of the bid requests and procurement of steel. . . . By the summer of 1960, studies of the computer results showed that much of the prior design had been inadequate. The overall moving weight of the instrument was calculated to approximate 36,000 tons which would be far in excess of the designed capacity of the supporting structure already under construction. The weight calculation was, even then, based on estimates for several highly important areas for which design had progressed to only a concept stage. Many major problems for which no precedent existed were still unsolved."

BuDocks then obtained the services of a new design firm, which found, as GAO put it, that "prior design assumptions could not be relied upon and that a total reanalysis and redesign of the project would be required. . . . In the meantime, much of the construction of the supporting structure had been completed."

### Speed and Secrecy

While BuDocks was pleading military urgency and pouring concrete, it was also hanging out top secret signs to fend off the participation of the very scientists who had helped originate the project. Although work at the Sugar Grove site was going full blast, the GAO concluded, "the scientific problems involved in the construction of a 600-foot radio telescope had not been solved, nor was there any prior experience in constructing an instrument of this size with the required mobility and close tolerances in all its parts. Therefore, the successful fulfillment of the project required close collaboration and the best efforts of the scientific and the construction agencies of the Department of the Navy.

"This need for close collaboration . . . was not adequately recognized until about the end of the history of this project. Rather, the record shows that BuDocks . . . almost completely eliminated effective scientific participation in the Big Dish project by scientific personnel until it became very clear to BuDocks that assistance from the scientific community was essential to solve several of the scientific problems.

"After BuDocks had been given responsibility for construction . . . communication with the scientific and research engineering community outside the Government diminished or was completely closed by the security classification of significant elements of the project and actions of BuDocks personnel, and liaison with Naval Research Laboratory and Office of Naval Research scientists and research engineers deteriorated."

In 1959, the GAO report continues, "despite evidence that design problems were getting out of hand," BuDocks proposed disestablishment of the Sugar Grove Steering Committee, whose representatives—from NRL, ONR, and BuDocks—were supposed to coordinate research, design, engineering, and construction. When the Chief of Naval Research protested that the committee was ONR's only formal link with the project's planning, BuDocks agreed, in July 1959, to retain the committee. The records show, however, that the committee held only one meeting after that date.

In that same year, the Office of the Secretary of Defense appointed an advisory group that the GAO described as "the country's outstanding experts in fields allied to those comprehended by the Big Dish." The group reported back that "the project is cloaked in a mantle of security which precludes participation by the scientific community in the formulation of the design for the dish."

### BuDocks versus the Experts

A few months later, the Defense Department's director of research and engineering brought together a group of specialists to consider the project. BuDocks, however, was not interested. A memorandum to the director from a member of his staff stated, "I have been informed that . . . the Bureau of Yards and Docks area commander, Norfolk, has intervened and stated that he will take charge of the meeting from the Navy side and that none of the experts mentioned above will be included. . . ." The Secretary of Defense had to take the matter up with the Navy to bring about the meeting with the expert group.

As for the NRL scientists who had first developed the concept for the telescope, they found that BuDocks and its original designers had little patience for their opinions. Although GAO concluded that "NRL had an abundance of structural engineering capability," NRL scientists found that their reservations about construction matters were not appreciated, and they were also told that BuDocks "could not wait for the 'scientific approach'. . . ."

By early 1960, it was clear that the project had acquired a vitality of its own and that it would not be easily responsive to the will of men. When NRL first worked out its plans, it assumed that a staff of 30 would do nicely, to man the telescope, its computers, the library, and other facilities. The Navy, the GAO found, "revised this concept to a planned complement of 1146 people with all the additionally required housing, commissary, and other support facilities. . . ."

As for GAO's contention that the project should have been slain in 1960, rather than in 1962, it was informed by the Secretary of Defense that—in GAO's words—"cancellation was tardy to some extent . . . but in almost all cases resulting in cancellation there is a significant delay between the date of the decision and the date that cancellation is actually effected. However, they stated that such a delay normally should not exceed about six months."

Perhaps the most disturbing thing about the Sugar Grove debacle is that it apparently has not driven anyone in Washington to raving anger. Part of the reason, of course, is that McNamara—over the violent protests of the military services—has since instituted review and management procedures that would make it difficult for a similar octopus to get loose. But the principal reason for the ho-hum attitude is that when a national security tag is hung on a project, sound judgment often goes out the window. It might be useful to speculate what would have happened in Congress if, let's say, the National Science Foundation had been responsible for what happened at Sugar Grove.

—D. S. GREENBERG

## RAND: R&D Nonprofit Pioneered a New Kind of Organization, Served as a Model for Others

The RAND Corporation is the archetype of the nonprofit research and development organizations formed after World War II to help the American military establishment with planning and problem solving by enabling scientists, engineers, and other professionals to work for the government but not in it.

What moved the Air Force to establish its Project RAND after the war

was the conspicuous wartime success of civilian scientists not only in developing military hardware but in applying scientific and mathematical techniques to strategy, tactics, and logistics. Operations research was the term then; a going cliché for the product now in the computer era is "software."

But while RAND was the first and is probably the best known of the cold war nonprofits, it is perhaps no longer typical. RAND continues to stress research while other, similar organizations have moved into the systems development business and the management of major projects and have consequently acquired larger staffs and budgets than RAND.

A concise description of RAND's work was provided by the corporation's president, Frank Collbohm, before Representative Chet Holifield's military operations subcommittee of the House Government Operations Committee in 1962 hearings on systems management and development, which provide the fullest congressional airing to date of the activities of the postwar planning helpmates of the services.

The RAND Corporation, said Collbohm, "is engaged primarily in long range research and analyses, largely on defense matters, as an aid to strategic and technical planning and operations. We do not manufacture hardware or components for sale. Normally we do not engage in design work and are not specifically concerned with the evaluation of specific products. We do not act as systems engineers as that term is usually used in industry. Finally, RAND does not engage in the technical direction of any programs other than its own."

Missile development and air defense programs have been at the center of American military planning since World War II, and a number of special purpose nonprofit organizations have been created to help with various phases of the effort. The Lincoln Laboratories, outside Boston, a lineal descendant of the wartime Radiation Lab at M.I.T., was established in 1951 to bring electronics expertise to Air Force problems; it devotes itself now mainly to hardware development for both offensive and defensive aspects of missile warfare.

At the request of the Air Force, M.I.T. in 1958 oversaw the formation of the nonprofit MITRE Corporation to take over the complicated task of seeing that all aspects of the air defense system were integrated. M.I.T. severed its ties with MITRE as soon as the nonprofit was able to cope with its big systems engineering job.

One of the newest and biggest of the nonprofits is the Aerospace Corporation, set up in 1960 in the Los Angeles aerospace complex to provide technical direction and systems engineering for the Air Force's ballistic missile and space program. Until 1960 the job had been done by what was described in the Holifield hearings as a "hardware-oriented, profit-seeking private contractor." The change seems to have been hastened by a military operations subcommittee report in 1959, which asserted that the value to the Air Force of a technical management organization depended on its "disinterested position" and went on to recommend a shift to "a nonprofit institution akin to the RAND Corp. and other private university-sponsored organizations which serve the military departments and other agencies of the Federal Government on a stable and continuing basis."

### RAND Progeny

RAND had a more direct hand in the establishment of two of the more specialized nonprofits. The Systems Development Corporation (SDC) was "spun off" by RAND in 1956 to help specifically with design and programing for the first computerized air defense system—known as SAGE (for Semi-Automatic Ground Environment). RAND studies on processing of information in a complex "systems environment" had led to the creation of a Systems Development Division inside RAND. When the systems engineering and training aspects of the job began to diverge from what RAND trustees felt was the corporation's primary mission, the division was cut loose as the independent SDC.

RAND also fostered another nonprofit with intimate ties to the Air Force. This is Analytic Services Incorporated (ANSER), located on the Pentagon side of the Potomac in the Washington area. In the words of its president, S. J. Lawwill, at the Holifield hearings, ANSER furnishes "to the director of development planning and to other elements of the air staff a well-balanced team of competent analysts who react quickly to pressing problems incident to planning for the research and development of aerospace weapon systems." RAND had been asked to take the job but apparently felt that the demand for instant research might conflict with RAND methods. Instead, RAND proposed that it assist in setting up an independent research organization. The Air Force accepted the offer, and RAND provided administrative and financial help and, in fact, most of the original staff. ANSER was established in 1958. The founding loan has been repaid, and RAND has cut virtually all ties.

In addition to the specialized nonprofits, however, other elements of the military have cultivated RAND-like organizations to serve their own purposes. The Defense Department itself is the chief patron of the Institute for Defense Analysis (IDA), set up in 1956 to conduct studies on the purpose and direction of defense R&D programs and on national security policy matters.

The Army in 1961 fostered the creation of the independent Research Analysis Corporation (RAC) to conduct operations research. RAC was the successor to the Operations Research Office, operated for more than 10 years on contract by Johns Hopkins University.

In 1962 the Navy also got its own version of RAND with the establishment of the Center of Naval Analysis (CNA) as a division of the Franklin Institute in Philadelphia. CNA was formed mainly by consolidation of the Operations Evaluation Group, which had been under the wing of M.I.T., and the Institute of Naval Studies, formerly a division of IDA.

RAND provided the legal model for most of the other tax-exempt, nonprofit, public service corporations, which have charters echoing RAND's ends: "to further and promote scientific, educational and charitable purposes, all for the public welfare of the United States of America."

Much of the credit for laying RAND's foundations is given to H. Rowland Gaither, a San Francisco lawyer with a distinguished record of wartime administrative service, who wrote RAND's articles of incorporation and helped to raise the initial working capital of $1 million—a $100,000 loan from the Ford Foundation and a $900,000 line of bank credit. Gaither also helped recruit RAND's trustees, who from the beginning have come

from the ranks of American business, education, and foundation magnates.

On the Air Force side, the chief progenitor of RAND seems to have been General H. H. Arnold, who was convinced of the necessity of extending the wartime alliance of civilian scientists with the military into the postwar years, and who found ways to make available $10 million in Air Force funds for the launching of Project RAND, as the Air Force side of the effort is still called. (The name of the corporation was coined by an elision of the phrase R and D, standing for research and development.)

As for RAND itself, from the start it has always insisted that objectivity is its most important product. And maintaining its detachment has been made easier by the fact that RAND's main headquarters are in Santa Monica, California, overlooking the Pacific Ocean and 3000 miles from the Pentagon. There is, of course, a heavy two-way traffic between Washington and the coast. Security guards pass 400 to 500 visitors from government and industry through RAND portals every month. And the corporation has a Washington office on Connecticut Avenue and a small contingent in the Pentagon itself. But there is little question that the Western exposure makes a significant difference.

The decision to locate in Santa Monica is no doubt traceable in part to RAND's having started out as a charge of the Douglas Aircraft Company in a plant a few miles away from the present RAND building. But General Arnold was among those who felt that keeping RAND and GHQ a continent apart would be a healthy thing for both, and Santa Monica it was to be.

On its downtown Santa Monica site the functional RAND building and its parking lot leave little room for campus-like landscaping. But to the casual visitor, the building, built around eight courtyards—or "patios," since it is Southern California—has the quasi-academic atmosphere of some of the aerospace consulting firms or hot electronics companies on Route 128 outside Boston.

RAND seems to tend more toward short-sleeved informality and brown-bag and snack-counter lunches, with shop talk at the umbrella-shaded tables in the patios.

Eccentricity, even in work habits, appears to be viewed benignly, and the place is open to RAND employees 24 hours a day, 7 days a week. Staff members are expected to put in 40 hours a week, but there appear to be no rigid controls and, to an observer, there appeared to be none of the bureaucratic clock worship which causes the British to say that the civil service, like the fountains in Trafalgar Square, play from 9 to 5.

From the start, RAND's aim in organization has been "creative flexibility." The names of the corporation's 11 departments indicate what RAND's work is like—aero-astronautics, computer sciences, cost analysis, economics, electronics, logistics, mathematics, physics, planetary sciences, social sciences, and systems operations.

A RAND study may be made by one person, or by a number of persons drawn from one department, or by a group of people recruited from several departments for the purposes of the study. The bringing to bear of a number of disciplines simultaneously on one problem may not be a RAND invention, but inside government, especially in the military, when such an effort is wanted, a "RAND-type study" is likely to be asked for. And visitors from universities have been highly complimentary about RAND trailblazing in interdisciplinary research.

### Assessing Influence

Assessment of RAND influence is difficult in part because so much of the organization's product is classified—an estimated 50 percent of RAND's output is classified. Also, RAND people staunchly insist that their job is not to make policy but to provide information to those who will use it in making decisions.

Often RAND reports and predictions have been ignored, or at least not acted on. In the we-told-you-so category were a 1946 study on the potential, both scientific and political, of an earth-orbiting satellite and the prediction in mid-1957 that the Russians would soon orbit a satellite. RAND missed the date of the Sputnik I launching by about 2 weeks.

Because the Air Force has been RAND's chief client it is natural that RAND has been deeply involved in problems related to the design of nuclear weapons, delivery systems, weapons effects, deployment of forces, air defense, nuclear arms testing and test detection, civil defense, and arms control and disarmament, and in problems of general strategy and foreign policy.

In recent years, other government agencies, such as the National Aeronautics and Space Administration and the Defense Department's Advanced Research Projects Agency (ARPA), have negotiated contracts with RAND, and a limited amount of work has been done for state and local governments and for foundations. But RAND still deals primarily with problems which have national security implications, and the Air Force provides about $15 million of the corporation's annual budget of roughly $20 million.

According to RAND executives, research projects are selected in a variety of ways. The Air Force or some other agency may ask RAND to study a problem, and if RAND thinks the problem important and believes its staff has the capability, it will undertake the job. By one estimate, about a third of RAND studies originate this way. Perhaps half are agreed upon mutually in the consultations that go on virtually continuously between RAND and the Air Force, and the balance are originated by RAND staff members. The corporation now has available some $500,000 a year of its own funds to finance research projects which it feels are worth while but perhaps not appropriate for agency financing.

RAND has paid for its buildings and financed this independent research with income it derives from cost-plus-fee contracts, which are its standard way of doing business. Since the start, the RAND fee has been 6 percent above direct and indirect costs. RAND has never asked more nor accepted less.

Its independent status makes RAND able to pay salaries which exceed civil service levels and are roughly competitive with university and industrial salaries except at upper executive levels in the latter category. Of the 1100-plus employees on RAND rolls published in the 1962 hearings, some 242 of the scientific and technical staff drew salaries of between $15,000 and $35,000 a year. Forty were in the $22,000 to $35,000 category. (About 160 RAND employees have doctorates; and 176, masters' degrees. RAND has some 300 regular consultants on its rolls.)

Going to work for RAND, with its semipublic operation, does not mean a trip to professional limbo for a scientist or engineer, such as may be in store if he joins one of the big intelligence agencies. RAND has proved a springboard to good jobs in both universities and industry as well as in government. Two RAND alumni, for example, are presidents of major aerospace compa-

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nies—L. E. Root heads Lockheed Missiles and Space Company and Thomas V. Jones is president of Northrop. Joseph A. Kershaw is provost of Williams College, and John L. Kennedy is head of the psychology department at Princeton. Charles J. Hitch, Assistant Secretary of Defense (comptroller), has played a prominent part in the McNamara regime, and in the Defense Department there are four deputy assistant secretaries with RAND in their backgrounds. Herman Kahn, author of *On Thermonuclear War*, who presides over the Hudson Institute, is perhaps the best known of the numerous former RAND staff members who have gone on to found or join other nonprofits or consulting firms.

RAND has had critics, mainly in the universities, who feel it is full of scholars obsessed with nuclear warfare. It also has its critics, mostly in the military, who think that RAND is too much like a university, and that too much detachment is dangerous.

RAND is like a university in some ways, but it is also like government and like industry in others, and it has something quintessential of its own thrown in. As a new kind of institution it filled a need created by events, and —to paraphase Voltaire—if RAND did not exist it would be necessary to invent it.

But RAND is changing as the problems of American security and the role of the Air Force alter; these changes will be discussed in another article in this space.—JOHN WALSH

## Announcements

**Overseas Educational Service** (OES) was formed recently under the sponsorship of the National Academy of Sciences, the American Council on Education, and Education and World Affairs. Plans call for the new organization to supplement the efforts of other agencies which are recruiting American personnel for developing areas and, eventually, to serve as a central clearinghouse for American agencies and for representatives of educational institutions in the new nations. John Scott Everton, former U.S. ambassador to Burma, is executive director of the organization. Information on OES is available through its headquarters, 522 Fifth Ave., New York 10036.

A 2-year program in **laboratory animal medicine** has been established at Tulane University's medical school. It is open to persons who hold a doctor's degree in veterinary medicine, and will lead to the master's degree in public health. Participants will be encouraged to develop research projects, with emphasis on the detection and control of laboratory animal diseases, and experimental design. Kenneth F. Burns, professor and chairman of Tulane's department of vivarial science and research, will direct the program.

### Scientists in the News

**Hasmukh J. Mehta**, assistant professor of anatomy at Western Reserve University, has been appointed professor and chairman of the department of anatomy in the recently organized St. John's Medical College, Bangalore, India, which is scheduled to open in July. He has been in charge of gross anatomy studies in the Western Reserve's dentistry school during the past year.

**Paul R. Peabody**, formerly supervisor of applied mathematics at the Jet Propulsion Laboratory, has been appointed manager of the new department of mathematical analysis at Computer Sciences Corporation, a data processing service organization in Los Angeles, Calif.

**Earl R. Parker**, professor of metallurgy and director of the Institute of Engineering Research at the University of California, Berkeley, has been named to receive the 1964 Albert Sauveur achievement award from the American Society for Metals. The prize, in recognition of "pioneering metallurgical achievements which have stimulated organized work" that has furthered knowledge in basic metallurgy, will be presented during the society's meeting in October.

**Don D. Bushnell**, a senior staff member of the System Development Corporation, has been elected president of the Association for Educational Data Systems.

**Victor T. Tomberg**, formerly with Kollsman Instrument Corp., New York, has been appointed senior research associate in the research department of neurosurgery, at the medical school of New York University.