, with an annual budget averaging over \$500,000. As a result of budgetary restrictions, almost all of its field programs were placed in abeyance (78).

### ***Air Force***

Near the end of World War II, General H. H. “Hap” Arnold, commanding general of the Army Air Forces, along with other senior officials and consultants in the War Department, was convinced of the need to keep intact part of the scientific corps that had been mobilized during World War II. On December 1, 1945, a new headquarters was created for the Air Force, led by the Deputy Chief of Air Staff for Research and Development. Its first head was Major General Curtis LeMay. The Air Force was particularly concerned about the areas where military policy, planning, and technology interacted. It created an entirely new organization, based upon the concept of independent scientific analysis. In a conference on October 1, 1945, the Air Force fully faced the constraints on the service it wanted:

- The project needed to be attached to an existing firm to get off to a good start.
- The founders did not believe that a university would want a highly classified project.
- A high-talent scientific group could not be assembled within federal government because of the salary and personnel practices of the civil service.
- It would be difficult to recruit scientists in a project directly administered by the military.

The Air Force wanted to locate the project away from Washington, DC so as to insulate the staff from routine requests that would interfere with research. A letter contract for \$10 million was issued to the Douglas Aircraft Company on March 2, 1946 to conduct “a program of study and re-

search on the broad subject of intercontinental warfare, other than surface, with the object of recommending to the Army Air Forces preferred techniques and instrumentalities for this purpose.” Project RAND, as it was called (an acronym for research and development), was created to address issues of interest to the Air Force. The first product was a report issued May 2, 1946 called, “Preliminary Design of an Experimental World-Circling Spaceship” (61, p. 77; 68). This report was prepared with a team of 50 analysts (18, p. 23).

RAND also subcontracted some of its work out to other Air Force manufacturers like Boeing and Northrop. In May 1947, Project RAND moved from the Douglas Aircraft Company to its own offices in Santa Monica. (See explanation box 1-2.) By early 1948, RAND had grown to some 200 staff, including mathematicians, engineers, aerodynamicists, physicists, chemists, economists, and psychologists (61, p. 4).

RAND in 1948 also conducted expanded research on the air-defense problem, but the Air Force decided that the kind of research that RAND was willing and able to perform would not meet program requirements and schedules for the type of research required. The Air Force, Army, and Navy requested that MIT establish a laboratory for air defense. The old wartime Radiation Laboratory had been closed, but ongoing work at MIT and the Air Force Cambridge Research Laboratory formed the nucleus for creating Lincoln Laboratory (75). Lincoln Laboratory work was often of an experimental nature, while RAND continued background and analytic work in this area (68, pp. 89,90).

### ***Army***

The Army, excluding the Army Air Forces, had no specific research programs to protect at the end of World War II. They simply sent the scientists they had employed back into civilian life and maintained no research not related to hardware development.

However, an April 30, 1946 memorandum by General Dwight D. Eisenhower, then Army Chief

## BOX 1-2: Avoiding Conflict of Interest

In the case of RAND, the federal government originally contracted the work to a private firm, Douglas Aircraft Corporation. This arrangement was greatly facilitated by the close personal relationship between General H. H. "Hap" Arnold, Commanding Officer of the Army Air Corps, and the president of Douglas. One of General Arnold's sons was married to Donald Douglas's daughter. The federal government expected all firms to participate and develop an interest in the work of Project RAND at Douglas. Not surprisingly, Douglas Aircraft's competitors viewed Project RAND with some suspicion. During its first two years of operation, people within the industry became concerned that this research organization being part of one of the major manufacturers might create a conflict of interest. Furthermore, Douglas Aircraft Corporation itself was interested in releasing Project RAND from its control, as they felt the federal government, in its attempt to appear to be completely even-handed, had not awarded Douglas contracts that might have been awarded otherwise.

It was therefore agreed that a new not-for-profit corporation should be established, separate from any manufacturer. The Ford Foundation provided the initial funding, and the RAND Corporation was officially established as an independent not-for-profit corporation, chartered in California with its own board of directors in November 1948. Its articles of incorporation were dated May 14, 1948, but the contract between the Air Force and RAND was not established until November 4, 1948. Up until then, of course, the work was still being done by the Douglas personnel, who then transferred to the RAND Corporation. Project RAND remained the major contract of the new corporation for some time. At the time that RAND was created as an independent corporation in 1948, it had approximately 300 employees.<sup>1</sup>

There was a strong feeling by 1948, both within private industry and in the Department of Defense, that study and analysis agencies should not be tied to a major private corporation.<sup>2</sup>

SOURCE: Office of Technology Assessment, 1995

<sup>1</sup>Gregg Herken, *Counsels of War* (New York, NY: Oxford University Press, 1987), p. 74.

<sup>2</sup>Bruce L.R. Smith, *The RAND Corporation, Case Study of a Nonprofit Advisory Corporation* (Cambridge, MA: Harvard University Press, 1966)

of Staff, discussed the establishment of a civilian research organization outside the Army. Eisenhower recommended that the Army contract extensively for scientific and industrial services. The effort was further developed by soldiers such as Lieutenant General A. C. McAuliffe, who headed the Army's research and development program after the war. In June 1948 the General Research Office was created, an organization similar to RAND. It commenced operations in September and was renamed the Operations Research Organization (ORO) in December (77).

ORO was established under contract with Johns Hopkins University, but its offices---originally at Ft. McNair in Washington, DC, and then

in Chevy Chase, Maryland---had no connection to Johns Hopkins University. The Army provided ORO with a senior military advisor, usually a colonel, who had a small staff. This office was setup in July 1948 and continued until June 1, 1972. In June 1952, when ORO moved to Chevy Chase, Maryland, its staff totaled 220 (66).

The decision to establish ORO as part of a university was certainly shaped by the ideas of Bush. Johns Hopkins University was chosen because it was conveniently located, enjoyed an excellent reputation, and had several years of experience running the Applied Physics Laboratory for the Navy (77). By tying the research organization to a university, the Army intended to:

- provide an atmosphere that would attract the best minds to ORO,
- create an atmosphere of intellectual independence, and
- create a university atmosphere conducive to good scientific research.

In contrast to the approach of the Air Force, which resolved some internal conflicts in setting up an organizational structure for RAND that provided for independent analysis, the Army did not develop a larger vision for their research organization. Many researchers at ORO, in their original conception of their mission, saw themselves as scientists who were to explore all aspects of warfare and its long-range implications, while the Army appeared to be primarily interested in seeking ways to apply operations research to questions concerning logistics and supply. Also, the Army did not seem to be interested in applying operations research to the use of weaponry in combat.<sup>2</sup> In fact, in the early 1960s, the background studies that led the Army to develop and deploy the Hawk air-defense missiles came from an Air Force study done by RAND. This study was then handed over to the Army by the Air Force (68, p. 109). This difference in viewpoint was the start of the troubled relationship between the Army and ORO that would persist throughout ORO's history (87,66,77).

## ■ Establishment of Laboratories at the End of World War II

The first contractor-operated federal research laboratories established came primarily out of the need to develop the atomic bomb during World War II. OSRD also established other laboratories for purposes other than atomic bomb research. MIT became involved in the war effort in 1940 when the NDRC established the Radiation Laboratory, the forerunner of Lincoln Laboratory, to further improve radar. The Johns Hopkins Univer-

sity Applied Physics Laboratory was established in 1942 to conduct research related to anti-aircraft firing. It did fundamental research and development and provided technical oversight for the design, production, and use of the proximity fuse and anti-air guided missiles. The Ordnance Research Laboratory was established in 1945, under the management of Pennsylvania State University.

In the development of the atomic bomb, the federal government had a strong desire to obtain access to the best research minds from the universities and, therefore, established the nuclear research laboratories at or in conjunction with universities. These projects were handled by a contracting organization called the Manhattan Engineering District, and the entire atomic bomb research program was referred as the Manhattan Project.

Established under the Manhattan Project were the Argonne National Laboratory, the Oak Ridge National Laboratory, and the Los Alamos National Scientific Laboratory, the Lawrence Radiation Laboratory, and Sandia National Laboratory. The Argonne National Laboratory evolved from the University of Chicago's Metallurgical Laboratory. It was under the auspices of the Metallurgical Laboratory that the first nuclear chain reaction occurred in 1942 under a stadium in the city of Chicago as part of the Manhattan Project. The Oak Ridge National Laboratory was also established under the University of Chicago, with its control reverting to an association of universities after World War II. The Los Alamos National Laboratory, located in New Mexico, was and still is operated by the University of California. It began operation in 1943 developing nuclear explosives for military purposes (49) and was the site of the first nuclear explosion. Even though it is reported as a university-operated laboratory, it has no association with the daily campus life and research activities of the university and is effectively a

<sup>2</sup> This conclusion was reached by comparing the discussions on the work OEG and RAND did to the actual list of reports prepared by ORO and SORO. Interestingly enough, a review of the reports issued by the British operational research establishments shows a considerable amount of analysis of weapons effectiveness, both from an engineering viewpoint and an applications viewpoint.

large independent not-for-profit corporation. The Lawrence Radiation Laboratory was administered by the University of California and housed the cyclotron invented by Dr. Ernest O. Lawrence (49). This laboratory was the father of two current FFRDCs, the Lawrence Livermore (27, p. 59)<sup>3</sup> and Lawrence Berkeley National Laboratories. In 1945, a subsidiary of Western Electric Company, Sandia Corporation, established a separate organization at the Los Alamos Laboratory. Sandia Corporation was a not-for-profit company established as a service to the federal government (49).

After World War II, some of these highly classified university laboratories were transferred to research facilities that were separate from their universities. In the case of Oak Ridge, management was transferred to Monsanto Chemical Company in 1945; later the Union Carbide and Carbon Company was awarded the contract to operate the facility and did so for many years until replaced by the present incumbent, Martin Marietta (49). Also, Oak Ridge Associated Universities were formed in 1946 to provide a vehicle for academic institutions to participate in federal atomic energy research in association with Oak Ridge National Laboratories. Most of these universities were from the southeastern United States, certainly nearer to Oak Ridge, Tennessee, than was the University of Chicago (51). Another consortium, the Associated Universities Incorporated, managed the Brookhaven National Laboratory, starting in 1947.

### ■ Formalization of FFRDCs

The earliest located official definition of an FFRDC is in a memorandum from the chairman to the members of the Federal Council for Science and Technology, dated November 1, 1967. This definition was updated, revised, and issued by the Office of Management and Budget on April 4, 1984, and registered in the Federal Register on

April 11, 1984 (73). The definition in the 1984 memorandum is as follows:

- (1) FFRDCs do not have a prescribed organizational structure. They can range from the traditional contractor-owned/contractor-operated or Government-owned/contractor-operated (GOCO) organizational structures to various degrees of contractor/Government control and ownership. In general, however, all of the following criteria should be met before an activity is identified as an FFRDC:
  - (a) Performs, analyzes, integrates, supports (non-financial) and/or manages basic research, applied research, and/or development. (Activities primarily engaged in routine quality control and testing, routine service activities, production, mapping and surveys, and information dissemination, even though otherwise meeting the requirements of paragraph 5.c., are specifically excluded from FFRDC designation).
  - (b) Performance of the functions in 5.c.(1)(a) is either upon the direct request of the Government or under a broad charter from the Government, but in either case the results are directly monitored by the Government. However, the monitoring shall not be such as to create a personal services relationship, or to cause disruptions that are detrimental to the productivity and/or quality of the FFRDCs' work.
  - (c) The majority of the activity's financial support (70% or more) is received from the Government with a single agency usually predominating in that financial support.
  - (d) In general, most or all of the facilities are owned by the Government or

<sup>3</sup> Edward Teller lobbied for the establishment of a second nuclear weapons facility (the Lawrence Livermore Laboratory) because of his continuing feuds with Robert Oppenheimer. This would be a case of a research center being established because of personal and professional animosity.

- funded, under contract, by the Government.
    - (e) The activity is operated, managed and/or administered by either a university or consortium of universities, other not-for-profit organization or industrial firm as an autonomous organization, or as an identifiable separate operating unit of a parent organization.
    - (f) A long term relationship evidenced by specific agreement exists or is expected to exist between the operator, manager, or administrator of the activity and its primary sponsor.
  - (2) In addition to the above criteria, the relationship between the activity and the Government should exhibit the following characteristics in order to qualify for FFRDC identification:
    - (a) The activity (organization and/or facilities) is brought into existence at the initiative of a Government agency or bureau to meet some special research or development need which, at the time, cannot be met as effectively by existing in-house or contractor resources.
    - (b) Work from other than a sponsoring agency is undertaken only to the extent permitted by the sponsoring agency and in accordance with the procedures of the sponsoring agency.
    - (c) The activity, whether the operator of its own or a Government-owned facility, has access, beyond that which is common to the normal contractual relationship, to Government and/or supplier data, employees, and facilities needed to discharge its responsibilities efficiently and effectively, whether the data is sensitive or proprietary or not.
    - (d) The primary sponsor undertakes the responsibility to assure a reasonable continuity in the level of support to the activity consistent with the agency's need for the activity and the terms of the sponsoring agreement.
    - (e) The activity is required to conduct its business in a responsible manner befitting its special relationship with the Government, to operate in the public interest free from organizational conflict of interest, and to disclose its affairs (as an FFRDC) to the primary sponsor. (73)
- This definition was modified slightly and condensed so as to be included in the Federal Acquisition Regulations, clause 35.017, which also defines "FFRDC." It is a derivation of the above definition and reads in part:
- (2) An FFRDC meets some special long-term research or development need which cannot be met as effectively by existing in-house or contractor resources. FFRDC's enable agencies to use private sector resources to accomplish tasks that are integral to the mission and operation of the sponsoring agency. An FFRDC, in order to discharge its responsibilities to the sponsoring agency, has access, beyond that which is common to the normal contractual relationship, to Government and supplier data, including sensitive and proprietary data, and to employees and facilities. The FFRDC is required to conduct its business in a manner befitting its special relationship with the Government, to operate in the public interest with objectivity and independence, to be free from organizational conflicts of interest, and to have full disclosure of its affairs to the sponsoring agency. It is not the Government's intent that an FFRDC use its privileged information or access to facilities to compete with the private sector. However, an FFRDC may perform work for other than the sponsoring agency under the Economy Act, or other applicable legislation, when the work is not otherwise available from the private sector.
  - (3) FFRDCs are operated, managed, and/or administered by either a university or consortium of universities, other not-for-profit or nonprofit organization, or an industrial firm,