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THE ROLE OF AEROSPACE AND MITRE CORPORATIONS IN AIR FORCE R&D

by

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THE ROLE OF AEROSPACE AND MITRE CORPORATIONS IN AIR FORCE RESEARCH AND DEVELOPMENT

by

Paul Flam

Submitted to the School of Industrial Management on April 14, 1965, in partial fulfillment of the requirements for the degree of Master of Science.

ABSTRACT OF THESIS

The rise in defense R&D expenditures since World War II altered patterns of organization of private industry and universities; resulted in the creation of profit and nonprofit contractors to operate government owned facilities; and spawned a proliferation of nonprofit corporations to provide operational analysis, operations research, systems engineering and technical direction to the military services. The most controversial of all nonprofit corporations has been the system engineering and technical direction (SETD) nonprofits, MITRE and Aerospace Corporations, established by the Air Force.

The purpose of this thesis is to provide a systematic study of MITRE and Aerospace Corporations through evaluation of (1) the conditions and events that led to their creation, (2) their growth patterns, (3) changes occurring within the military and industrial environment in which the companies functioned. The methodology employed not only a literature survey but also a series of interviews with personnel in eight aerospace and electronics companies; military and civil servants at various levels of the defense R&D hierarchy; and employees of both MITRE and Aerospace Corporations.

The study revealed that the raison d'etre of SETD nonprofits - that they were created to meet a special need which could not be fulfilled by government, universities, or industry - was not supported by historical facts. The major technological advances in ballistic missiles and SAGE were made by the organizations that preceded the SETD nonprofits and the special need existed prior to the creation of either MITRE or Aerospace Corporations.

Once established, however, the SETD nonprofits underwent a very rapid expansion in manpower, physical plant and dollar revenue. This expansion did not take place in research and experimentation that offered the greatest potential for advanced technological breakthroughs, but occurred mainly in manpower support for system program offices for evolutionary weapon and support systems of lesser importance and priority. The SETD nonprofits are being used as a source of manpower rather than a resource of great capability to be focused on selected and highly sophisticated technical tasks.

The forces at play during the early days of the ballistic missile program supported the Air Force use of an associate contractor method with a separate corporation to perform systems engineering and technical direction. But many changes had occurred that made continued use by the Air Force of the SETD nonprofits questionable: (1) program decision making previously made by the Air Force was now being done at DOD level; (2) Air Force programs did not have the sense of urgency and priority of early ballistic missiles and SAGE efforts; and (3) industry had developed a systems capability that was strong, capable and anxious to perform SETD jobs.

The study showed that as captives of the Air Force, the SETD nonprofits exist as appendages to the military bureaucracy. As a national resource of scientific skills and expertise they are decaying under administrative controls and assignment of technical effort to projects of secondary need and priority. The writer, therefore, recommends that the Air Force contracts with MITRE and Aerospace Corporations be discontinued on or before July 1, 1968. Furthermore, unless the Department of Defense can assign them specific jobs of national urgency and importance, MITRE and Aerospace Corporations should be dissolved or permitted to break their defense ties to seek other governmental R&D tasks of national need.

Thesis Advisor: Donald G. Marquis

Title: Professor of Industrial Management

136 Tudor Road
Needham, Massachusetts
April 30, 1965

Professor William C. Greene
Secretary of the Faculty
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Dear Professor Greene:

In accordance with the requirements for graduation, I herewith submit a thesis entitled "The Role of Aerospace and MITRE Corporations in Air Force Research and Development".

I would like to express my appreciation to Professor Donald Marquis and Professor Carroll Wilson for their guidance during the writing of this thesis. I also wish to thank Dr. Howard Murphy, historian at the Electronic Systems Division of Air Force Systems Command, L. G. Hanscom Field, Massachusetts for many helpful and stimulating discussions.

Sincerely yours,

PAUL FLAM

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CHAPTER I

INTRODUCTION

> "Our purpose is not merely to describe and classify the phenomena, but to conceive them as brought about by the play of forces in the mind, as expressions of tendencies striving towards a goal, which work together or against one another. We are endeavoring to attain a dynamic conception of mental phenomena. In this conception, the trends we merely infer are more prominent than the phenomena we perceive." Sigmund Freud.[1]

Initial Inquiry:

This study began as a result of what appeared early in my Sloan Fellowship year to be an uncomplicated query: What happens to a research and development (R&D) organization that is conceived and established to perform a specific task after the mission is accomplished or greatly reduced in scope and importance?

The investigation began with one hypothesis; i.e., the organization obviously underwent change when its raison d' etre changed. If an investigation were made of R&D organizations, one might be able to isolate common change factors and possibly perceive some recommendations for accommodating change. From a "big picture" standpoint, this investigation might provide some small contribution or insight to the larger question of the organization and management of large scale research and development.

From the very beginning, the study was directed to looking at organizations that were involved in federal and, more

specifically, defense R&D. My entire adult life had been spent within a military environment, initially on active duty as an Air Force (AF) officer, a few years with industry on an AF contract, and since 1952 as a civilian member of the Airways and Air Communications Service and its successor, the Air Force Communications Service (AFCS). The Command was vitally affected by changing technology and the R&D programs that translated these changes into military hardware. For the past seven years, the problem of integrating new communication systems into the AF and DOD operational environment had been my primary job responsibility.

The name, MITRE Corporation, frequently came up in correspondence or discussion as being involved in communications projects of interest to the Command. Initially, it appeared that a case study of MITRE might provide insight into the initial inquiry. The concern with MITRE soon led to an interest in the whole field of nonprofit corporations working in defense R&D. It soon became obvious that the overall field was much too broad and overwhelming to be investigated in the time available.

Within the AF, MITRE and Aerospace Corporations belonged to a group labeled system engineering and technical direction (SETD) nonprofits. These companies were by far the most controversial of all nonprofit activities. Initial review revealed that although these activities were the subject of countless Congressional

investigations and hearings, special reports in magazines and trade journals, short articles in books on management, no systematic study had been made of them. This study was hopefully designed to correct this deficiency.

Defense Research and Development:

World War II demonstrated that our military strength was largely dependent upon our exploration of science and technology. The rapid postwar demobilization was based on a rosy-hued vision of peace everlasting through a new world order of the brotherhood of people and nations. This dream was short lived. For the past twenty years a major national objective has been to retain military superiority through new and improved weapons. In this world system of power rivalries, science and technology have reached a position of unprecedented importance in the maintenance of our national security.

The formal evidence of this importance was the creation of governmental institutions and the phenomenal increase in appropriations for R&D. Federally financed R&D work increased from 100 million dollars in the late 1930's to over 15 billion dollars in fiscal year 1965. It was estimated that about 60% of all the scientists and engineers in R&D in this country were working wholly or in part on government financed programs. The DOD's share of these expenditures exceeded 7 billion dollars, or more than 40% of the total R&D bill.

The rise in federal R&D expenditures in general, but particularly in the defense area, altered patterns of organization of private industry and universities; resulted in the creation of profit and nonprofit contractors to operate government owned facilities; and spawned the proliferation of nonprofit corporations to provide operational analysis, operations research and systems engineering and technical direction to DOD activities.

The system for conducting federal R&D rests upon a complex partnership among public and private agencies, related in large part by contractual arrangements. The implications of this application of government contracting since World War II have been noted by Carl F. Stover in a Stanford Research Institute report:

> "Once limited almost entirely to use in the procurement of goods, the contract has now become a mechanism for securing a variety of services as well, including especially scientific research and development policy planning, and the management of government facilities. A pragmatic response to some of the nation's most serious needs, the contract system has emerged as one of the truly significant governmental inventions of this century. A key instrument in establishing a new partnership between governmental and nongovernmental agencies in the performance of public functions, it is intimately associated with many of the fundamental dilemmas we face in trying to maintain a free and just society under modern conditions." [2]

The more than 7 billion dollars spent by the DOD for development and production of weapons represents the largest individual element of government spending. The distribution and award

of government contracts, the amount of effort accomplished by in-house laboratories, the extent of effort placed in the hands of nonprofit corporations are matters of continuing political interest.

Bell Committee:

As a result of Congressional and public group pressures, President John F. Kennedy on July 13, 1961, requested the Director of the Bureau of the Budget, Mr. David Bell, to conduct a "broad review of the Government's experience in contracting with private institutions and enterprises to provide for the operation and management of Federal research and development facilities and programs, for analytical studies and advisory services, and for technical supervision of weapons systems and other programs administered on a contract basis." [3] The President specifically requested criteria that should be used "in determining whether to perform a service or function through a contractor or through Federal operations, including any special consideration to be given to the nature of the contractor and his relationship to production contractors." [4]

The Bell Committee reached these conclusions: (1) existing diversity of systems with varying degrees of interdependence and collaboration between government and private institutions was desirable and should continue; (2) this diversity provided required flexibility and means of comparative evaluation between systems;

and (3) choice of system or contractual arrangement should be left to the discretion of responsible Government officials.

In 1954, during the House Military Operations Hearings, better known as the Riehlman Hearings, Dr. Lloyd V. Berkner, then President of Associated Universities, Inc. stated:

> "The problem of administration of military research and development is relatively new because large scale military research and development is new. Therefore, if present arrangements for management are imperfect or not suitable to maintain our progress well in the vanguard of the enemy, the failure does not reflect discredit or blame on our military organizations. Rather it reflects the development or our understanding of what form of management of research and development will work, and what forms do not work, in light of accumulated experience with different kinds of organizations." [5]

Ten years have elapsed since the Riehlman Hearings and three years since the Bell report. Each of the military services and NASA have employed varied management approaches to weapon system research, development and acquisition. A mass of claims, often contradictory and conflicting were used by military agencies to explain the rationale behind their use of a particular organizational management form. The comparative evaluation between systems visualized by the Bell Report has not materialized. The advocates for the continued use of a variety of management organizations follow a line of reasoning advanced by Dr. Simon Ramo:

> "There must be flexibility in the ways in which different projects are organized and directed. Projects vary according to urgency, size, complexity, reliance on new science and on components not yet developed and experience possessed

by government and industry with the problems involved. Because all these factors have to be taken into account each time a project is organized, neither industrial nor government groups can afford to become fixed in their concepts of how the development of a weapon system is to be directed." [6]

Current Views of Defense Research and Development:

Currently, the issue of continued large expenditures of funds for military R&D is marked by diverse and conflicting opinions. In this connection, it is useful to recall some observations put forth by Roswell Gilpatric, former Deputy Secretary of Defense. In April 1964, Mr. Gilpatric discussed the kind of military establishment which might be appropriate for the United States assuming the present trend to less troubled relations with the USSR continued through the end of this decade. He considered a 25% reduction in the defense budget possible, but this reduction would not apply to R&D, as indicated by the following:

"Strong efforts would presumably continue in research and development, to assure that we were not left behind in major technological developments that could upset the balance of power between the blocs. Consequently, military research and development expenditures would remain high, such declines as did develop being the result mainly of savings on the large expenses of final engineering and testing of full-scale new strategic systems, rather than from a reduction in the breadth of our research programs or in pushing new frontiers of technology." [7]

On the other hand a strong argument for reduction of military R&D expenditures was advanced by Doctors Jerome B. Wiesner and Herbert York, distinguished scientists, Presidential and DOD

advisors. In a recent article in Scientific American, they concluded:

> "Both sides in the arms race are thus confronted by the dilemma of steadily increasing military power and steadily decreasing national security. It is our considered professional judgment that this dilemma has no technical solution. If the great powers continue to look for solutions in the area of science and technology only, the result will be to worsen the situation. The clearly predictable course of the arms race is a steady open spiral downward into oblivion." [8]

Military leaders repudiated such thinking and maintained that the military need for new technology was greater than ever. Gen. Bernard A. Schriever, Commander Air Force Systems Command (AFSC), at a Northeast Electronic Research Engineering Meeting in Boston maintained that Soviet and Chinese Communist scientific and technical achievements posed threats to our security and added:

> "In the face of this continuous challenge we must insure that we maintain the strength needed to deter war and counter aggression. In an age of technological explosion, the only way to maintain this strength is to push technology forward. Some may not agree. They believe that military technology is nearing the end of the road. I assure you that this is not the case." [9]

In January 1965, an Arthur D. Little report predicted that during the 1965-69 period, "the production portion of the defense budget available to industry will decline about 30% and defense research, testing and evaluation will decline about 15%." [10] The findings of this study will be discussed in later chapters

of this thesis; however, the A. D. Little conclusions assumed that unforeseen technological and political developments would not change the overall military environment during the period.

Within Congress, many of the legislative leaders consider that the nation cannot continue indefinitely to expand military R&D at the breathtaking pace and magnitude of the past decade. Representative Melvin Price of Illinois and Chairman of the R&D Subcommittee of the House Armed Services Committee said that "We cannot afford to support every research and development project which might be conceivable, or even desirable. We must be increasingly discerning in the projects we choose to support." [11]

Although the President had noted the need for improved military weapons, the defense R&D budget continued to decline. President Johnson's program for the "Great Society" called for increased government expenditures in general welfare and health areas accompanied by a decreased tax structure. Under such conditions, the financing of additional spending for welfare programs must come from further reductions in military expenditure.

Many of the military weapons in our arsenal today were the result of R&D programs implemented under the urgency of very high defense priorities. Success was measured by performance and availability rather than dollar or manpower costs. In the environment of today and the foreseeable future, dollar costs will

play a key role in DOD decision making and approval of a military R&D project. Dollar costs must play a major role in the service determination of the technical management system they will employ to bring the weapon into being. The AF maintained that the best method of obtaining military weapons and support systems was through a management system using (1) associate contractors, with (2) systems engineering and technical direction performed by nonprofit corporations, and (3) overall program control retained by the AF.

Expanded Challenge:

This then was the background of the expanded challenge, of new areas of interest that opened up as soon as the formal investigation of SETD nonprofits began. The AF expenditures of approximately $125 million in fiscal year 1965 to support MITRE and Aerospace Corporations seems insignificant in relation to the total defense R&D budget. Such a measure might lead one to underestimate the importance of the SETD nonprofit role within the AF. Their decisions influenced a major portion of the total AF R&D expenditures and this fact led to the following inquiries:

(1) Where do SETD nonprofits fit within the overall framework of defense R&D?

(2) Are the functions performed by SETD nonprofits legitimate?

(3) Are the AF claims for their management system employing the concepts of concurrency, associate contractor, and SETD nonprofits supported by historical fact?

The need for flexibility in managing diverse R&D programs is generally expressed as a truism. Should such a statement be accepted without investigation? Were the different systems used by government agencies based on a systematic evaluation of their worth or were they based on partisan whims?

This thesis will not address itself to evaluating the diverse and conflicting opinions concerning defense R&D expenditures. Instead these assumptions will be made: (1) our national security demands that changing technology be explored to determine possible military application; (2) defense R&D will continue to represent a substantial share of the total federal budget; and (3) dollar costs will play a more important role, not only in determining weapon system technological approaches but also in deciding which management system will be employed. If one accepts these assumptions, the inquiry may be further expanded to attempt to answer the following:

(1) Is there a need to better understand defense R&D management systems that have been or are still in use?

(2) Is it possible to make a comparative evaluation of these R&D systems to determine when and under what conditions one system is better than the other?

(3) Is the present DOD management of R&D conducive to technological innovation and change?

These questions are indicative of the fact that one cannot investigate the changing role of SETD nonprofits without

becoming enmeshed in the overall problem of defense R&D organization and management. Every effort has been made to stay as close as possible to the issues directly associated with the thesis topic. The implications of the investigation, however, "are more prominent than the phenomena we perceive". [12]

Methodology:

> "It has been remarked as an imperfection in the Art of Shipbuilding, that it can never been known 'till she is try'd, whether a new Ship will or will not be a good Sailer; for that the Model of a good sailing Ship has been exactly follow'd in the new One, which has prov'd on the contrary remarkably dull ... Yet I think a Set of Experiments might be instituted, first to determine the most proper Form of the Hull for swift sailing; next the best Dimensions and properest Place for the Masts; then the Form and Quantity of Sails, and their Position as the Winds may be; and lastly, the Disposition of her Lading. This is the Age of Experiments; and such a set accurately made and combined would be of great use. I am therefore persuaded that erelong some ingenious Philosopher will undertake it; to whom I wish Success." Benjamin Franklin. [13]

Ben Franklin was the epitome of the enlightened man. His pragmatic approach illustrated by his comments on the art of shipbuilding, unfortunately, was not applied to the art of R&D organization and management. No one has been willing to conduct a "set of experiments" that might enable government to determine when and under what conditions one R&D management system offered greater potential for success than another.

There was no shortage of written material related to federal and defense R&D and SETD nonprofits. The initial effort

was devoted to historical research. The best data came from hearings and reports of Congressional committees and various governmental and private studies. Analysis of the mass of claims and counterclaims with the historical record made it possible to separate fact from fiction and helped to provide a "dynamic conception" of SETD nonprofits through a better understanding of: (1) conditions and events, the host of forces at work, that led to their establishment; (2) their growth; (3) their changing role as the AF position varied; and (4) changing military and industrial capabilities to perform major system SETD.

Historical analysis by itself, however, was inadequate to provide a "dynamic conception" of the nonprofit corporation. In addition, a series of personal interviews were conducted in the Boston, New York, Washington and Los Angeles areas with: (1) industrial concerns that had worked with either one or both companies; (2) AF personnel at Hq USAF, AFSC, Ballistic Systems Division, Space Systems Division, Electronics Systems Division and research laboratories; (3) DOD personnel; and (4) Aerospace and MITRE officials.

The next four chapters of this study are based on the historical review and analysis and the information collected through interviews. The last two chapters represent my

evaluation of the SETD nonprofits and my recommendations for their future use in the total defense R&D picture.

CHAPTER II

HISTORICAL FACTORS BEARING ON THE PROBLEM

> "Why then do we have nonprofit corporations?
> "The answer, at least for those heavily engaged in defense work is that they were created to meet a special need which the government could not service internally, and which was not considered appropriate for university or profit making industrial laboratories." C. W. Halligan [1]

> "The common thread running through these accounts is that each of the new organizations was the product of a particular necessity. It will be apparent also that in all cases the responsible officials of government fully examined the organizational alternatives and found them unsuitable or actually to have failed." Gen. James McCormack, Jr. [2]

The justification of "special need" is the most popular explanation for the creation of both Aerospace and MITRE Corporations. In later chapters, the events that led to the establishment of these activities is discussed more fully. It appears from the record, however, that "special need" was a convenient catchall that neither explained the historical background nor the reason that the particular organizational form was adopted by the AF.

It is unfortunate that within organizational life in general, whether public or private, so little attention is paid to history. Many activities, especially within the military services, employ historians to document events and compile histories that are filed carefully in bookcases but rarely read.

One could not help but be impressed with the wealth of information available in published and unpublished military histories. The cycles of events and the lessons to be learned tended to confirm the old saying "there is little new under the sun."

If there was a "common thread" it was not in the national need but in the historical forces at play that one noted, time and again, in the decision to establish nonprofits and in the determination of their role. This chapter is an effort to bring these forces into focus.

Role of Science and the Scientist in World War II:

R&D was not an important factor in military organization prior to World War II (WW II). Field experience was the primary consideration in the improvement of existing equipment and the development of new weapons. The Army and Navy operated a few laboratories; however, most of the military research activities were accomplished by contract, under rigid specifications normally associated with production contracting. These conditions permitted the acceptance of few imaginative ideas even when good research was done. The transition from innovation to weapon application was extremely difficult because of the military resistance to change and lack of understanding and support between laboratory and industrial scientists and military leaders.

An illustration of this difficulty may be noted in the

development of radar. In the 1930's, radar research was carried out by the Naval Research Laboratories and the Army Signal Corps Fort Monmouth Laboratory, assisted by industry. While the effort showed much promise, it found little acceptance by either of the military services. The commanders at Pearl Harbor were not even aware of the potentialities of ground radar and Naval leaders were unable to see the tactical application of the air-borne radar systems designed by Naval Research Laboratories. Military tradition called for planning only in terms of existing weapons.

Many scientists too, considered that it was not their role to enter into organized political life. In 1933, the eminent physiologist, A. V. Hill, expressed this detached view of the social responsibilities of science and the scientist:

> "Not meddling with morals and politics: such, I would urge, is the normal condition of tolerance and immunity for scientific pursuits in a civilized state ... science should remain aloof and detached not from any sense of superiority, not from any indifference to the common welfare, but as a condition of complete intellectual honesty ... If science is to continue to make progress, it must insist on keeping its traditional position of independence, it must refuse to meddle with, or be dominated by divinity, morals, politics, or rhetoric." 3

Prior to WW II, these three factors then were fundamental obstacles to a successful program for weapon technology:

(1) Internal organization of the military services did not recognize the requirements and potentialities of science as an integral part of warfare.

(2) Military leaders, by training and tradition, generally did not visualize the impact of science or recognize the position that scientific research must occupy to produce a successful program for national defense.

(3) There were no emergency pressures to force scientists generally to recognize their social responsibilities or military leaders to accept changing weapon technology.

The outbreak of war in Europe in 1939 led many of our scientists to recognize that strong scientific support to military operations was mandatory. The organization of the National Defense Research Committee in 1940 and the subsequent Office of Scientific Research and Development grew out of pressure from the scientists on the Executive Branch of government and not out of support from the military. Scientific leaders such as Doctors Vannevar Bush, Karl T. Compton, Merle Tuve, and James Conant recognized that the success of the war would be dependent upon new weapons created by scientific and engineering research.

The success of OSRD in marshalling scientific resources, original thinkers capable of translating their ideas into reality; in collaborating with industry in bringing early prototypes into effective production; and in selling their ideas to the Armed Forces was a major achievement. The success of the organization was due to three important factors:

(1) Enlisted institutions rather than individuals. The government contract became a new type of federalism by which MIT took on the responsibilities for developing radar, California Institute of Technology rockets, and the University of Chicago sustained nuclear reaction.

(2) Reported directly to the President and had the support of the administration. The scientific community had never been in so exalted a position with direct access to the Chief Executive; a position exceeding any of the military service chiefs.

(3) Authority and funds to support and initiate research on matters considered essential to the national defense.

Under the OSRD organizational establishment, the military was a collaborator and not a manager, director or initiator of military system development. Collaboration was achieved through military liaison staffs in OSRD offices, who could give advice and guidance but could not control the direction of the research office. The scientific impact on weapon technology and planning was not always acceptable to the military.

> "The OSRD usually found very great resistance to any new idea or weapon while it was in the process of development. The files are replete with statements of high military authority concerning these 'ridiculous' ideas and, in most cases, these ideas would have been killed had the military been in control ... When the OSRD was able to bring an idea or weapon to the point of demonstration and successful tactical test, resistance to naval weapons and ideas almost uniformly disappeared, and thereafter the idea or device met with great enthusiasm on the part of the Armed Forces." 4

Role of Science and Scientist After World War II:

After the war, it remained clear that the national security would remain dependent on scientific research. In a letter to

the National Academy of Science, the Secretary of War stated:

> "This war emphasizes three facts of supreme importance to national security: (1) powerful new tactics of defense and offense are developed around new weapons created by scientific and engineering research; (2) the competitive time element in developing these weapons and tactics may be decisive; (3) war is increasingly total war, in which the armed services must be supplemented by active participation of every element of civilian population.
>
> "To insure continued preparedness along farsighted technical lines, the research scientists of the country must be called upon to continue in peacetime some substantial portion of those types of contribution to national security which they have made so effectively during the stress of the present war." 5

In his report to the President in 1946, Dr. Bush presented a recommended program for postwar scientific research. He urged that the Army and Navy continue their internal R&D activities but restrict their efforts to the improvement of current weapons. The activities of the wartime OSRD should be carried on by a permanent civilian activity, who would supplement the research work of the services, and provide the innovations and technological breakthroughs. This activity, he warned, if it were expected to make major contributions must not be subject to the complete direction of the military, and should have independence of funds. A partnership between the military and civilian scientists was necessary, but a true and effective partnership was possible only if both parties were equals and independent in prestige, authority, and funds. He wrote:

> "Military preparedness requires a permanent independent, civilian controlled organization, having close liaison with the Army and Navy, but with funds directly from Congress and with the clear power to initiate military research which will supplement and strengthen that carried on directly under the control of the Army and Navy." 6

Dr. Bush considered that this civilian organization would parcel out the long range research involving application of the newest scientific discoveries to military needs to civilian scientists in universities and in industry. In this way the "federalism by contract" developed by OSRD would be continued and would enable the government to obtain the most competent scientists to accomplish such tasks successfully.

Dr. Bush's advice went largely unheeded with the general and rapid demobilization of the Armed Services. The Office of Scientific Research and Development was discontinued in 1946, and programs were assigned to the Army and Navy for disposition. Under Dr. Bush's urging, the Secretary of War organized a Joint Research and Development Board to coordinate all R&D programs of the two military departments. With the enactment of the National Security Act of 1947 and the creation of the AF, the task of coordinating the programs of all services was assigned to the R&D Board. It was made a part of the newly established Office of the Secretary of Defense. The Board had no power to initiate research programs on its own, but was

restricted to advocate those programs to be carried on by the military services.

The Board was doomed to failure if only because of its organization. It had none of the strengths of OSRD. The Board carried out its coordination through a complex organization of committees, panels, and subpanels composed of full time representatives of the military services and part time civilian consultants from universities and industry. The civilian scientists found themselves embroiled in service rivalries; engaged in weapon improvement rather than weapon innovation; and subordinate to the military. As Dr. Bush indicated in his report to the President an effective partnership between military and civilian scientists was possible only if both parties were equal and independent in prestige, authority, and funds. The civilian scientist in the R&D Board had none of these attributes. The Board failed to achieve the primary objective of plugging strategic military needs with new weapon systems. Dr. Bush as a member of the Rockefeller Committee on DOD Organization in 1953 recommended the abolition of the R&D Board.

In testimony before the Riehlman Committee in 1954, Dr. Bush voiced his grave concern over the great split in relationships between military and civilian scientist:

> "During the war that integration was brought about, but under the conditions of war it was possible to cut corners,

> and moreover, the Office of Scientific Research and Development during the war reported directly to the President of the United States and had his vigorous support. Under those circumstances it was possible to bring about a liaison, a relationship under which OSRD worked closely with the military at all points and effectively. Today we do not even have good cordial relationships between the scientists and the military within the Department of Defense." [7]

Although there was general recognition that science and technology were vital to our national security, in eight short years the scientist fell from an active advisor to the President and the prime manager of urgent weapon systems to a part time and oftimes ineffectual advisor to the Secretary of Defense. This decline may be partially attributable to the difficulty of extending wartime measures into peacetime, or the extensive reductions in military R&D spending in the postwar years of 1946-48. However, by 1950, the military R&D effort exceeded the $600 million attained during the last year of WW II and with the Korean incident began to increase sharply. This failure to retain or regain the position of prominence achieved in WW II was due primarily to military resistance, pressures and tactics.

Military View of the Scientist's Role:

The position of authority attained by the scientist in WW II was unacceptable to the military. In the first place, the weapon systems developed by the scientist caused a complete change of planning and tactics. As previously indicated, most

of the innovations were strongly resisted by the military. The motivation underlying the almost inevitable opposition of the Armed Forces to development of radical new weapons or tactics is inferred by Dr. Elting E. Morison, Sloan Professor of Industrial Management at MIT, in his fascinating description of the Navy opposition to continuous-aim firing, which changed naval gunnery from an art to a science:

> "To these numerous innovations, producing as they did a spreading disorder throughout a service with heavy commitments to formal organization, the Navy responded with grudging pain. It is wrong to assume, as civilians frequently do, that this blind reaction to technological change springs exclusively from some causeless Bourbon distemper that invades the military mind. There is a sounder and more attractive base. The opposition, where it occurs, of the soldier and the sailor to such change springs from the normal human instinct to protect oneself and more especially one's way of life. Military organizations are societies built around and upon the prevailing weapon systems. Intuitively and quite correctly the military man feels that a change in weapon portends a change in the arrangements of his society." [8]

Normally, innovators have extreme difficulties in getting their ideas accepted. But in the case of OSRD, the academic or industrial scientist working in an atmosphere relatively free from the adverse pressures of convention, prejudice, or commercial necessity had access to the very highest levels of governmental decision making. The military, who would be affected by the innovation, were, for all practical purposes, by-passed. Military liaison staffs could provide advice and offer assistance

but, as previously indicated, could not control the direction of the research. The fundamental strength of military organization lies in the quality of its discipline. The scientific innovator requires a substantial degree of intellectual freedom and tends to resist the dogmatic direction associated with military discipline.

The "federalism by contract" preferred by the scientist, the assignment of strategic military weapon development to universities or university type nonprofit organizations, would place the military in a secondary role. Since the scientist considered the weapon system in a national and not an interservice role, they jeopardized the existing structure of the military services. The independent funding arrangement desired by the scientist for weapon development would not only jeopardize traditional service roles but also compete for funds considered necessary by the services for the improvement and operation of accepted and existing weapons.

The inherent strengthsof scientific effort represented by an organization like OSRD were points of contention and a source of severe irritation to the military. The termination of WW II provided them with an opportunity to turn the tables on the scientific community and regain their predominant role in defense R&D.

In order to resist outside control by the scientists the military effectively smothered the advisory machinery of the R&D Board by procedures and tactics. The military had the authority to determine requirements, to decide what scientific work was needed; the civilian scientist merely became the watchdog looking for duplication. The research programs were paid for out of money appropriated to the military departments and administered by personnel within the military chain of command. The civilian scientist working part time on review committees was unable or unwilling to make basic program decisions and deferred to the full time military representative. The management system developed by the military used the prestige of the scientific community to lend credence to their actions but effectively left the scientist impotent to direct, control, or even effectively advise the military of major technological changes.

Military Use of the Scientist to Establish Roles and Missions:

The military did realize that science and technology had destroyed the traditional basis of services organized around strategic land, sea, and air missions. The Key West Agreement of 1949 tried unsuccessfully to establish more realistic roles and missions for the services. The traditional lines were retained, however, and the gray areas bordering normal service

responsibilities were covered in general terms and skirted the issue of service responsibility. All services were mentioned in the air defense role but no one put in charge; a compromise was made on control of nuclear weapons with the AF getting sole right to a strategic air arm but the Navy permitted to use the A bomb against "naval targets"; and guided missiles were not even mentioned.

The 1950's were thus marked by continuous, and oftimes bitter battles by the military services competing for key roles and missions. Each side enlisted military, political and public sympathies in its battle for survival or supremacy. In the competition, the AF saw in scientific research the essential key to the development of its tactics and strategy in such a way as to increase its own importance in competition with other services.

The period marked the beginning of large scale use of special study contracts by the services. In Project Hartwell the Navy asked MIT to investigate fully anti-submarine warfare and the entire problem of maintaining transport over the seas. Hartwell was followed by Project Troy, Charles, East River, Vista and Project Lincoln Summer Study. Dr. Price records:

> "By 1952, the military departments had set up so many studies of this kind and were competing so strenuously for the services of scientists and universities that the Research and Development Board insisted that they would have to get its approval before starting any new ones." [9]

Some of these studies saw good cooperation between military and civilian scientist and resulted in strategically important ideas for guidance of weapon technology. On the other hand some of the studies resulted in serious differences of opinion between the scientist and the military. Thus when Project Lincoln Summer Study revealed a serious air defense situation the AF minimized the ability of the recommended technology to solve the problem.

Several prominent scientists accustomed to a position of authority from OSRD days began to carry on a public campaign criticizing the AF for its failure to take advantage of new "technological break-throughs" that would permit solution of the air defense problem. This action raised the question of the propriety of scientists working under military contract to study a vital military problem and to report or advertise their findings to other than their military client. There was no doubt that the scientist was not content to leave his advice entirely at the mercy of the military. He remembered OSRD days and desired to play an active role in determining what was done within the R&D program. On the other hand, the services many times were not interested so much in advice as they were in scientific support for their position of tactics and mission responsibility. The battle lines between the military and the scientist were drawn around whether the latter should be on tap or on top.

Army, Air Force Rivalry for Roles and Mission:

The National Security Act of 1947 created the AF, ironically at a time of declining importance of airpower and rising ascendency of missile power. Modern guided missile developments were begun on a small scale during WW II in an effort to achieve or exceed German V1 and V2 weapons. A Committee on Guided Missiles was established in the Joint R&D Board, consisting of two civilian members and not more than two members each from the three military departments.

> "Further, the committee was to prepare at least once a year an integrated plan of research and development for military purposes in the field of guided missiles; allocate responsibilities between the military departments for programs in this field; recommend means to exploit critical resources and new advances, develop sources, avoid undesirable duplication, and promote liaison, cooperation, and direct dealing among engineers; and recommend to the Board the funds required for research and development programs and facilities in this field." [10]

As previously indicated the organization of the Board predetermined its failure. Each of the services was in direct competition for space and missile roles. No service was willing to entrust to the other the conduct of its research program. Since the Committee was composed principally of service representatives, who were also the litigants in the dispute, there was no independent judge. The civilian scientists as previously indicated became pawns in this contest for service supremacy.

The leading personalities in this conflict were Gen. Schriever for the AF and Gen. Medaris for the Army. These two dynamic and dedicated individuals, however, spoke not for themselves but for the service they represented. Basic differences in technical capabilities led to the selection of different technical management strategies which played a key role in the ultimate decision.

The Army "arsenal" system of in-house research and engineering centers represented the backbone of their technical management system. These centers were not only responsible for modernizing existing weapons but also capable of developing prototypes of new weapon systems. The latter were usually turned over to industry for production of quantity needs. Although the arsenal system used industrial and university study contracts to supplement their capabilities, their in-house resources were capable of performing system engineering and technical direction, advanced planning and basic research.

In their missile development program the Army used predominantly in-house resources. In 1949, the Redstone Arsenal at Huntsville, Alabama was activated and under Dr. von Braun's direction large numbers of experienced scientists and engineers were transferred or recruited to this center. The greatest in-house government missile capability was under Army control.

By 1955, the Guided Missiles Division at Redstone had 3600 experienced personnel including 500 scientists and engineers, many of whom had worked closely with von Braun and his team of German scientists from the time of his arrival in the United States.

The AF did not have an arsenal system comparable to either the Army or Navy. It had a large capable group of in-house scientists and engineers at Wright-Patterson AFB, involved in aircraft development. This group had the capability to provide assistance in missile development but they were busy in the aircraft field and their leadership was neither concerned with the future role of missiles nor assigned a missile/space role; and the group was not systems oriented. It is probable that Gen. Schriever made no effort to recruit the Wright activity as an AF "arsenal" for missiles because the group could not be brought under his direct operational control and its basic interests would be split between advanced aircraft and missiles. Gen. Schriever explained:

> "In the case of the Air Force, it is generally true we do not go to the other service laboratories. We know what they are doing, but our development, our whole philosophy has been one of going to industry and having industry produce for us." [11]

The AF had no time to create new government laboratories to compete with the Army. A new system, the establishment of a

special private corporation founded entirely for the purpose of carrying on scientific programs, was conceived. The AF proceeded to rent its scientific strength by the contractual method.

By this new approach, the AF not only bought technical competence but in the early 1950's it bought industrial approval and support of their fight with the Army for the major role in missiles. As previously indicated, the Army missile program was an in-house program which employed a strong arsenal approach. Industry threw its support behind the philosophy of Gen. Schriever, which stressed "having industry develop and produce for us." While they recognized some of the difficulties inherent in the AF approach, industry considered them less dangerous than the Army arsenal system.

Industry Void in Systems Management:

Our entry into the ballistic missile era marked a transition in weapon system management - a radical increase in requirements for competence in what has been called "systems engineering." This term described the operations involved in engineering a complex system requiring the integration of a number of sub-systems, each involving a different branch of technology. The system is tied together by the interface of the physical sciences, principally physics, with all phases of engineering. The systems contractor must be sufficiently competent in all

fields of technology to understand the problem in each subsystem and to make appropriate compromises between the conflicting requirements for optimization in each area to order to get the best total system. Such skills did not exist in any industrial group or even at our major universities. It had to be developed.

The aerospace giants did not recognize the total challenge of systems engineering and considered the problems solvable by the production engineering methods they had so successfully demonstrated in WW II. This fact was noted when Convair appeared before the Scientific Advisory Committee in July 1954:

> "Gen. Joseph T. McNarney (retired) and other Convair representatives outlined their management concept of the ICBM program and made a bid for complete weapon system responsibility. Committee members were not impressed; later they voiced disappointment in Convair's standpat position and expressed doubt that Convair's management structure was strong enough to handle the whole ICBM program ... The members left the Committee meeting with a rather general opinion that Convair was not strong enough for systems management of the Atlas project and that other airframe companies also were lacking in this regard." 12

The changing role of the scientist in military R&D from WW II through the 1950's; the military view that the scientist posed a definite threat to their control of the R&D program; the destruction of traditional service roles by "technological giant steps" and the conflict between the military services seeking power and responsibility in new mission areas; and the industrial strength in production skills but void in systems

management after WW II were real forces that played a vital part in the creation of SETD nonprofits. The recurrence of these forces, time and again, were noted in the development of Aerospace and MITRE Corporations, described in the next two chapters.

CHAPTER III

AEROSPACE CORPORATION

The history of Aerospace Corporation, which was organized in 1960, can only be understood and evaluated in light of the history and role of Ramo-Woolridge (R-W) Corporation, the first technical manager of the AF ballistic missile program. This history was fully documented in two studies by the House Committee on Government Operations: (1) House Report #1121, Organization and Management of Missile Programs, dated September 2, 1959; and (2) House Report #324, Air Force Ballistic Missile Management (Formation of Aerospace Corp.), dated May 1, 1961.

These reports detailed the events leading to the creation of Space Technology Laboratories (STL), a separate corporate entity of R-W, and today a wholly owned subsidiary of Thompson Ramo Woolridge, Inc. The reports were comprehensive and well documented. It served no useful purpose to repeat the detailed history; however, salient points were extracted and additional data contained in AF files included in this historical review.

Early Committees:

As previously indicated, the role of missile power was recognized, if not fully understood, by the military services after WW II. The AF had let study contracts with Convair beginning in 1946 to determine problems associated with long

range missiles. The degree of effort varied between 1946 and 1952 depending on budgetary situations and military interest. The heavy warhead weights posed rocket engine thrust and guidance problems that were extremely difficult and beyond state-of-the-art considerations. These problems made the ICBM conceivable but impractical until the thermonuclear developments in 1952-53. This technological breakthrough by Atomic Energy Commission (AEC) scientists in warhead size made the practicality of a successful ICBM more meaningful.

An ad hoc committee headed by Dr. Clark B. Millikan of the California Institute of Technology was established by the AF Scientific Advisory Board to evaluate the Atlas project, the name assigned to the Convair investigations, and to determine the probable future of this industrial study effort. After visits to contractor facilities, AEC and AF briefings, the committee gave the Atlas program a cautious endorsement. They recommended continuation of the program under Convair's direction but did not accept the contractor's recommendation to proceed immediately to the design and production of a large tactical missile. They advised acceptance of a three step development program with military/scientific evaluation at the end of each step to determine the desirability of continuing construction of a proposed test vehicle or possibly proceeding directly with a

prototype missile.

These recommendations were not acceptable to some AF people. Mr. Trevor Gardner, Special Assistant for Research and Development, who had worked closely with the nuclear panel of the Scientific Advisory Board, considered the Millikan Committee caution unrealistic in light of the Soviet threat. He considered that the report failed to recognize the national urgency of ICBM development and the implications of the thermonuclear development. Mr. Gardner also felt that a part time scientific advisory group could not provide the impetus required for the program. Against the advice of military personnel in the AF, he urged the establishment of a full time technically qualified group, to work on the ballistic missile problem. In October 1953, the Strategic Missiles Evaluation Committee (SMEC), consisting of distinguished scientists from universities and industry, under Dr. John von Neumann was established. The Committee was to obtain continuity through the employment of a full time technical staff.

Ramo-Woolridge and von Neumann Committee:

Considerable attention was given to the technical staff problem. Three groups were considered initially: Rand Corporation, but this activity was eliminated because of their involvement in other AF programs; California Institute of Technology and

MIT who were hesitant to consider such a role but agreed to accept the task only if no other resource were available. Mr. Gardner then approached Doctors Simon Ramo and Woolridge, who had left Hughes Aircraft that year with a few colleagues and formed their own advanced research company, to accept the technical staff role for the Committee. The scientists were hesitant to accept the job for their company for fear of unfavorable industry reaction; however, in October 1953 they signed an AF Contract accepting the technical staff responsibility for the SMEC or von Neumann Committee.

The von Neumann Committee report submitted in February 1954 advised that an ICBM could be developed and made operational in five to six years but not under current AF management acquisition procedures. The AF had recently inaugurated the weapons systems project office approach, which recognized systems management by colocating Air Research and Development Command and Air Materiel Command project personnel; however, systems engineering and technical direction were left with a prime contractor responsible for the development and manufacture of the weapon system itself. The Committee asserted that a revolution in military technology had taken place. The accelerated rate of technological change and the complexity of the ballistic missile system interfaces in electronics, propulsion, guidance, reentry, etc. was beyond the capability of Convair or

any other prime contractor. The Committee therefore recommended:

> "The most urgent and immediate need in the IBMS program is the setting up of the above mentioned new IBMS development-management agency for the entire program ... The nature of the task for this new agency requires that overall technical direction be in the hands of an unusually competent group of scientists and engineers capable of making systems analyses, supervising the research bases, and completely controlling the experimental and hardware phases of the program." [1]

Mr. Gardner had also reviewed Rand studies on the impact of thermonuclear advances, that supported the von Neumann technical findings. The Rand study further implied that the increased centralization of R&D by Headquarters USAF, which imposed layers of review and cumbersome approval procedures, would have to be bypassed if the 1960 operational date were to be met.

With the confirmation by eminent scientists in hand, Mr. Gardner advised the Secretary of the Air Force that in order to achieve the desired missile operational capability in the specified time there would have to be a dramatic acceleration of the program, and an organizational structure established that would simplify controls and channels of communication. He further suggested that two General officers be assigned to the program who would be authorized to direct all military and industrial program elements and would have direct channels of communication to the Secretary of the Air Force.

Western Development Division:

On May 1954, the Air Force assigned its highest development priority to the Atlas project. The Air R&D Command (ARDC) was assigned full responsibility to develop a complete ICBM weapons system including operational, logistic and personnel concepts. In keeping with Mr. Gardner's recommendations, ARDC established a separate missile office on the West Coast, the Western Development Division (WDD), with a General officer slot for its Commander, and delegated its missile responsibilities to that organization. Gen. Bernard A. Schriever was assigned command on July 1, 1954 with complete authority, responsibility and control over all program aspects of the ICBM, including weapon system engineering decisions.

Gen. Schriever recognized that the technical management system he adopted for WDD would have to satisfy three groups - the scientist, industry and the military. He was well aware of the dissatisfaction of many scientists with their role in the R&D Board. The kind of technical support he desired could not be achieved if the organization was an anathema to the scientists. The scientists, if dissatisfied, might withdraw from the program, or in a more positive way might carry their case to the highest levels asserting the need for a special organization outside of military control to carry out the ICBM program. Gen. Schriever

considered that such a move, if successful, would endanger the military philosophy of research and development. He was determined to design a management system that would prove acceptable to the scientist.

It must be stressed at this point that the task confronting Gen. Schriever was not only the development of an ICBM but, more important, the attainment of a complete missile operational capability at the earliest possible date. These controlling factors had to be considered in developing the technical development plan for WDD:

(1) Technical complexity of the project was considered greater than past development projects, including the Manhattan effort.

(2) Interface of varied engineering and scientific skills combined with short development time schedule demanded strong industry support and a broader industrial base than possible under a prime contractor or arsenal management approach.

(3) Strong and open support by the scientific community was necessary.

(4) Close and continuous integration between the technical efforts of industry and the scientist with the military personnel responsible for weapon operation, logistics, personnel and training.

(5) Retention of overall control by the AF.

Five Management Plans Considered:

With these factors to be considered, Gen. Schriever's staff formulated and evaluated five possible management plans for WDD:

Plan 1: Award a single prime contract to one industrial organization to manage and provide the complete development. As previously indicated, the von Neumann Committee did not consider Convair capable of dealing with the technical complexities of the program. They considered that Convair lacked across the board competence in the physical sciences considered vital for interfacing technology and engineering. Industrial organizations had not been successful in attracting or holding top flight scientific personnel because of their failure to provide key or responsible positions for them in their organization and the imposition of strong controls over their research activities. The hiring of top level scientists at higher salary levels and increased levels of responsibility for this program could cause serious personnel and morale problems, which an old established company would be reluctant to face. In addition, the Air Materiel Command strongly opposed the prime contractor approach because it considered that the AF would lose much of its management control. A large segment of industry also objected to the prime contract approach for it severely limited broad industrial participation. This method recommended by Convair was rejected

on all counts.

Plan 2: A second alternative was to create a new large laboratory within a university structure. While this approach would make it easier to attract top level scientists necessary for the R&D aspects of the program, it would not provide the best vehicle for control and management of the industrial base required for hardware development and production. There was a great reluctance on the part of universities to accept the responsibilities of such a broad program. The military, too, was unwilling to surrender management control to powerful university groups, who had access to highest governmental circles, and were considered undisciplined by military standards. The staff rejected this proposal.

Plan 3: AF retention of overall systems management responsibilities in-house was rejected because past experience had demonstrated the inability of government to recruit the necessary scientific and managerial talent through normal civil service channels. Hiring at higher salary levels and with responsibilities different than specified in directives posed Civil Service problems that the government was not willing to face. Although a limited in-house capability existed at Wright-Patterson, the guided missile program would have to be superimposed on a thriving manned aircraft R&D program. As previously indicated,

Gen. Schriever did not consider this diversity of interests desirable. The fact that the Wright Patterson group would be outside of his direct operational control was considered detrimental to effective program management. Industry too looked with suspicion on an "arsenal" approach and their support was considered essential.

Plan 4: Establishment of R-W Corp., the technical staff element of the von Neumann Committee, as a technical staff element of the Commander WDD with systems engineering residing in the hands of a prime contractor. This staff position role was favored by Dr. Ramo because it not only permitted him to retain good relationships with industry but also enabled the corporation to stay within a reasonable growth factor. From Gen. Schriever's standpoint this position was acceptable because the Corporation could provide him with outstanding ability in systems management and engineering as well as important background in SMEC concepts. Doctors Ramo and Woolridge were leading scientific figures of great repute. Their ability to attract academic excellence was demonstrated by the fact that several full professors and university department heads had accepted leave-of-absence assignments to work for the Corporation on the von Neumann Committee effort. This approach appeared to have the greatest overall appeal to the three

elements whose cooperation was considered vital to success - the military, the scientist, and industry. However, it left the position of the prime industrial contractor for systems responsibility open to question. Mr. Donald A. Quarles, then Assistant Secretary of Defense for Research and Development, after listening to a briefing on the above management possibilities stated that systems responsibilities must not be left vague but clearly delineated. Either Convair had to be judged competent and given the overall systems job, including technical direction of associate and subcontractor effort, or else R-W must be assigned total systems responsibility. If Convair were considered competent, a small R-W group would remain as a WDD staff element to provide technical assistance to Gen. Schriever. As previously noted, Convair's capability to assume systems responsibility was questioned by the scientific community. The consideration by Gen. Schriever to broaden the industrial base by using associate contractors for each of the major elements of the system would also complicate Convair's ability to effectively exercise total systems engineering responsibility. Thus, a fifth management approach was developed and considered.

Plan 5: Establishment of R-W as a technical line element of WDD with full responsibility for systems engineering and technical direction. The relationship was described in this way:

> "But Ramo-Woolridge, a prime contractor on this regard, still would be part of the Air Force family, operating from WDD Headquarters and giving technical advice to the Air Force. The Air Force would control Ramo-Woolridge and Ramo-Woolridge would control the associate contractors ... In this arrangement, Convair would be one of the associate contractors, having important responsibility for missile assembly, but looking to Ramo-Woolridge for the technical direction and systems engineering which otherwise Convair would have performed as the prime contractor."

SETD Relationship of Ramo-Woolridge:

Gen. Schriever described these approaches in a presentation to the Scientific Advisory Committee on October 15, 1954. He advised them of his selection of the last approach and the concurrence of the Commanders ARDC and AMC that R-W be given systems engineering and technical direction responsibilities for the ICBM program. One objection was voiced within the Committee. Mr. Frank Collbohm, President of Rand Corporation, challenged the wisdom of divorcing engineering design and responsibility from the airframe contractor. He considered that a number of companies were qualified and capable of producing the missile. He questioned whether an independent design group could achieve the strength of a design group working with a major manufacturing organization. It appeared to him that airframe companies would not care for the secondary position and might refuse to participate in the ICBM program. He stated that "a manufacturer who is given responsibility of delivering an untried system which will work should not be

expected to start with specifications and design concepts in which his organization has had no voice." 3

Dr. von Neumann appointed a three member panel of the Committee to consider Mr. Collbohm's objections. The panel "rejecting Mr. Collbohm's views, reaffirmed the Air Force finding that the role marked out for Ramo-Woolridge and already in effect was 'logical and sound and should be continued'." 4

Scientific committees provided the confirmation not only for the technical direction of the program but also for the management direction. This included centralization of budgeting, program planning as well as the functional activities of production, procurement, logistics, operations and training. Gen. Schriever was happy to accommodate the scientific recommendations in establishing his organizational and management guidelines for WDD since he was in complete accord with such centralized responsibilities. In late 1954, the Air Force signed the contract that gave R-W systems engineering and technical direction of the ballistic missile program.

The prime consideration from a military standpoint was to insure that the AF retained overall responsibility for this complex project. The selection of R-W and its acceptance of a line relationship permitted the centralization of technical

management within AF control.

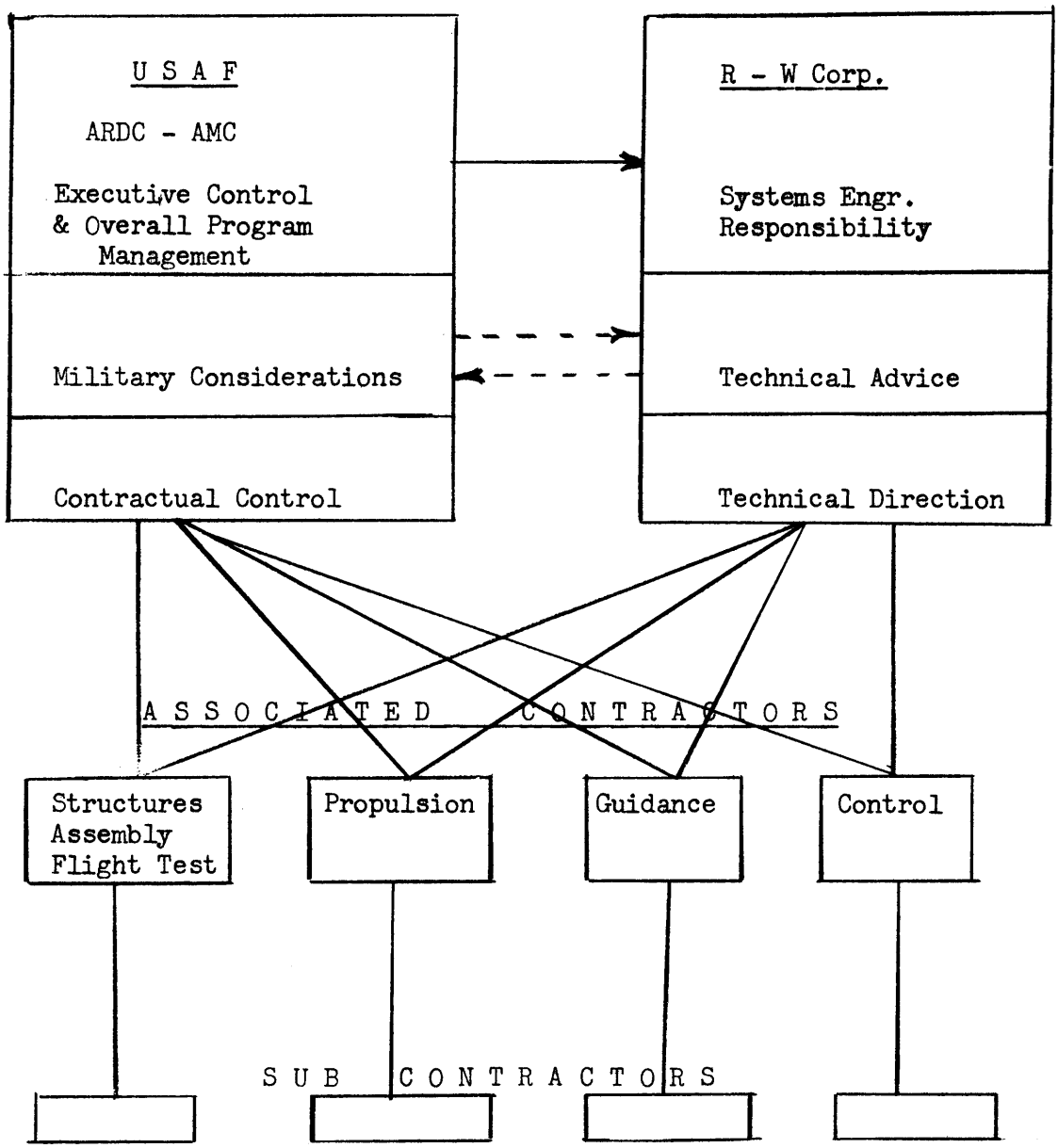
The organizational role assigned to Ramo-Woolridge within WDD may be noted in Figure 1. In its line responsibilities for systems engineering and technical direction as well as its staff role for technical advice and advanced planning, R-W was an integral member of the WDD military family. This approach not only centralized AF management but also brought into the military complex an unusually competent and objective technical team to carry out many of the functions previously assigned by the AF to a prime weapon system contractor.

The broad industrial base normally provided by the prime contractor was now performed by associate contractors. However, before the associate contractors could play their role, the systems engineers in R-W had to translate military system objectives into specific design requirements. This involved assessment of the state-of-the-art, engineering synthesis of controlling system parameters, determination of competing system configurations capable of meeting military requirements and then operational analysis to determine a single functional configuration. The system was then divided into subsystems and assigned to associate contractors for separate, concurrent development.

Technical direction had to be provided the associate contractors to insure optimal mating of the subsystems within the

FIGURE 1

AIR FORCE - RAMO-WOOLRIDGE RELATIONSHIP



Solid Line - Line Relationship
Dotted Line -Staff Relationship

Source: Hq AFSC

total system. R-W held the technical direction responsibility to work out with associated contractors the technical decisions as to which subsystem characteristics should be modified and compromised in order to achieve compatibility with the whole and to provide an optimum total system. This role was described by Max Golden, General Counsel of the AF:

> "Above all, the contributions of the systems contractor would be critical. He would be the technical overseer of the many subsystem contractors; the arbiter of tolerances and compromises among countless components; and the cement that bound all together, into the optimum weapon system." [5]

The job required the gathering together of very competent scientific and technical people in a variety of disciplines. As previously indicated, Doctors Ramo and Woolridge were able to attract these skills. It is highly doubtful that, at the time, either industry or government could have assembled the same competence or provided the working relationships necessary for the effective execution of the ballistic missile program.

The management complex assembled at WDD was unique in the DOD. All elements of the total weapon system were colocated and centralized in one area: (1) the developer, WDD; (2) the systems engineer and technical director, R-W; (3) the logistician, AMC; and (4) the operator and user, SAC. This military-scientific-industrial team engaged in a radical experiment in weapon system development and management. The WDD complex was granted greater

autonomy and independent authority than had been granted to any previous AF management organization. The AF placed full responsibility for speeding ballistic missile development through to an earliest possible successful conclusion in this management complex. The remarkable results achieved in the development of Atlas, Titan, Thor and Minuteman stand as a monument to this system. The Committee on Government Operations report stated:

> "From the performance standpoint, Ramo-Woolridge (STL) along with BMD can point to the fact that they 'beat the clock' and surprised many experts in getting operable Atlases and Thors from factory to the field in so short a period of time. There will be many - in industry among participating contractors, in Government among rival services - who discount the contribution of Ramo-Woolridge (and STL) but this organization can take pride in its own right for what it has done for the United States." [6]

Conflict of Interest:

The AF/R-W relationship was extremely successful technically but in a few short years floundered because of political and economic pressures. Systems engineering and technical direction demanded an objective and impartial contractor. The original Ramo-Woolridge contract debarred R-W and its minority stockholder, Thompson Products Co., from any AF hardware development or production work; however, this restriction did not apply to any ballistic missile contracts already held by Thompson Products. Initially, this restriction did not overly concern the company. In the latter part of 1958, R-W and Thompson

Products merged into Thompson Ramo-Woolridge for the express purpose of acquiring a larger share of the missile business. The hardware ban cut them off from a major share of defense contracts. The company also realized the potential of space business. Space Technology Laboratories (STL), the R-W activity now sitting in the line-staff relationship with the AF wanted to free itself from the encumbrances of a hardware ban.

The initial support by industry of the R-W role was based on the consideration that this system was less of a threat than the arsenal approach. The growth of R-W and the new Thompson Ramo-Woolridge organization posed a definite threat to industry.

> "The convention adopted by the Air Force of referring to Ramo-Woolridge as its 'prime' contractor or as a 'line' contractor on a par with other missile contractors, does not obviate the fact that this contractor alone sits at the very seat of Government, three or four thousand strong, and wields an enormous influence on the course and conduct of multi-million dollar missile programs. This influence - there is nothing insidious about the term as used here - is the more powerful because it is exercised in the name of the Air Force. And while much emphasis is given to the fact that STL hews closely to the line of 'technical' decisions and keeps out of business and contracting decisions, the other fact is that the technical decisions are critical to and shape the course of the business decisions. In the missile programs, technique is master; business is the housekeeper." [7]

Thompson Ramo-Woolridge desire to expand its operations led to a breakdown of relations with industry. To keep up with the state-of-the-art, R-W systems engineers needed access to industrial

scientists. Contractors were reluctant to furnish information that might then be used by R-W for its own competitive advantage. The objectivity and impartiality of R-W became subject to question. Did the company have an axe to grind when they defended in-house designed subsystems? The questions posed by the changing nature of military and space technology, the changing position of R-W, and the political pressures brought to bear by industry led some to be concerned with the continued effectiveness of the AF ballistic missile program. This concern was voiced by the Congressional Committee that had studied the missile program so extensively:

> "The subcommittee believes that if STL is to have any future with the Air Force, it must be converted into a nonprofit institution akin to the Rand Corporation and other private and university sponsored organizations which serve the military departments and other agencies of the Federal Government on a stable and continuing basis. Government relationships with nonprofit organizations also pose problems, but they are less important than the benefits received and certainly less crucial than those posed by the STL tie with the Air Force." [8]

Mr. Max Golden claimed:

> "Just as the need for an independent systems contractor did not arise until the missile had introduced a new era in technology, so the problem of his profit-seeking status did not become acute until the space age had spawned still another generation of systems ... The traditional prime contractor, the independent systems contractor, and the nonprofit corporations are but progressive attempts to keep forms of management abreast with technology." [9]

This misstatement of fact glamorized space system needs that

were basically no different from those faced in the ballistic missile program. The space age opened up new vistas for profit-making aerospace and electronics industries. A R-W willing to play the initial role assigned to it by the military in 1954 could have effectively retained that position with the AF in the space age. It was not changing technology but the unwillingness of Thompson Ramo-Woolridge to divorce itself from missile and space hardware that led to the creation of Aerospace Corporation.

A change was required. Again the AF went to the scientists for assistance. In 1959, a committee of scientists headed by Dr. Millikan was appointed by the Secretary of the Air Force to study the management needs of the AF ballistic missile program. The Millikan Committee concurred with industrial and congressional critics that the relationship between STL and the AF should be changed; however, they insisted that the AF would continue to need the competence that STL provided. The congressional critics wanted divestiture of STL by R-W and transformation of the organization into a nonprofit corporation. In his testimony to the Millikan Committee, Gen. Schriever considered these actions necessary.

"a. Complete independence of STL which dictates divestiture by Thompson Ramo-Woolridge.

"b. That the divestiture be accomplished in a manner which

could not lead to speculation and the concurrent necessity for growth and diversification.

"c. That there be no production or possibility of production competition between STL and the manufacturing divisions of industry.

"d. That the growth of STL be closely controlled.

"e. That the arrangements insure against divergent interests arising through conflicting private and government objectives and thus eliminate the internal and external pressures which create an aura of misunderstanding and distrust.

"f. That the organization have an aloofness which will assure the fullest measure of confidence and support of Industry, the scientific fraternity, the Congress, and the American public." 10

Thompson Ramo-Woolridge refused to divest itself of the strong resource it had in STL and permit it to become a nonprofit corporation. The AF then acted to create a new corporate body.

Creation of Aerospace:

In April 1960, the Secretary of the Air Force, requested Mr. William C. Foster, corporation executive and veteran government administrator, to head an organizing committee for the new organization. The Article of Incorporation filed June 3, 1960 which incorporated Aerospace as a nonprofit corporation under the laws of the State of California set forth the following mission:

"The purposes of the Corporation are exclusively scientific, as herein set forth; to engage in, assist and contribute

to the support of scientific activities and projects for, and to perform and engage in research, development and advisory services to or for the United States Government." 11

The letter contract under which Aerospace was authorized to supply services to the AF in fiscal year 1961 incorporated this statement of the company's mission:

"... to aid the United States Air Force in applying the full resources of modern science and technology to the problem of achieving those continuing advances, in ballistic missile and military space systems which are basic to national security. The Aerospace Corporation is responsible for providing the Air Force missile and space efforts with an organization which is objective, possessing high technical competence and characterized by permanence and stability. The Aerospace Corporation will provide a vital link between the Air Force and the scientific and industrial organizations in the country with a capability and interest in the ballistic missile and space field; and, the Aerospace Corporation through its unique role, will help to insure that the full technical resources of the nation are properly applied and that the potential advances in the missile and space field are realized in the shortest possible time." 12

Space Program:

At the time of origin Aerospace became responsible for ballistic missile as well as space oriented systems engineering, technical direction and planning. However, to avoid disruption to the development of the national priority Atlas, Titan and the Minuteman programs, STL retained responsibility for these vital programs. This split arrangement was to be transitional only until the three large missile programs phased out. The responsibilities of these programs represented a substantial workload for STL that, although decreasing in size, exists today.

CHART 1

STL MANPOWER UNDER AF CONTRACT

Fiscal Year	Total Employed	Scientists & Engineers (MTS)
1961	2582	995
1962	2716	896
1963	2407	839
1964	1354	655
1965	1287	460

Source: Holifield Committee Reports and Hq AFSC

The retention by STL of the ballistic missile programs of vital national interest and urgency led some observers to consider "initially, at least, the newly formed Aerospace Corp. worked almost exclusively on space systems." This emphasis on space activity stemmed from a directive by the Secretary of Defense in March 1961 which stated that:

> "... research, development, test and engineering of Department of Defense space development programs or projects, which are approved hereafter, will be the responsibility of the Department of the Air Force." 13

On May 25, 1961, President Kennedy sounded the battle cry for the nation's space effort:

> "If we are to win the battle for men's minds, the dramatic achievements in space which occurred in recent weeks should

> have made clear to us all the impact of this frontier of human adventures ... Now is the time to take longer strides - time for this nation to take a clearly leading role in space achievement ...
>
> "Let me stress also that more money alone will not do the job. This decision demands a major national committment of scientific and technical manpower, materials and facilities, and the possibility of their diversion from other important activities where they are already thinly spread. It means a degree of dedication, organization, and discipline which have not always characterized our research and development efforts." 4

Although Gen. Schriever, the Millikan Committee, and Congressional committees considered that the growth of Aerospace must be limited, the open season in space effort resulted in a big personnel buildup in Aerospace Corp. As a result of an initial "Memorandum of Procedure and Understanding" between STL and Aerospace regarding transfer of personnel, Aerospace obtained approximately 270 scientific and technical personnel and 1400 administrative and technical support people. As a result of intensive recruiting, Aerospace had approximately doubled their scientific and technical staff and had a total employment of 3149 by the end of Fiscal Year 1961. Within one year they had surpassed the employment level of STL support to the AF, as noted in Chart 1.

Changing Environment:

The creation of Aerospace came just less than six years after the assignment of R-W as the SE TD technical arm of the WDD. The "host of forces" at play in 1954 were not the same as those existing in 1960. The most important force that permitted the establishment of revolutionary management techniques no longer existed; i.e., the urgency and priority of the ballistic missile program was downgraded as soon as the nation had an umbrella of missile strength in being or in production. Then too, insofar as Aerospace was concerned, the Titan and Minuteman programs remained as STL projects.

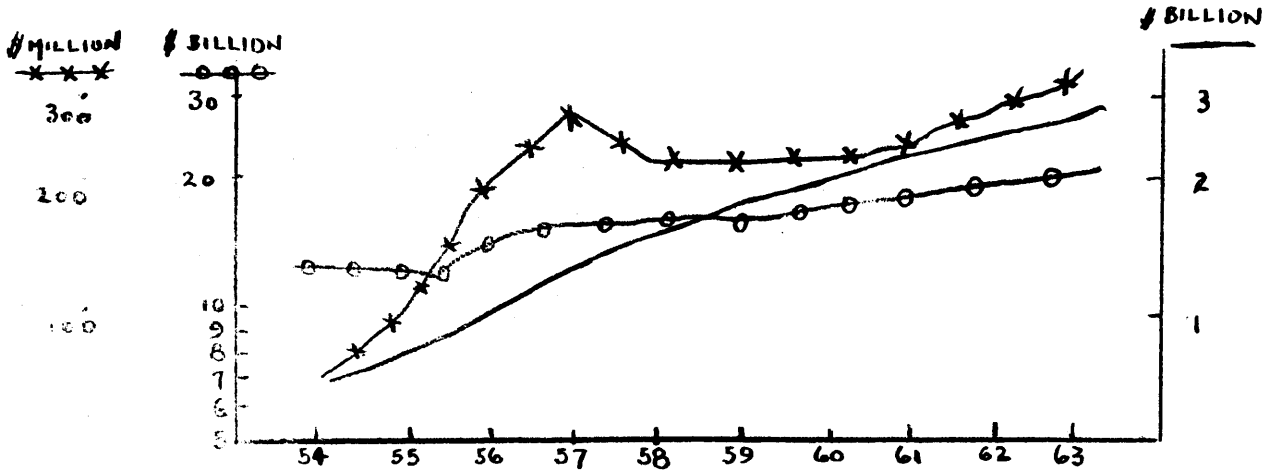
In 1954, too, ballistic missiles were associated with a complex new technology. By 1960, while the technology was growing, the growth was more in the nature of evolutionary steps rather than giant revolutionary strides in technology. The system was building on the old, improving booster capabilities, integrating existing power plants to provide greater thrust and reliability for new and exotic experimental programs and improving guidance and control capabilities.

The giants of the aerospace industry once the ballistic missile program began recognized their deficiencies in

systems technology. They began developing their technical and managerial skill and sophistication in R&D. The aerospace industry began to invest heavily in new facilities and equipment. In the ten year period, 1954-63, the industry invested no less than $2.63 billions in expansion and modernization. According to an Arthur D. Little report almost all of this capital expansion went toward research facilities. While the market grew only 75 percent, the value of plant and equipment of the major aerospace companies increased 300 percent as indicated in Fig. 2.

FIGURE 2

GROWTH OF NET PLANT VS. GROWTH OF MARKET
1954-1963 AEROSPACE INDUSTRY



Value of Cost of Land, Plants & Eqpt, 16 Aerospace Co.
Expenditures on New plant & Equipment, 16 Aerospace Co.
Federal Aerospace Market (DOD & NASA)

Source: Arthur D. Little Inc.

Major administrative changes had taken place within the missile program during the period. In late 1958, Gen. Schriever was appointed Commander Air Research and Development Command and moved from Los Angeles to Andrews AF Base. He carried with him an aura of success for the ballistic missile program. His new staff was anxious to get on the "bandwagon of success". ARDC began the process of reorganization designed to put into practice throughout the weapon systems management area many of the things learned in the management of the ballistic missile program.

There were some within the WDD system who were greatly concerned lest the study group appointed at ARDC see in the WDD example a workable solution to the overall management problem of systems acquisition throughout the AF. The procedures adopted by the ballistic missile program conceivably were ad hoc procedures addressed to a specific situation and not meant to be of general application. These people considered that the special procedures in a real sense were not a management system and should not be institutionalized as such.

Gen. Schriever however, retained the strong conviction that for each new complex system a highly competent and objective technical and management group must be established.

To reduce the long time cycle from concept to weapon, in his mind, required centralization not only of technical management but also of funding, budgeting, procurement, programming and all related activities under a single manager If the WDD experience were valid, its institutionalization would permit a unified direction of technically related weapon systems.

The result was the establishment of Air Force Systems Command (AFSC) in April 1961, created from the former ARDC and the systems procurement and production organizations that were assigned formerly to AMC. AFSC responsibilities for systems acquisition covered the broad areas from applied research through production. The Command established four product or system divisions responsible for systems management: Aeronautical Systems Division (ASD), Electronic Systems Division (ESD), Ballistic Systems Division (BSD), and Space Systems Division (SSD). Each of these divisions except ASD was technically supported by a supporting contractor.

FIGURE 3

AFSC SYSTEM DIVISION SUPPORT

Source: Hq AFSC

The WDD management system which had been given greater autonomy and independent authority than had been granted to any previous AF management organization was institutionalized into the AFSC Management Concept for Systems Acquisition. The system program office, the system program direction, the system package program - all of these elements were carefully spelled out in the 375 series of AF Regulations: "to insure uniformity, completeness, and ease of review." One AF officer stated at the Holifield hearings:

> "... 375 series is in essence a description of how to conduct a program including its documentation. It generally follows the format laid down in the ICBM program, and was extended to all Air Force programs prior to the time that the Hitch package program came into existence." 15

The higher level budgetary, reporting, and management controls that were not applicable to WDD during the initial stages of the ballistic missile program, were reinstated when Aerospace was established. To protect themselves from Congressional critics, the AF described in detail Aerospace responsibilities and documented AF/Aerospace relationships. Memoranda of understanding were also prepared spelling out in detail relationships in systems engineering and technical direction, technical planning and research.

Aerospace Role:

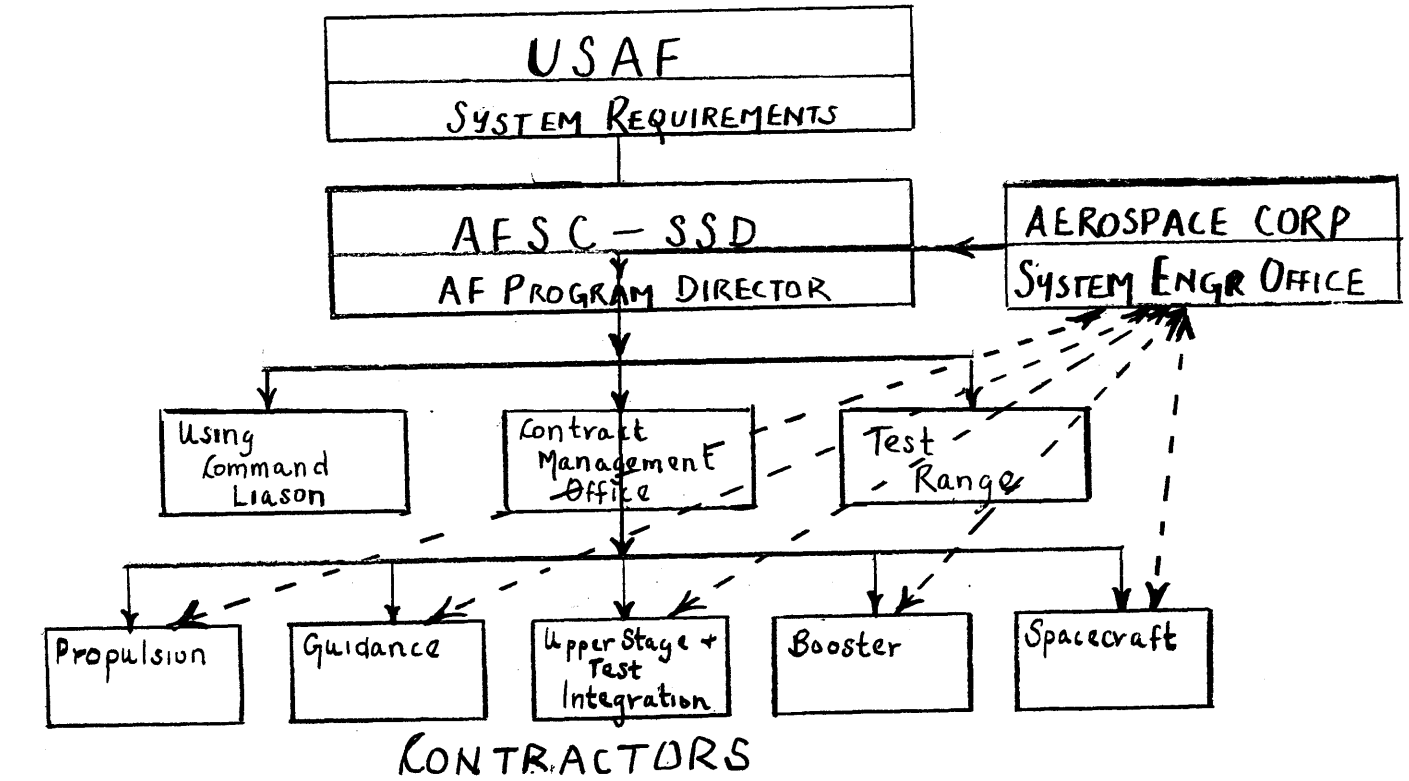
In his testimony before the Holifield Committee on August 7, 1962, Dr. Getting, President of Aerospace listed "several fundamental forces working to insure such successes as we have enjoyed to date": 16

(1) AF need and awareness of the need for the architect-engineer services in areas of advanced ballistic missile and space systems. The Aerospace concept shown in Figure 4 was similar to the R-W relationship, shown in Figure 1.

(2) Complexity and magnitude of the task attracted accomplished scientists and engineers, who came almost entirely from industry. This fact was substantiated in 1964 as noted in Chart 2.

(3) "The real strength of Aerospace Corp. is its technical manpower", Dr. Getting stated, and this fact was supported by the high educational level noted in Chart 3.

FIGURE 4: AF/AEROSPACE RELATIONSHIP



——— TECHNICAL DIRECTION CHANNEL - - - - - INFO + PERSUASION CHANNEL

SOURCE: Aerospace Corporation

CHART 2

SOURCES OF AEROSPACE TECHNICAL MANPOWER

AS OF SEPT. 27, 1964

SOURCE	PERCENT
STL	22.5
North American Aviation	6.9
Hughes	4.4
General Dynamics	5.0
Lockheed	5.0
Northrop	4.3
Douglas	4.0
Martin-Marietta	2.8
Aerojet	2.0
Aeroneutronic	1.6
GE	1.4
RCA	1.3
Bendix	1.2
Other Firms With Less Than 1%	24.2
Nonprofits	2.9
Government	1.9
Faculty	1.7
New Graduates	6.9
Total	100.0

Source: Aerospace Corp.

CHART 3

EDUCATIONAL LEVEL - AEROSPACE TECHNICAL STAFF

AS OF JUNE 28, 1964

DEGREE	PERCENT
B.S.	48
M.S.	34
Ph. D.	16
No Degree	2
Total	100

Source: Aerospace Corp.

How does one go about comparing the ballistic missile effort of 1954-60 with that effort assigned or accomplished by Aerospace since its establishment? A quantitative method of evaluating weapon system importance was not available in the literature studied. From a subjective standpoint, there was no disagreement within government, industry, or the nonprofits that the urgency and priority of the initial ballistic missile programs has not been met by any of the programs assigned or contemplated for Aerospace Corporation.

The Atlas, Titan, Thor and Minuteman programs, that were monuments of pre-Aerospace AF success, were characterized by

the following conditions:

(1) Project of national importance and highest priority.

(2) Extreme urgency requiring a crash program and justifying high priority and flexibility in channeling resources.

(3) Giant step in technology.

(4) Radical impact on military operational techniques.

(5) Concurrency of development, production, and operational preparation.

In his testimony before the Holifield Committee in 1962, Dr. Getting briefly discussed the technical work performed by the Corporation during its first two years of service. Key sentences have been extracted from this testimony and words and phrases considered meaningful in evaluating the nature of their effort have been underlined. [17]

In the space booster area, studies and analyses included work on Project Phoenix, conception of a flexible family of relatively low cost large space boosters; NASA contract to assist the Large Launch Vehicle Planning Group to define a coordinated national booster development program; and Titan III feasibility concepts. In the area of standard launch vehicles, the corporation provided technical support for Thor, Thor-Ablestar, Atlas, and Atlas-Agena vehicles. In the ballistic missile area, the corporation conducted feasibility studies of future ICBM

programs; conducted theoretical and experimental investigations of reentry; developed a basis of a greatly improved missile detection system using infrared detection measured by a rocket-borne radiometer conceived and designed by laboratory personnel; established a mobile midrange ballistic missile (MMRBM) program; general systems engineering of the NIKI-ZEUS targets, including launch, a system within the overall systems cognizance of the Army and Western Electric Co.

In the manned space flight, the corporation provided valuable assistance to NASA in the success of Project Mercury through general systems engineering and modification of the Atlas booster; general systems engineering for the Gemini booster which will employ the AF Titan II; and studied intensively the functions and military requirements of man in space. In satellite systems, Aerospace assisted in the launch of Navy navigational satellites launched by Thor-Ablestar boosters; established the feasibility of medium altitude, random orbit communications satellite systems to satisfy military requirements; investigated a continuous, synchronous communications satellite system; upgraded AF's worldwide space tracking network.

In 1954-58, the ballistic missile program met the criteria for "special need." What was the "special need" of the 1960's? The space efforts of national importance and priority were

assigned to NASA. From Dr. Getting's testimony, Aerospace appeared to be a helper not a prime mover. From the very start of Aerospace, the AF did not have a "product" of national urgency that Aerospace could tie its coat-tail to.

The same situation was noted in reviewing the Aerospace progress report for 1964. This report, dated November 12, 1964, contained the same words "to assist", "provide technical support", "provide technical assistance." Again one could not find an AF-Aerospace responsibility for a "product" of national priority and urgency. Three major programs pursued by Aerospace, Titan III, Manned Orbital Laboratory (MOL), and midrange ballistic missile program (MMRBM) received setbacks at DOD level. The MMRBM program was cancelled and the other systems were kept in limbo for continued study. Much of the Aerospace effort provided assistance to NASA, other military services, and DOD activities. An illustration of the intricate interlace of responsibilities that can exist in a national program may be noted from the opening paragraph of a recent magazine article describing responsibilities in the interim military communication satellite program:

> "SSD is the executive agent for producing the system and launching it; Aerospace Corp. is providing general systems engineering and technical direction - Army Satellite Communications Agency, Ft. Monmouth, N.J., has responsibility for system ground station, and Defense Communications Agency is coordinating and integrating the total program. TRW Space Technology Laboratories is a major subcontractor to Philco." [18]

The probability that the AF-Aerospace team will be assigned programs comparable to Atlas, Titan and Minuteman in the immediate or distant future is very dim. The lack of urgency and the reduction in key AF and NASA programs in space and missiles in the national program was reflected in President Johnson's 1965 budget submitted to Congress in January 1965. Articles appearing in aerospace and electronics trade publications warned industry:

> "If industry anticipates any major new programs or bold new steps in space exploration, it won't find them in President Johnson's mild-mannered $5.26 billion proposal for space agency operations in fiscal 1966, starting July 1
>
> "... the new budget slams the door on three big propulsion programs that have cost the taxpayers an estimated $115 million ...
>
> "Communications satellite funds took a big dip - $2.8 million for the year beginning July 1, compared to $8 million being spent in the current fiscal period." 19

In a recent article "The Air Force Role in Space", Mr. Eugene Zuckert, Secretary of the AF, discussed the fact that AF pioneering in missile technology provided the technological base for our efforts to land a man on the moon this decade and also spawned the great aerospace industry of today. He made this comment:

> "Even though we have 10 technologically explosive years behind us during which we amassed a great amount of new knowledge and gained much experience with new, fantastically

> complex systems, we still have no manual or other guide to work by. We must continue to apply our best technical judgement, test its validity and build experience. This painstaking process has produced results and will continue to do so.
>
> "The 'building block' philosophy which evolved is aimed at creating a stable of major components. These boosters, guidance systems, and command and control systems can be used for various payloads". [20]

The ballistic missile effort of the 1950's was revolutionary - to accomplish either tasks that had not been done before or, if not new, with accuracy and reliability not even considered possible. The effort today in space and ballistic missiles is doing something which has been done before, possibly slightly better or with departures from the past - it is basically an evolutionary process of a 'building block' philosophy as explained by Mr. Zuckert.

Even with this less meaningful role, if urgency and national priority can be used as a criteria, the AF use of Aerospace technical manpower increased yearly. This increase was even evident in recent years when the dollar income has leveled off. The leveling off, however, was the result of Congressional pressures to limit growth rather than the desires of the systems program officers at SSD and BSD. The military system program offices stated requirements for Aerospace scientific and technical personnel increased annually but screening by the AF contract

management office at Aerospace limited growth in accordance with directed Hq AFSC directed budgetary figures.

CHART 4

AEROSPACE INCOME

Fiscal Year	Total Income Incl Fee	Total AF Funding	AF Line Item	Other AF Funds	Fee
1961	34,264,910	32.0	28.4	3.6	1.5
1962	61,340,227	49.6	31.5	18.1	2.8
1963	75,777,697	67.2	31.7	35.5	3.7
1964	79,069,349	70.5	30.0	40.5	4.3
1965 (Est)	78,000,000*	68.7	30.0	38.7	

Source: Hq AFSC

*Source: 1964 Progress Report Aerospace Corporation

CHART 5

AEROSPACE MANPOWER GROWTH

Fiscal Year	Total Employment	Scientists & Engineers (MTS)
1961	3149	608
1962	3721	631
1963	4559	1100
1964	4337	1275
1965	4236	1307

Source: Hq AFSC

CHART 6

COMBINED AEROSPACE & STL MANPOWER SUPPORT TO THE AIR FORCE

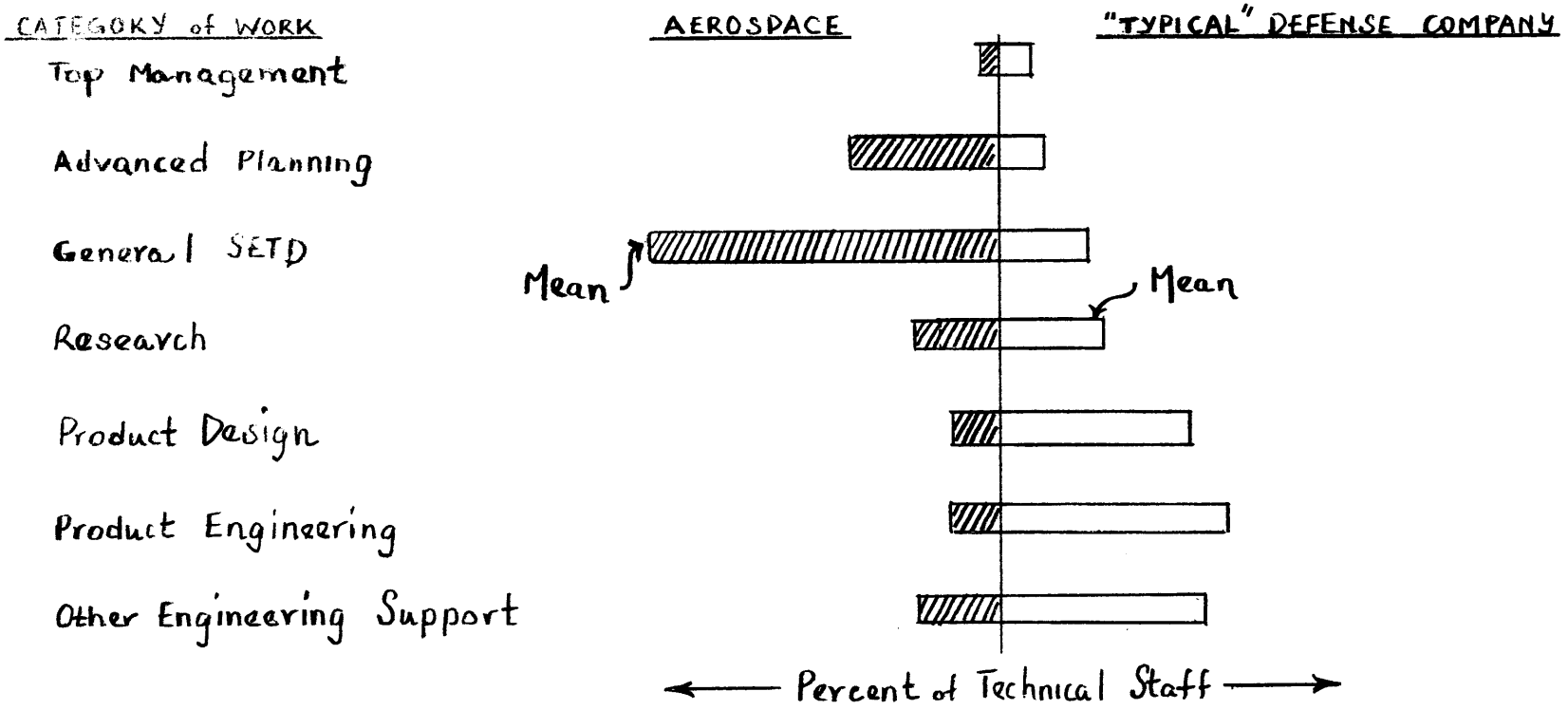
Fiscal Year	Total Manpower	Scientists & Engineers (MTS)
1961	5731	1603
1962	6437	1527
1963	6966	1939
1964	5691	1930
1965	5523	1767

Source: Charts 1 and 3

The 1964 Progress Report of Aerospace Corporation stated that "the Corporation conducts basic and applied research projects which contribute to the Nation's store of knowledge in space science and technology, and which enhance the Corporation's ability to assess and apply the potential of new discoveries." 21 It was interesting to note that the percentage of MTS applied to research and experimentation declined annually. (Chart 7)

Another indication of the technical staff mix of the corporation may be noted in Figure 5, which shows the percentage of staff engaged in SETD effort. At the same time a review of "Other AF Funds" column of Chart 4 provides a dollar indication of Aerospace support for missile and space projects.

FIGURE 5: DIFFERENCES in TECHNICAL STAFF MIX



Source: Aerospace Corporation

CHART 7

AEROSPACE RESEARCH AND EXPERIMENTATION (R&E)

Fiscal Year*	MTS (R&E)	% Total Direct MTS
1961	32	16.5
1962	110	14.0
1963	150	12.5
1964	140	10.0
1965	156	9.0

Source: Aerospace Corporation

*At beginning of 3rd quarter.

Until 1965, the history of Aerospace was marked by steady growth in dollar volume and personnel; growing emphasis on the SETD aspects of the business; evolutionary rather than revolutionary steps in technology; development of large industrial resources for systems management; and a period marked by feasibility studies and program planning of potentially large space and missile programs but no DOD funding approval to implement a program of national urgency and priority. The Corporation accomplished the jobs assigned to it by the AF, but it could not point to "monuments of success" that were the hallmarks of the early ballistic missile program.

CHAPTER IV

MITRE CORPORATION

The history of MITRE Corporation, which was organized in 1958, can only be understood and evaluated in light of the MIT-Lincoln Laboratory role in developing an air defense system for the North American continent and the AF experiment with R-W as the systems engineer and technical director of the ballistic missile program. It is for this latter reason that the Aerospace story, which begins two years after MITRE, insofar as official incorporation dates are concerned, has been covered first in this presentation.

Early Air Defense Effort:

In December 1947, Gen. Hoyt S. Vandenberg, then Vice Chief of Staff of the USAF, sent a memorandum to Dr. Vannevar Bush, Chairman of the R&D Board, stated his concern over the lack of an air defense system for the U.S. This expression of concern led to an investigation of the problem by a committee of civilian scientists, technical experts, and military personnel within the R&D Board. The problems associated with the organizational alignment of the R&D Board were discussed in Chapter 2. The belief persisted that no world power in 1946 could seriously menace the Continental U.S. through air attack, particularly since we had sole possession of atomic weapons. The committee

responded, after analysis of the problem, that the modernization programs in being for the improvement of the air defense posture were adequate for our forseeable national security needs.

The initial demonstration of nuclear capability on the part of the USSR in 1949, jolted our national complacency with regard to overall weapon superiority. The Russians had copied our B-29 and thus had a long-range striking force. With the bomb, plus a suitable vehicle, all that was necessary was the intent of a potential aggressor to use them against us. Gen. Vandenberg, who by then had moved to the position of AF Chief of Staff, shortly after the Soviet atomic explosion prepared a paper to the Joint Chiefs of Staff (JCS) calling attention to the desperate need for a more effective air defense for the Continental U.S. Concurrently, he requested the AF Scientific Advisory Board to give their attention to the air defense problem. This led to the establishment of a special study group under the chairmanship of Dr. George E. Valley of MIT, known as the Air Defense Systems Engineering Committee (ADSEC).

The Vandenberg paper to the JCS resulted in a study by the Weapon System Evaluation Group (WSEG) of the DOD. In the fall of 1950 this group confirmed Gen. Vandenberg's fears concerning inadequate defenses but provided no constructive answer to the problem. The ADSEC Report published in October 1950, was

harshly critical of the existing air defense system comparing it to a "lame, purblind and idiot-like" animal. It asserted that of these attributes the strongest trait was "idiotic" for it made "little sense for us to strengthen the muscles if there is no brain; and given a brain, it needs good eyesight". [1]

Project Lincoln:

These harsh indictments coupled with his basic concern caused Gen. Vandenberg in December 1950 to write to Dr. James R. Killian, then President of MIT, asking that the university establish and operate a large laboratory on contract to the AF dedicated to the air defense problem. The pattern and precedent for this approach had been established by the Office of Scientific R&D during WW II.

In early 1951, the university conducted Project Charles, an intensive three month study of the air defense problem, under the chairmanship of Dr. F. W. Loomis, on leave from the University of Illinois. The Charles study confirmed the AF belief that the Russian atomic bomb capability made air defense a problem of extreme urgency and urged an immediate program to fill the need. In July 1951, the MIT Corporation assented to this request made by Gen. Vandenberg. The result was the beginning of a full scale laboratory effort designated Project Lincoln. In May 1953, an article in the Air Force Magazine made this comment:

> "MIT's willingness to undertake this vast task was a tribute to the Institute's management and its President, Dr. James R. Killian, Jr., since assuming the responsibility for Lincoln placed the Institute under a heavy strain. It was taking on a project whose budget was twice that of MIT's entire undergraduate teaching program." [2]

MIT had a long and enviable record of service to the military services in resolving technological problems. The university position was that in a time of emergency universities have no choice but to undertake R&D to assist the military in resolving problems of national importance. This philosophy was undoubtedly uppermost in their minds; however, the MIT Corporation may have been influenced by another internal situation at the university.

In 1946 the Navy asked MIT to develop an airplane stabilizer analyzer. The Servomechanisms Laboratory at MIT, which had been assigned the project decided that the analog computers then available would be inadequate for the job. They convinced the Navy that an electronic digital computer that could perform large and complex calculations at great speed was practical and desirable. This decision led to the MIT development of Whirlwind I.

The Servomechanisms Laboratory headed by Mr. Jay Forrester had solved the basic design problems and subcontracted prototype production of Whirlwind I to Sylvania by 1948. The Office of Naval Research was enthusiastic about Whirlwind's technical

excellence and tried to convince other Navy activities of the potential use of the computer to solve other problems besides that of analyzing aircraft stability. The Laboratory development costs began to exceed original estimates and since they were unable to interest other groups in using the computer the Navy began to question whether it could afford to support the Whirlwind program. It began studies to determine whether the aircraft stability analyzer program really needed a computer of Whirlwind's capability and if a more reasonable approach might be to cut off the MIT program and revert to use of a less expensive analog computer.

By 1949, the Navy advised MIT of the tight budgetary limitations and asked the laboratory to furnish operational hardware as soon as possible. They discouraged continued scientific study of computer and electronic technology at their expense and implied that they would be quite happy to see MIT pursue its computer research effort but only if some other service could be persuaded to foot the bill. The air defense requirements that would require a large scale digital computer like Whirlwind, thus came at an opportune time for MIT and the Servomechanisms Laboratory.

This comment on Whirlwind I is not to impugn the motives of

the MIT Board in accepting the air defense problem. The AF received the benefits of the research effort carried on and supported at great cost by the Navy. The establishment of a university laboratory at MIT to undertake this task offered other advantages:

(1) Greater flexibility in management and operation than possible in an AF operated laboratory.

(2) Scientific leadership and prestige of MIT, as well as the excellent environment for scientific achievement, would attract personnel that would not work in service laboratories under civil service.

(3) A special laboratory established for a specific aim gave a sense of urgency to an operational system rather than mere technical investigation.

From the very start the MIT scientists recognized that an ivory tower solution was not an acceptable answer to the air defense problem. Fortune magazine quoted Dr. Valley, who was instrumental in establishing the laboratory program:

> "The worst thing that could happen would be for us to spring a monster. We want to deliver something that works - the prototype of a continental system that will be proved out in its essential parts; and with which a cadre of technicians will have already familiarized themselves before the hardware has been produced." 3

The contractual documents between the AF and MIT did not assign the responsibilities for the design and development of an operational air defense system to Lincoln Laboratories. As indicated by Dr. Valley's comment they were responsible for the prototype of a continental defense system, a complex technological task.

> "The air defense of the United States presents the most complicated problem this nation has faced. No problem holds greater priority within our military system. The answers are being sought through an effort comparable to that which produced the first atomic bomb. Indeed this effort is even broader in its scope.
>
> "This air defense equivalent of the wartime Manhattan District is known as Project LINCOLN, managed by the Massachusetts Institute of Technology under an Air Force contract." 4

Lincoln Laboratory Task:

It is important to note that in this program of highest national priority the assignment of technical responsibility to MIT was divorced by the AF from the systems responsibility for the operational weapon system. This latter point became a source of many controversies and irritation between the Lincoln Laboratory and those AF agencies having vital interest in an operational air defense system - ARDC, AMC and ADC. This relationship stood out in marked contrast to the WDD which was given the assignment and role responsibility to produce an operational ballistic missile in the earliest possible time.

The Lincoln Laboratory task was further complicated by the fact that each of the military services had an interest and role in the air defense task, even though the AF had been loosely assigned overall responsibility. There was also a great difference between different weapons advocates, even within the same service, and between scientists as to the "best" defense system measured in terms of bearable costs. How much was it "worth" to go from a 50-60 percent to a 85-95 percent kill rate, for example, became a battleground of contention not only between military and scientists but between military partisans within each of the services.

In 1952 a small group of scientists within Project Lincoln were allowed to initiate the Summer Study Group to look into certain fields, primarily electronic detection, which might permit possible extension and speed up of the initial Project Lincoln air defense plan. One of the recommendations of the group, which became a political football among the military, Congress, and scientists themselves, was a recommendation for a multi-billion crash project to provide early warning stations across the Artic. This system, the group considered, would increase the kill ratio from 50-60 percent to 85-95 percent and, more importantly, would permit four to six hour warning. This time element would not only allow the SAC time to bomb-up

and initiate counterstrike action before the enemy force crossed the U.S. frontier but would also permit civil defense action to begin evacuation of our major cities.

The AF, with the support of other scientists, was skeptical. It considered that the ultimate expense of establishing and maintaining a DEW (distant early warning) line had been grossly underestimated; Artic communications and logistics made reliability questionable; and that after the first Artic warning, no means existed for tracking the enemy strike force down through Canada into the U.S. defense perimeter. The military position was to make the close-in defense solid and then push the warning and interception line farther out along the continental approaches as technical advances justified the heavy investment. The AF argued that an active air defense system alone did not provide "security" and even if a near perfect air defense existed it offered no hopes of a lasting peace. There was concern among key AF leaders that if huge sums were spent for this defense system, the money would be obtained by budgetary cutbacks and crippling of strategic retaliatory strike force.

In its contractual relationships with MIT, as previously indicated, the AF had not established clear cut understanding as to their right to guide and monitor the Lincoln effort. The school because of its power, prestige and access to highest

AF channels preferred to deal directly with the Chief of Staff or the Secretary of the AF in matters of major policy significance and was unwilling to accept supervision from the ARDC, ADC, or AMC officers trying to direct the program. To some extent, the Lincoln unwillingness to deal with these offices resulted from the political controversies and the continuous infighting going on between these offices to gain a dominant position in the air defense program. These difficulties may have influenced the Quarles decision in 1954, discussed in the previous chapter, which emphasized the need for WDD to delineate ballistic missile systems responsibilities to either Convair or R-W.

Insofar as Hq. USAF was concerned, Hq. ARDC was expected to monitor and guide the Project Lincoln efforts. Hq. ARDC expected its local agent in the Boston area, the Air Force Cambridge Research Center (AFCRC) to assume management responsibilities for the project. The Electronics Research Division of AFCRC recognized that the assignment of such a role would put them in the middle of a tug of war between the strong scientific skills of MIT and the operational pull of the AF commands. The AFCRC group argued successfully that it was basic research oriented and this new role would sap its resources and weaken its capability to perform a vital research role.

The advent of the intercontinental ballistic missile era posed a whole new set of problems. It not only renewed internal AF dissensions concerning the division of budget allocations between strategic offense but also revitalized old Army and AF rivalries for dominance in the air defense role. By the time the Lincoln Labs developed and proved their prototype air defense system development in 1957 serious doubts were raised about the system's capability to defend the nation against ICBM's. Several Rand discussions were unofficially reported as early as 1955 which implied that the SAGE (semi-automatic ground environment) system was obsolete before it was installed.

SAGE Implementation:

It must be remembered, however, that a considerable amount of dollars and scientific resources had been spent to develop the system. The SAGE system provided a major advance in air defense capability against manned bomber attack. In the 1955-58 time period it was assumed that the amount of fissionable material was fixed, and only a small number of bombs could be produced and that the next war would be fought with a combination of bomber aircraft and ballistic missiles. The AF vigorously supported the need for making the SAGE system operational as soon as possible. It considered that the integration of the Lincoln prototype system into an operational SAGE system would require

the services of a technically competent systems engineering contractor. ARDC initially considered two sources:

(1) Lincoln Laboratory, the system developer, could assume the role. However, the university, which recognized its responsibilities to perform the R&D role, was loath to accept the implementation role. The decision of MIT that it would be improper for a university to act as technical supervisor to industry was generally given as the reason for the eventual creation of MITRE Corporation. While this may have played a part in the decision making, ARDC made no concerted effort to have MIT change its mind. Lincoln Labs had always displayed what the military considered an unwarranted independence in the SAGE development program. As previously indicated, MIT had been reluctant to accept managerial guidance in technical matters from the military. During the development phase ARDC unhappily permitted this independence of action, but in the implementation phase it could not tolerate such freedom in actions and decisions affecting military operations.

(2) System Development Division of Rand Corporation, which was established in December 1955 to undertake the adaptation, installation and maintenance of the computer programs for each SAGE Center, was also considered. The System Development Corporation (SDC), the nonprofit successor to the System Development

Division was willing to accept the systems engineering role. However, it was agreed that competences found at MIT as well as SDC would have to be combined to supply the required technical needs of the air defense program. Officials of both organizations were unable to concur in the details of an acceptable integration and "modus operandi". ARDC was unwilling to press the issue because of the reluctance of the Commander ADC to permit SDC to add air defense systems engineering to their workload for fear that these added responsibilities would dilute and detract from the company's ability to prepare the initial SAGE operational computer program.

In October 1957, the Commander ARDC invited thirteen major electronics companies to participate in a meeting in Baltimore to discuss this matter. The representatives agreed that the technical competence required could be obtained through the services of a prime industrial contractor, assisted by subordinate contractors. However, only one contractor, RCA, indicated a willingness to accept the assignment. Initially the other contractors went along with recommending RCA for the prime contractor role but then had uneasy second thoughts when they considered the question of how much of the large production contract RCA would be willing to subcontract. They also expressed concern with the release of proprietary information to

a prime with such hardware producing capabilities. Their initial recommendation was converted to a divided position of (1) retention of MIT effort through Lincoln Labs, (2) use of Western Electric Co., and (3) establishment of a new agency to be formed from the technical resources of interested or participating industrial organizations.

After consideration of all of these recommendations, ARDC recommended the selection of RCA. This recommendation was not acceptable to the Secretary of the AF, who leaned toward giving the task to Western Electric (WECO), the field engineering and production arm of the American Telephone and Telegraph Corporation (AT&T). The Secretary considered WECO technically well qualified and, as a regulated public utility, less susceptible to charges of conflict of interest. This was the same kind of reasoning that had been used by the AEC to entice AT&T to establish a nonprofit subsidiary, the Sandia Corporation, to operate the Los Alamos Corporation. However, while the Los Alamos venture was in a field remote from their main interest, the SAGE systems engineering job was in a area of prime concern to AT&T. The company was deeply involved on many of the subsystem contracts. They rejected the offer.

Creation of MITRE:

After almost a year of fruitless effort to find a solution

satisfactory to the three parties, the AF returned to MIT for help. The university again concluded that a long term system engineering task of this type was not appropriate for a university laboratory. MIT proposed as an alternative solution that they would sponsor the formation of a nonprofit corporation to take over the work, first under a subcontract and later as a prime contractor. In July 1958, the MITRE Corporation was founded, first as a nonprofit subcontractor to MIT and later that year they superseded MIT as the prime contractor to the AF.

The Corporation mission, as quoted in the Certificate of Incorporation, read almost exactly like the Aerospace mission previously quoted:

> "The objects and purposes of the corporation are exclusively scientific, as herein set forth: to engage in, assist and contribute to the support of scientific projects for, and to perform, engage in, and procure research, development, engineering and advisory services to or for the U.S. Government, or any department or agency thereof." 5

When translated into specifics, this broad and generalized charge meant that MITRE would undertake the systems engineering and technical direction of the SAGE air defense system for the Air Defense System Integration Division (ADSID) of ARDC. In 1958, ADSID had been established at L. G. Hanscom Air Base near Bedford, Massachusetts to act as the central military organization for air defense in the same capacity as WDD for

the ballistic missile. In like manner, the AF assigned a General officer, Major General Kenneth Bergquist to provide the leadership and strength deemed necessary to weld the ARDC, AMC and ADC interests into a unified whole.

SAGE was the first large computer-based command and control system. The heart of the system was a computer, the electronic brain that planned the interception. The computer assimilated data coming from dispersed radar sites and figured out instantly the direction and speed at which a given interceptor could get within striking range of the invader. It then displayed these data to the ADC Commander who selected the offensive weapon, BOMARC missile, anti-aircraft fire, or aircraft fighter-interceptor to be used and the tactics to be employed for interception. The original AF air defense system was based on an area defense concept and called for the installation of SAGE computers at 42 air defense direction centers.

From the very start, MITRE recognized the job as twofold. First, it called for the construction of large physical facilities to house the system and the installation of extensive hardware. This job was assigned to the WECO which provided systems installation and integration to the AF. While MITRE provided broad general system specifications and test parameters the conversion of this data to installation specifications and

test plans was left with Western Electric, which because of its experience was best able to provide these services. The second and more important part of the job was systems integration of the various air defense subsystems and associated software, or computer programming.

SAGE Integration:

The key to the success of the air defense system was integration and the ADSID role was to provide this integration. All segments of the air defense system, the Army anti-aircraft sites and their Missile-Master control, BOMARC missiles, Navy picket ships, fighter as well as strategic air components had to be integrated within the system. MITRE occupied a line position to the Commander ADSID and was directly responsible for the systems engineering, technical direction and technical integration.

Integration was complex not only because of the many activities and functions involved but also because the introduction of the computer modified the traditional boundaries of responsibility of the AF commands. ADC found that their control of the computer program was essential if they were to control the operational characteristics of the system. This meant putting ADC in the equipment specification business to a degree never before encountered in previous weapon systems.

ARDC found that it was not enough to engineer the components. System component testing could not be accomplished without getting deep into the computer program, which put it closer to the operations business. As a result the testing phase became one of the major cost elements of the entire system. But unlike a ballistic missile, the development process was never finished because modifications and improvements were always necessary. Thus, ARDC found itself in the act long after the system became operational because expansion and modification of the system resulting from operational experience and changing technology never stopped.

AMC found that the computer added new complexities to the procurement and production of all components. It found that the traditional depot maintenance procedures no longer applied and normal lines that separated ARDC and AMC areas of responsibility were fuzzy. The three commands found it difficult to stay out of each other backyards. Although the intent of ADSOD was to obtain WDD characteristics by consolidating and collocating staffs, the activity was neither given the budgetary freedom nor the management autonomy granted Gen. Schriever.

For the first year of its existence, MITRE had a single large system engineering job, SAGE. Less than a year later, reconsideration of the defense problem in the missile era by

the DOD led to a deemphasis of manned bomber defense and a decision not to proceed with any major system improvement except those already in the pipeline. The growing MITRE effort on air defense began to diminish. It is interesting to note that the WECO efforts in the SAGE program flourished because installation continued even with deemphasis of priority. However, the installation program was reduced from 42 to 34 direction centers.

Command and Control:

The nuclear era caused the SAGE effort to diminish but emphasized the need for automated military command and control systems. The paramount importance of communication between the commander and the weapon wielders had long been recognized. Prior to SAGE, the components of the air defense system were linked together by human beings. SAGE eliminated many of the human links in the system and showed the key role that automatic data processing systems might play in obtaining, transmitting and rapidly displaying intelligence with the required reliability and in a format that permitted quicker decision making.

The atomic missile reduced the decision making process to minutes and allowed fewer and fewer alternatives to completely automated warfare. By the time the commander was briefed in the traditional method, deliberated, and reached a decision, the need for this decision might well be past. Thus the importance

of the data handling system approached the importance of the weapon system for which the data was being handled. MITRE became deeply interested in the development of command and control systems.

Their study of the problem soon led them to expound concepts that were considered heretical to the official military party line. MITRE and the Commander ADSID recognized at an early date that "command and control" could not be separated into distinct and separate systems for each commander, could not even be considered in the framework of just a total AF system, but must be considered in the context of a national military system. In 1959, the ADSID-MITRE group were expounding concepts that were not accepted until three years later when the DOD established the National Military Command System.

SAGE demonstrated to the AF commander that it might be possible to obtain a system showing them what was happening anywhere in the world, what he had available to commit to combat and the ability to implement his commands whenever and wherever action was required depending upon battle conditions.

The major air commands jumped on the bandwagon to get their own command and control systems. Very little study effort went into the decision. Each command considered its own problem without regard to the integration problem that had proved the

biggest difficulty in SAGE. MITRE personnel considered that this proliferation of command and control systems was wasteful. They considered that what was needed was not speedy development but study effort to determine on a national basis what was needed in the way of command and control systems and how these systems should fit together.

ADSID-MITRE Role:

This position was not shared by Hq ARDC who looked upon ADSID-MITRE concepts as "egghead", what one could expect from a group reared in an academic environment. ARDC failed to recognize the peculiarities of command and control systems. They took the point of view that a system, electronic or otherwise, was a distinct entity, only incidentally related to other systems, and as a thing to be developed, manufactured, installed and put to use as quickly as possible. It was under pressure from the major commands to get operational systems in being and it was determined to produce as quickly as possible without questioning the soundness of concepts behind the system. MITRE scientists considered that the mere technical integration of these systems made little sense unless accompanied and preferable preceeded by "functional integration", a thorough rethinking of the operational and organizational requirements of electronic warfare.

It must be remembered, however, that MITRE was a line element to the Commander ADSID. As a separate private corporation on contract to the AF they could advise the ADSID Commander to oppose other major commanders but this would take place through normal military channels. Their open and vigorous criticism of the approach that was being taken in command and control could only have occurred with the full support of General Bergquist, Commander ADSID. The reason that the General felt so strongly about this issue that he was willing to antagonize his military peers and superiors may have stemmed from an event he had personally witnessed and experienced at Hq ADC in 1952. The account of that day, April 17, 1952, is recorded in Arnold Brophy's book, The Air Force, and recounted in Herman Kahn's book, On Thermonuclear War.[6]

On that day four vapor trails were sighted over Nunviak Island and reported through the existing Air Defense System. The intelligence officer at Hq ADC, Captain Wood, considered this sighting of possible extreme importance because of intelligence material he had on hand. This information was reported through the ADC Deputy for Intelligence to Gen. Bergquist, then Deputy Chief of Staff for Operations. Brophy's account indicates the concern and effort made to ascertain the reliability of the information that had been passed on by an Eskimo. His description continues:

"The General did not waste anytime in getting to the Command Post. Again, everything was checked and the officers attempted to clarify the Nunivak sighting by contacting Elmendorf through the Western Defense Force. At this point the message came into Colorado Springs: 'Nothing here:'

"And then all the lines to Alaska went dead.

"By now the tempo of activity had been shoved into high gear. Telephone lines were loaded with calls back and forth with the three defense forces. Conferences were held over classified circuits".

The general officer on duty at the USAF Command Post in the Pentagon, Washington, D. C. was informed of the situation. Gen. Bergquist advised Gen. Smith, Vice Commander of ADC, who rushed down to the ADC Command Post. Brophy continues:

"It was 3:10 a.m. when Wood walked over to the two senior officers. Eastern had just called in and reported five unknown coming in over Presque Isle. Presque Isle is in Maine.

"Smith looked up quickly. This triggered it. 'The Air Defense Command goes on full Air Defense Readiness immediately', he said.

"The time was 3:11 a.m., April 17, 1952. Air Force Headquarters in Washington was notified. The Joint Chiefs of staff alerted. President Truman was awakened.

The incident vividly and forcibly brought to Gen. Bergquist's attention that such decisions were really issues of war or peace and required centralized and responsible decision making - decision making that was beyond that residing in the field commanders, service heads, or any military representative, but at the level of the President or his designated representative.

The issue of ADSID role was put in the hands of Gen. Schriever, who had been promoted from Commander, BMD, to Commander, ARDC. From the previous description of Aerospace history there was no question that "implementation", earliest delivery of an operational weapon, was the common goal of both the military and R-W in ballistic missile programs. Gen. Schriever considered that advanced conceptual planning was done by the Air Staff at the Hq USAF and passed on as authoritative guidance to ARDC. MITRE and other technical experts were to accept this authoritative guidance and examine and evaluate the different command and control systems in the light of the authorized concepts. When feasibility and systems engineering were completed by MITRE, then the WDD philosophy of concurrency would apply, rapidly translating electronic technology into useful and approved command and control systems.

C^2D^2 Concept:

As previously indicated in the discussion of Aerospace Corporation, the tendency was to jump on the Schriever "bandwagon of success". The ARDC staff wanted to duplicate the ballistic missile experience with command and control systems. It considered that the best way to accomplish this was to abolish ADSID and establish the AF Command Control Development Division (AFC^2D^2) to manage the development and implementation of command

and control systems.

Gen. Bergquist attempted to convince Gen. Schriever that command and control system development was vastly different from ballistic missile development. Missiles were revolutionary. The development and operation of a new missile was divorced from the operation of systems in place. One did not have the interlace and integration of the various pieces that was necessary in a command and control system. The latter was evolutionary, and new systems were built upon the old structure, improving rather than creating a new weapon. Gen. Bergquist stressed that the major effort should be advanced conceptual planning and he argued that this was vastly different from planning the concurrent development of a system or group of systems. He argued that the planning that was required must start first with a new and open look at the aims of national military policy; than a review of the state of the art; and finally, formulation of broad recommendations for system parameters. At that stage and not before, could you plan, design and develop the many "L" systems that the AF operational commanders were seeking.

Gen. Bergquist persisted in the belief that the role he and MITRE considered necessary could not be achieved within the framework of C^2D^2. Rather than surrender to the ARDC desires he preferred that ADSID and MITRE remain independent and be

assigned directly to the Air Staff or the DOD; or if this were not acceptable, be integrated within ADC.

Gen. Schriever and his staff were not convinced by the arguments. They recognized too that an independent ADSID organization would be a threat to their assigned responsibilities. They considered that the ADSID mission must be assumed within the proposed C^2D^2 and MITRE must join the organization in a technical line-staff relationship just as R-W functioned for the ballistic missile program. In November 1959, C^2D^2 was established by Hq ARDC and Gen. Bergquist was named as the first Commander. ADSID was abolished and MITRE became the technical arm of the new division.

Strictly speaking C^2D^2 neither developed command control systems nor evaluated the need and requirements of the system. It was primarily a planning and managing organization that expedited the development and tried to integrate each system technically and functionally with other related systems. MITRE was given responsibilities for twelve of the fourteen separate command and control systems known as "L" systems. Their responsibilities ranged from technical consultation to complete system design.

Growth of MITRE:

In this atmosphere, MITRE flourished insofar as physical growth was concerned. On January 1, 1959 the Corporation had a technical staff of 205 scientists and engineers; by September 1, 1962 the number had more than tripled to 661 technical personnel.

CHART 8

MITRE PERSONNEL GROWTH

Calendar Year*	Average Technical Staff	Support Personnel	Total (Average)
1959	262	589	851
1960	371	879	1250
1961	478	993	1471
1962 (6 mos)	588	1121	1709
Fiscal Year**			
1963	592	1414	2006
1964	495	1348	1843
1965	481	1260	1741

*Source: Holifield Hearings, 1962
**Source: Hq AFSC

The peak in personnel strength was reached in fiscal year 1964 when the total manpower approached 2100 people; however, budget reductions soon thereafter caused personnel cutbacks and the average total employment for that year was slightly less than fiscal year 1963. On the other hand, total dollar revenues to support the MITRE effort continued to increase.

CHART 9

MITRE TOTAL REVENUES

Period	Total Revenue
21 Jul 58 - 31 Mar 59	2,343,784
1 Apr 59 - 31 Mar 60	19,351,617
1 Apr 60 - 31 Mar 61	25,420,577
1 Apr 61 - 31 Mar 62	31,053,090
1 Apr 62 - 31 Mar 63	36,661,930
1 Apr 63 - 31 Mar 64	38,242,186

Source: Holifield Hearings 1962
MITRE Annual Report 1962, 1963, 1964

The annual increase in total revenue, even with recent reductions in manpower, was attributed to annual cost of living increases and the fact that the educational level of the personnel employed at MITRE had increased. To help sustain their technical competence, MITRE encouraged and supported advanced employee education. In 1963-64 there were candidates for 88 Masters degrees and 30 Doctorate's in their various educational assistance programs.

CHART 10

MITRE TECHNICAL EDUCATION LEVEL

	1962		1963		1964	
Degree	Number	Percent	Number	Percent	Number	Percent
B.S.	317	48	327	44.1	292	40.5
M.S.	263	39.8	318	42.9	326	45.2
Ph.D.	56	8.5	69	9.3	77	10.7
No degree	25	3.7	27	3.7	26	3.6
Total	661	100.0	741	100.0	721	100.0

Source: MITRE Annual Reports 1962, 1963, 1964

CHART 11

MITRE DISCIPLINES (1964)

Disciplines	Number	Percent
Electrical Engineering	287	39.8
Other Engineering	55	7.7
Mathematics	136	18.9
Physics	70	9.8
Psychology	35	4.8
Other Fields	112	15.5
No Degree	26	3.5
Total	721	100.0

Source: MITRE Annual Report 1964

National Military Command System:

In 1958-59, as previously indicated, MITRE recognized that "command and control" could not be a conglomeration of individual systems for the many commanders within the military services. They recognized that "command and control" must be considered in the context of a national military system. The validity of these ideas were not recognized at the time. Air Force commanders wanted the advantages of computer technology, C^2D^2

encouraged and supported the proliferation of separate command and control systems, and MITRE's revenues increased and their personnel strength grew. In 1962, the DOD reached the conclusion that a national military command system was required - a need recognized by MITRE in 1958.

The DOD began the development of a completely integrated command system at the highest level that would be survivable and assure continuity of military operations at all times. A technical support office was established at DOD level. Mr. Esterly Page, founder and former President of Page Communications Inc., was selected as Director of National Military Command Systems (NMCS) Technical Support, an office assigned to the Director of Defense Research and Engineering. The Defense Communications Agency (DCA) was assigned responsibility for the necessary engineering and system integration functions. Major General Bestic was transferred from Hq USAF to DCA to become Deputy Director, NMCS. The centralization of decision making and management control at DOD level was felt in the AF command and control program.

DOD Policy:

On October 26, 1963 the Secretary of Defense issued a policy paper, subject: "Development, Acquisition, and Operation of the Command and Control Systems of the Unified and Specified Commands"

which assigned to the unified and specified commanders these responsibilities for the development, acquisition and operation of a command and control (C&C) system:

> "(1) Establish and submit to the Joint Chiefs of Staff and Secretary of Defense for approval the operational requirements, and any modification thereto, for his C&C system;
> "(2) Participate in the formulation of system design and system performance and design specifications for his C&C system;
> "(3) Participate in the formulation of engineering, management, procurement, facility, construction, and installation's plans developed to satisfy his C&C requirements;
> "(4) Review system design; system performance and design specifications; and the principal engineering, management, procurement, facility, construction, and installation plans and schedules proposed by the military department supporting his command before initial contracts are negotiated or before amendments are negotiated to outstanding contracts; and submit his views thereon to the Secretary of the supporting military department before the Secretary of the military department concerned takes final action or submits recommendations to the Secretary of Defense;" [7]

This directive spelled out clearly that decision making in command and control that had previously been made at Air Staff level would now be done at DOD level. Secondly, it assigned system responsibilities to the unified and specified commanders that had previously been held by AFSC and its command and control division, ESD. As a Hq USAF letter stated, "the referenced DOD memorandum requires a reappraisal of management relationships and responsibilities." [8]

As of this date, ESD and Hq AFSC have been unable to develop a management relationship that the Air Staff will approve. The

large scale command and control systems such as 465L (Strategic Air Command and Control System) or 425L (NORAD Combat Operations Center) - systems large enough to require a SETD organization were considered to be things of the past. The AF guidance to major commanders emphasized that "improvements in command and control capabilities will normally be accomplished incrementally and in an evolutionary manner." [9] The result has been that in the past two years MITRE and ESD have not been authorized to start a new command and control system.

This fact stood out clearly in a series of advertisements run by MITRE Corporation in trade publications in 1964. These ads stressed the challenge of the work effort going on at MITRE. The projects mentioned were SAGE (semi automatic ground environment), BUIC (backup interceptor control for the SAGE system), NORAD Combat Operations Center, BMEWS (ballistic missile early warning system, NUDETS (nuclear detonation detection and reporting system) and NMCS. All of these systems except NMCS were many years old and the development as well as the major technical integration work had been completed. In the case of NMCS, as previously indicated, the prime engineering responsibility for this system had been assigned to DCA.

MITRE provided assistance to DCA in the development of the NMCS; it was also involved in various enroute air traffic

control projects for FAA. In these efforts, however, they provided well qualified scientists and engineers to assist these organizations. FAA and DCA had their own engineering staffs and there was no effort made by these activities to integrate MITRE into their organizations in a line and staff relationship, the kind of relationship deemed necessary by the AF for SETD nonprofits.

CHAPTER V

PRESENT VIEWS OF SETD NONPROFIT CORPORATIONS

Historical factors were given a prominent role in the previous chapters in reconstructing the forces that resulted in the establishment of the particular organizational entity in defense R&D labeled the SETD nonprofit. The historical analysis indicated that initially, the AF recognized a need for industrial and scientific blessing and acceptance of their nonprofit creation; however, this acceptance underwent alteration with time and a changing environment.

The criticism of SETD nonprofits from government, industrial and academic circles continued to grow in the 1960's, as previously indicated. In order to get an up-to-date picture of how the different parties most directly involved with the SETD nonprofits viewed the situation and issues today, a series of interviews were held with personnel in DOD, the AF, industry, universities and the nonprofit corporations.

These interviews form the basis of this chapter, in which MITRE and Aerospace Corporations are viewed through four pairs of eyes: (1) AF, (2) DOD, (3) industry, and (4) the nonprofits themselves. Much of the data collected was subjective rather than objective; however, it represented the opinions of

people and industrial corporations that have a large stake in defense R&D from either a public or private standpoint. As such, it must be recognized and evaluated.

Air Force View of MITRE and Aerospace Corporations:

Within the AF one found numerous opinions concerning the use, value and future of MITRE and Aerospace Corporations. In this regard, the broad spectrum of opinion regarding these activities was no different from that noted outside of the AF. Since system engineering non-profits were identified with the AF, there were official policies supporting their existence and use. Opposition within the AF family was covert rather than overt. One found strong anti-nonprofit sentiment expressed verbally; however, official papers in opposition to MITRE and Aerospace were non-existent.

The position noted in this section was based upon policy statements of the Secretary of the AF, position papers used by Gen. Schriever at Congressional hearings, and written documents obtained from AFSC activities. The official AF position has undergone little change since 1954.

In his testimony before the House Committee on Appropriations in 1963, Gen. Schriever argued that the basic criteria and principles that led to the determination to use R-W as the systems engineer and technical director of the ballistic missile program

in 1954 applied to other major fields of military technology which had now become critical to the AF's mission. These conditions were: (1) technical complexity, (2) requirement for a broad industrial base, (3) strong university support, and (4) integration of the industrial and scientific base with the military retaining overall control. Therefore, SETD nonprofits were required not only for ballistic missiles but also for space and command and control programs. The AF supported SETD for aeronautical systems with in-house resources.

Difficulties With In-House Personnel Resources:

The question repeatedly asked was, Why haven't in-house resources assumed SETD responsibilities for all AF programs? The significant increase in scientific in-house capability assigned to support the AFSC mission may be noted in these charts:

CHART 12

ARDC/AFSC SCIENTIFIC AND ENGINEERING PERSONNEL GROWTH

	Military	Civilian	Total
1951 (30 Sep)	1800	3097	4897
1964 (30 Jun)	4866	5176	10042

CHART 13

AFSC ACADEMIC LEVELS OF SCIENTIFIC AND ENGINEERING PERSONNEL
(As of 30 Jun 1964)

	Ph. D.	Masters	Bachelors	No Degree
Military	2% (95)	38% (1845)	57% (2751)	3% (175)
Civilian	3% (146)	14% (710)	70% (3614)	13% (706)
Total	2% (241)	25% (2555)	64% (6365)	9% (881)

Source: Hq AFSC

These impressive statistics, unfortunately, concealed skill and retention problems. These problems were:

(1) Technical obsolescense of many middle management people. The initial manning of the Command in 1951 came from the Engineering Division of the former AMC. Although personnel requirements were high then, their experience levels dated from WW II. Many of these men were "obsolescent engineers" and were unable to provide the systems engineering skills and capabilities required to support the technical complexities of new systems. This military problem was no different from that experienced by industry in areas of rapidly changing technology.

(2) Maldistribution of AFSC R&D personnel. The distribution of R&D personnel assets is noted in Chart 14.

CHART 14

R&D PERSONNEL BY LENGTH OF SERVICE

4 year obligees	29%
4 - 13 years service	40%
Korea (17 - 19 years service)	17%
WW II (22+ years service)	14%

Source: Hq AFSC

(a) The retention of new technical officers was extremely low and has not exceeded 20%. These men, who came from Officer Training School and the AF ROTC Program had unimpressive school records as noted in Chart 16, which although based on FY 63 records was considered valid for FY 64 and FY 65.

CHART 15
FY-63
R&D PERSONNEL ACQUISITION AND TRAINING

	Officer Tng School	AF ROTC	Total
Total Acquired	5248	3392	8650
No. With Engineering Degree of any Kind	341 (6%)	728 (23%)*	1128 (13%)
No. With C+ or Better Average	87 (2%)	256(7%)	343 (4%)

*(Only 19 were electronic engineers, a critical speciality)

Source: Hq AFSC

(b) Seventy-two percent of all R&D officers in the 7 - 14 group were on flying status and subject to a priority levy by Hq USAF for qualified pilots to fill cockpit jobs in flying commands. Efforts were made to defer R&D officers from this levy; however, the critical needs of the AF resulted in losses of good technical people from the Command.

(c) In the next six years voluntary and mandatory retirements will result in the loss of large numbers of the most experienced R&D officers with WW II and Korean war experiences as noted in Chart 16.

CHART 16

RETIREMENT PICTURE FY 65-70

	FY 66 Eligibility For Voluntary Retirement	FY 70 Mandatory Retirement
R&D Colonels	98%	70%
R&D Lt. Colonels	88%	54%

Source: Hq AFSC

The Command exerted tremendous efforts to upgrade its in-house technical and managerial capabilities through education and training. Officer and civilian education was encouraged.

In fiscal year 1964, for example, AFSC officers completed 9,864 courses at colleges and universities, and civilians were enrolled in 5,886 courses at graduate study centers, executive development programs, or military and civilian institutions for specialized instruction.

In the case of civilian in-house resources, the higher Civil Service pay scales adopted in fiscal years 64 and 65 reduced turnover of personnel; however, continued DOD emphasis on reducing the level of government manpower made future approval of increased civilian authorizations extremely unlikely. In fact, civilian manpower authorizations in the AF were projected to decrease in future years.

Although the scientific and technical manpower of the Command more than doubled since 1951, the AFSC R&D mission increased even more. If measured in dollar magnitude, it grew more than 250% from 1954 to the present, even after adjustment downward to discount inflation of the dollar. A more meaningful yardstick might be to compare total technical effort required for an aircraft weapon system of ten years ago compared with a ballistic missile system. The B-47, B-52, and B-58 required from 3 to 9 million manhours while the Atlas "D" required 31 million manhours of total scientific and engineering manhours from design to first test or configuration "freeze".

Nonprofits vs. Industry for SETD Role:

The AF considered that the technical obsolescence of many of their middle management people; the failure of the AF to attract and retain young technical officers; and the attrition of experienced technical managers through retirement precluded the attainment of an in-house capability to accomplish SETD of a growing R&D program. In their justification for nonprofits rather than industry for the SETD job, the AF based their decision on these factors: (1) objectivity; (2) unique competence; (3) access to privileged information, and (4) flexibility.

Objectivity:

Even today, the AF claimed, few, if any contractors, regardless of size and competence were capable of producing a complex system without using subcontractors to accomplish portions of the effort. The determination by the prime as to which portions to subcontract became a difficult decision insofar as the overall interests of the government and the prime contractor were concerned. The prime may desire to perform a job in-house in order to build or augment his facilities and competence, ignoring either a qualified producer or the fact that a satisfactory product may already be in existence. From a government standpoint such action might be detrimental to the overall national interest.

Conflict could also arise in the resolution of technical interface problems during the integration of subsystems. The SETD activity was required to oversee the subsystem contractors, at times was forced to compromise one set of subsystem specifications to improve optimum system performance. The role was critical and subject to extreme political pressures. The problem that faced the AF in selecting the SETD agent was indicated by Max Golden:

> "We could not risk a systems contractor who might be personally affected by the outcome of his decisions. He must have no axe to grind, no subsystem of his own to favor or defend, when he sought to resolve conflicts and and bring subsystems into balance."[1]

If a company producing hardware had to make such a decision they would be put in a position of both litigant and judge. When a company had to make a choice when its own product was involved, the AF stated that bias was difficult to eliminate.

On the other hand, nonprofits could be objective in resolving technical interface problems because (1) they were not profit motivated; (2) salesmanship was not involved since they did not compete for work; (3) they produced no hardware, and (4) they had no production design responsibilities which might influence test plans.

The full interchange of knowledge was accepted and demanded by university scientists; however, important industrial scientific

discoveries were, at times, considered company secrets and were not disseminated. The knowledge of this fundamental industrial development work was necessary not only to determine the state-of-the-art but also to evaluate production feasibility. The AF claimed that nonprofit characteristics of "no profit" and "no hardware production", encouraged closer cooperation and interchange of information between nonprofit and industrial scientists than could be achieved with an industrial contractor.

Unique Competence:

MITRE and Aerospace Corporations had a special and continuing relationship with the AF. They were considered part of a specific military organization having a broad but defined area of work in either ballistic missiles, space, or command and control. As a result, they developed and sustained a high level of competence in the many technological fields and interfaces associated with these specific areas.

This concentration of effort within a single broad area of interest permitted the integration of scientists and engineers with varied skills to solve complex systems problems. Their family relationship with the AF made them cognizant of military requirements and needs gained through their close working relationship, according to the AF, enabled the nonprofits to act as a bridge between the military and the academic and industrial

scientific community to bring the best of the changing technology to weapon system development.

Since it dealt with only one prime client, the nonprofit corporation organized with the sole objective of providing the best possible support to that customer. Recruitment and training of people, organizational structure and job allocations were carried out to the specific tasks of the customer.

System development and implementation generally exceeded the three to four year tour of assignment of a military officer to a system program office. Continuity of effort by nonprofit personnel on a single system from conceptual and advanced planning stages through initial system engineering provided a stability of effort of inestimable value. The continuity of effort over a period of years for new but associated systems provided a background of experience on diverse projects which enabled the nonprofit corporation to draw together quickly necessary teams of people with the proper background to undertake the new project. This unique capability resulted from the special position of the nonprofit, and AF managers stated it could not be obtained from industry.

Access to Information:

There were inhibitions to using an industrial contractor for the important tasks of advanced system research, analysis and

planning, and research and experimentation. Full participation in these tasks required access to military plans and data of great military and commercial sensitivity. In the command and control area, for example, it was essential that the engineer have access to war plans and decision making apparatus of the operational commands so that effective man-machine relationships could be designed in the system. Selection of a competitive, profit seeking corporation on a continual basis for these functions would give this contractor an unfair advantage over competition in later procurement. The recommendation that this job be rotated among competing companies, or, if this was not feasible, to assure that each competitor was given access to the same or equivalent information was considered impractical. The AF was also responsible for the technical evaluation of contractor proposals, either unsolicited or in response to military procurement invitations. Private industry, the AF stated, could neither be allowed access to this information nor be permitted to assist in the development of the technical criteria used by the government in decision making. The technical competence required to evaluate these proposals was not always available in in-house resources; therefore, the AF used the nonprofits in their staff capacity to advise them technically.

The decision making role was restricted to the military, the AF claimed, and was not delegated to nonprofit personnel.

Certain programs dealt with information of such sensitivity that it was considered inadvisable to permit a few or even one contractor full access to such data. In such a condition, the "need-to-know" was so restrictive that technical design and integration was performed by a few government, or, if necessary, nonprofit employees. The Manhattan project was handled in this fashion and, in recent years the development of certain intelligence systems required such restrictive security measures.

Flexibility:

The physical collocation of nonprofit with ESD, BSD and SSD personnel, and the contractual arrangements between the corporations and the AF, permitted quick response and flexibility in the assignment of personnel to immediate military demands. When situations demanded technical assistance without delay, resort to normal contracting procedures involved unacceptable delays. The AF also considered that the introduction of new organizations to such problems, where an accumulated data source was already available in the nonprofits, was costly and time consuming.

Flexibility was also achieved through organizational and personnel alignment of nonprofits with the military structure

they supported. MITRE and Aerospace established project-oriented managerial units that more or less paralleled the military management structure. For all practical purposes the nonprofit people were considered part of the "Air Force family", and allowed unusual military-contractor relationships that the AF considered was not attainable with an industrial contractor.

In a period of defense economy and cost effectiveness, the AF emphasized the importance of the plant, special facilities and technical laboratories that existed at Aerospace and MITRE Corporations. The AF had paid for these facilities and considered that the nation could neither afford to let these facilities go to waste nor allow the facilities to be duplicated by industry for the sake of competition.

Basis of Air Force Relationship:

The AF justification and guidelines for use of Aerospace and MITRE were subject to criticism from industry, Congressional committees, and various representatives of the DOD. In September 1961, Secretary of the AF Eugene Zuckert issued policy guidance, intended to provide a basis for AF relations with five nonprofit corporations - Aerospace, Analytical Services, MITRE, RAND, and System Development Corporation. He considered that the special status of these corporations, in their "close and continuing relationship" with the AF, set them apart from other organizations

either profit or nonprofit, and made special rules of procedures, conduct and control necessary. His guidance letter to Gen. Lemay stated:

> "We look to these nonprofit corporations to focus the nation's finest scientific and technical talents on selected and highly sophisticated tasks. They must not become convenient catchalls for projects which could be performed by private industry; the elite nature of their technical staffs must be preserved. Any dilution of the select quality of these organizations can only have an adverse effect on their ability to carry out their vital Air Force work. Procedures must be developed to require them to coordinate with the Air Force before undertaking assignments from other Government agencies or commercial sources." [2]

Government control and supervision of these nonprofit corporations was considered necessary to prevent abuse of their special status. He urged that:

(1) Business aspects of their affairs be open and subject to AF review and claimed that "such accountability is not inconsistent with freedom of thought and independence on technical matters."

(2) There must be no conflict of interest between employees and trustees of these corporations and the public interest.

(3) Corporations must be objective in their evaluation and dealings with industry and exercise discretion in their handling of contractor proprietary information.

(4) Fees be tailored to their special status and should permit stability of effort.

(5) Government should make every effort to provide the physical facilities required by the corporations, but, if necessary, physical facilities, could be acquired and paid for through fee arrangements. Upon dissolution of the corporations, the disposition of these physical facilities should be determined by the Secretary of the AF.

(6) Salary levels must be such as to attract and retain the highest order of talent but should not exceed the market rate for such individuals. The overall salary structure of the corporations must be subject to AF review.

AFSC Policy Letter of April 1963:

Congressional criticism continued and opponents stressed the proliferation of nonprofit corporations and foundations and the "spiraling budgets" of AF nonprofit contractors. In April 1963, Gen. Schriever supplemented Mr. Zuckert's instructions with a policy letter which contained these key points as regards MITRE and Aerospace: [3]

(1) Programs assigned to ESD, BSD, or SSD will not automatically be assigned to nonprofits.

(2) Nonprofits must remain relatively small in order to retain elite nature of their support.

(3) Ratio of support to technical staffs must be controlled.

(4) Nonprofits must not become involved in hardware

production for either prototype or service use.

(5) Nonprofit must not be used to circumvent manpower ceilings or curb service laws.

(6) Nonprofits must not be used to perform nontechnical or administrative services.

The reason for the continued use of MITRE and Aerospace Corp. by the AF, under the growing barrage of criticism in Congress, industry, and the DOD was summarized by this comment made by Gen. Schriever before the House Appropriations Committee in both the 1962 and 1963 hearings: "I would not know what I would do if I did not have this capability. I just could not get the job done." [4] He emphasized, however, that the management system he pioneered and institutionalized was not a dereliction of his responsibilities but resulted in tighter AF management control of weapon technology development. He contended that the AF approach met the Bell Committee qualifications of "getting the job done effectively and efficiently with due regard to the long-term strength of the Nation's scientific and technical resources; and avoiding assignment of work which would create inherent conflicts of interest." [5]

Department of Defense View of MITRE and Aerospace Corporations:

The DOD had no single official position on the use and future role of SETD nonprofit corporations. Within the DOD

conflicting opinions and strong feelings about the continued use of nonprofits were expressed. These opinions were stirred and restirred by Congressional and industrial pressures to do something about the "growth of these activities". Decision making in this area was made as a reaction to pressures rather than as a result of a systematic study of the "legitimate" requirements of the AF and, therefore, the DOD.

The result was that the present DOD policy was to impose rigid fiscal control over all nonprofits and stop further growth. In the interim, DOD and other governmental activities continued to investigate, review, and evaluate the nonprofit corporations. A recent trade magazine article summarized the present state of affairs this way:

> "General Accounting Office will make its own evaluation of Defense Department policies affecting the future of a few key nonprofit organizations performing design, technical direction and systems engineering functions for the military services 'after the dust settles' according to Comptroller General Joseph Campbell.
>
> "Defense Department has clamped fiscal ceilings on six of these organizations to prevent their growth and is inviting increased industry competition in the areas of technical direction and systems engineering.
>
> "There is a difference of opinion within the Defense Department as to what the results will be. Dr. Eugene Fubini, deputy director of defense research and engineering, expects the key nonprofit firms to continue at about their present level of activities. Adam Yarmolinsky, special assistant to Defense Secretary Robert S. McNamara, anticipates that

> sharply diminished defense requirements will dictate an 'unwinding' of some of the organizations, notably Aerospace Corporation and MITRE Corporation." [6]

The various opinions found within the DOD have been arbitrarily categorized into three separate groups in order to simplify analysis: (1) federalist position, (2) industrial position, and (3) industrial objectivity through contract. It must be noted, however, that many of the opinions were dimensional and overlapped the boundary lines established within this classification system.

Federalist Position:

There was a large group in the DOD composed mainly of career civil servants, who felt strongly that there were certain functions in the management and control of Federal R&D that were clearly responsibilities of government that could not be delegated to a contractor, either nonprofit or profit. These people considered that the AF had delegated to the nonprofits, policy decision making responsibilities that could not be delegated. The term "fictitious relationship" was used by this group to deride Gen. Schriever's contention that the SETD nonprofit use in his management approach did not represent a dereliction of responsibilities but actually imposed tighter AF control.

The "federalists" were unable to find fault with the official AF documents that described military-nonprofit relationships.

They were well written and seemingly described a situation in which the nonprofit acted in a conceptualizing and advisory capacity, provided technical input to the military managers of the system program offices to enable them to make the final decisions. Unfortunately, this was not a description of the real world in which the system operated, they contended. Instead of developing an effective program based on technical advice from the nonprofits, the situation, according to one critic," was one in which one individual, "the nonprofit engineer, justifies and defends the program to us while the military director is many times unable to answer our queries about the presentation. The captive has become the captor." Decision making, they claimed, was in reality done by the nonprofit and not by the military.

The AF use of the nonprofit became a crutch that they were unwilling to forego. These critics questioned whether a real effort was made to develop a strong in-house capability and were generally unaware of AFSC efforts outlined previously. The reliance and dependence by the Commanders of ESD, BSD and SSD, according to this group, caused competent and technically well qualified military and civilian scientists and engineers assigned to system program offices to play a secondary role rather than the dominant position they could and should exercise.

The dangers of a contractual helping hand outside of the government service was expressed by Dr. Harold Brown, Director of Defense Development Research and Engineering in an address in 1961:

> "Government policy, like science itself, needs to be conceived and pursued with some regard for its totality as well as its parts. By giving priority to the parts - by turning over the administration of public functions to private institutions - we have strengthened our ability to do many separate things, but not our ability to give integrity and discipline and direction to our total effort. Indeed by relying too much on the contracting method we have probably weakened the quality of the scientists within the civil service, whose help is needed by the executive who seeks to manage our scientific programs as a coherent system." 7

This DOD group was not impressed with the unique operational experience claimed by the nonprofit corporations. Examples were provided of situations where new program assignments led to hiring of new people rather than the allocation of old experienced hands. Cases were cited where the nonprofit showed less flexibility for manpower reassignment than that possible with military or civil servants. Recent AF experiences at DOD level of pre-program definition studies prepared by nonprofit corporations had been "disastrous", according to one administrator. The programs submitted did not have "impeccable technical content" and, as a result, AF stated requirements were returned without action by DOD or the AF was asked to redo their justification.

Criticism was directed also at the high cost of nonprofit technical manpower. DOD personnel were unable to reconcile the $40 - $50,000 per manyear cost of Aerospace and MITRE engineers when industry provided people with comparable skills at a $20 - $25,000 price. Efforts to quantitatively measure the type of individual provided by the profit and nonprofit corporations were unsuccessful. The typical comment was that for the work effort required the individuals provided by the profit corporation at half the price were fully capable.

There was a general feeling within this group that the allowable costs and fees approved for the nonprofits were being used to provide physical facilities and expensive laboratory facilities that the AF could not obtain through normal military programming efforts. Critics were vocal in their belief that the System Development Laboratory bought by MITRE but belonging to the AF was a dodge by the AF to obtain an expensive "plaything" that they could never justify and obtain defense funding for through normal programming action.

The fixed costs associated with the sustenance of the nonprofit corporations adversely affected the performance of the functional divisions of AF Systems Command, they claimed. The critics contended that these costs forced the Divisions to allocate work to the nonprofits that could better be accomplished

in military or industrial laboratories, or by academic institutions. The flexibility that the AF obtained from nonprofits was offset by the inflexibility of funding required to keep the nonprofits "alive". Instead of having a kit of management techniques available to do specific jobs in the best way possible, system program managers had little choice but to depend on one approach - the nonprofit route.

Even with all of its criticism and complaints, however, this group considered the AF use of systems engineering-technical direction nonprofits less immoral than the delegation of these responsibilities by government to industry. Their position followed the line of reasoning contained in the Third Report of the House Committee on Government Operations:

> "No single weapon - systems contractor, however large his contract commitments and diversified his industrial resources, can have the breadth of vision, the alertness to national defense needs, the degree of access to information, the choice of alternative systems, the decision-making responsibilities, and the dedication to the public interest expected and required of a government agency, and if the government agency, in this case the Air Force, does not have the required resources and capabilities to fulfill its requirements and meet its obligations, it must get them as best it can." [8]

In summary then, this group contended that government has certain decision making responsibilities in R&D management that cannot be delegated. Military and/or civil servants must make such decisions. The AF has, formally or informally,

delegated to system engineering-technical direction nonprofits such responsibilities. They have weakened the military structure, but more important, they have brought suspicion and criticism to the whole operation of federal R&D. This group recognized some problems relating to military or civil service manpower authorizations to provide the manpower required by the AF to accomplish its total R&D job; however, this was no justification for the abdication of certain federal responsibilities to non-governmental activities. Nonprofit corporations may have to exist in the system but they must be assigned tasks and managed to insure that the work they perform is legitimate for non-governmental activities. An important member of the DOD office of Research and Engineering stated, "their management is a bigger problem that their technological contributions."

Industrial Position:

The centralization of military decision making at DOD level led to a great expansion of the department's work force. Many of the key positions in DOD were filled not by career civil servants but by well qualified individuals recruited from industry and universities. These individuals, with an extensive knowledge of industrial capability, considered that the continued AF dependence on nonprofit corporations usurped responsibilities that could better be accomplished by industry.

This group conceded that the establishment of R-W in 1954 as the SETD of the ballistic missile program was warranted, if for no other reason than the void within industry of a systems capability. One DOD representative asserted that "industry defaulted its rights to the systems-engineering job in the 1950's", and then continued, "but the same situation does not exist in the 1960's". The key aerospace and electronics companies successfully implemented large weapon system programs, recognized the need for a systems approach, and have accumulated the skills and assistance of capable, competent scientists and engineers for multidisciplinary systems tasks. Competence, experience, and understanding of system problems provided within industry "centers of excellence" that were capable of competing with nonprofits.

In the development of weapon systems there was a proper place and function for the scientific and technical resources of government in-house laboratories, SETD nonprofits and industry. The problem that existed, the industrial group claimed, was the failure to understand the proper role of each of these organizations. They recognized the government's responsibility for determining and characterizing weapon needs; the fact that in-house laboratories did not always have the talent, resources and environment to perform this task; and the assistance

provided by nonprofits to perform a government function. This group supported the following statement that appeared in the Holst Report to the Holifield Committee Hearings in 1962:

> "It is essential that these organizations recognize their responsibilities and proper spheres of operating, and the resulting limitations on their freedom of operation. They are needed as idea creating or conceptualizing entities, or as evaluators of the concepts of others. They are not themselves charged with the responsibility for the defense of the Nation or operation of its defensive systems. It is the Government, through the military Services, or otherwise, who must actually defend the Nation, and consequently must have the responsible and final role in the specification of the needed systems, components and related materials. Similarly, it is the Government which must undertake actual procurement, test, installation, and evaluation, and subsequently the operation of the system." [9]

Our economy and the greatest technological strength within the nation existed in the staffs and facilities of profit seeking industrial facilities, this group maintained. This private base of technological strength must continue and grow. The assignment of tasks that were not inherent responsibilities of government to nonprofit corporations inhibited this growth.

Innovation and creativity were not noted as strong attributes of the nonprofits by this group. In fact, they argued that the systems competence of many industrial activities generally exceeded those of nonprofits because of their widely diversified interests and operations. Innovation, especially in military weapon systems, appeared to result most often at the interface

of the engineering and physical sciences. The broad scope of large industrial activities brought together scientists of diverse backgrounds and interests working on varied problems and offered greater potential for discovery at the interfaces of science and engineering than might be attainable in nonprofit activities that were more specifically aligned to one specific field of endeavor.

The position of this group can be summarized as arguing for a definite limitation of jobs assigned to the nonprofit. It accepted the position of Max Golden, former General Counsel of the AF, who debunked the concept that the nonprofits usurped the legitimate function of government and argued: "so far as Aerospace is concerned, is that it fills a role that has been filled by private industry, not Government, since the earliest days of aircraft." [10] Industry was ready and able to take back those functions and tasks that legitimately belonged to them. The major problem facing industry in assuming their "proper role", according to one member of this group, was their "dichotomy of personality". He continued, "they want to be a partner not a mistress; however, they can't make up their mind whether they want to be protected or evaluated on performance."

Industrial Objectivity Through Contract:

Individual conflict of interest had been a perennial government concern. The AF experiences with R-W in the ballistic

missile program brought to a head the problem of organizational conflict of interest. The result, indicated in Chapter III, was the divorce of R-W from future SETD work in the AF ballistic missile and space programs. If industry was to regain that role for government now performed by MITRE and Aerospace Corporations, two conditions had to be satisfied: (1) from government's view, the organization must provide impartial, technically sound and objective assistance and advice; and (2) from the standpoint of the rest of the industry, that company performing the role must not be able to gain unfair competitive advantage.

In the view of some DOD personnel, DOD Directive 5500.10 entitled "Prescribing Rules for the Avoidance of Organizational Conflicts of Interest", issued in June 1963, provided the contractual vehicle by which industry could resume many of the functions now performed by SETD nonprofits. This directive was developed by Mr. Adam Yarmolinsky, special assistant to the Secretary of Defense. In this effort he was assisted by the Defense Industry Advisory Council (DIAC), an industry group formed in 1962 to act in an advisory role to the Secretary of Defense on industry relations.

The development of a code of conduct for contractors, although under consideration for some time, was expedited to

respond to the recommendation of the Bell Committee Report of 1962. That report stated that one of the prime considerations of government agencies in deciding whether to do R&D in-house or to contract it out was "avoiding assignment of work which would create inherent conflicts of interest." Four rules of conduct were outlined in DOD Directive 5500.10 to avoid organizational conflicts of interest:

> "1. If a contractor agrees to provide systems engineering and technical direction (SE/TD) for a system, without at the same time assuming overall contractual responsibility for: (a) development, or (b) integration, assembly, and checkout (IAC), or (c) production of the system, then that contractor shall not later be allowed to supply the system or any major components thereof, or to be a subcontractor or consultant to a supplier of the system or any major components thereof..."
>
> "2. If a contractor agrees to prepare and furnish complete specifications covering non-developmental items to be used in competitive procurement, that contractor shall not be allowed to furnish such items, either as a prime or subcontractor, for a reasonable period of time including, at least, the initial procurement ...
>
> "3. If a single contractor, other than a company which has participated in the development or design of a system, agrees to assist the DOD or a contractor of the DOD in the preparation of a statement of work, or agrees to provide material leading directly, predictably, and without delay to a statement of work, to be used in the competitive procurement of a system or services, that contractor shall not be allowed to supply the services, or the system or major components thereof, unless he is the sole source...
>
> "4. If a contractor agrees to conduct studies or provide advice concerning a system, which work requires access to proprietary data of other companies, the contractor must agree with such companies to protect such data from

unauthorized use or disclosure so long as it remains proprietary." [11]

The directive also noted the role of the nonprofit corporation and made these comments about the future need to create additional nonprofits.

"It is the policy of the Department of Defense that such organizations are created only under extraordinary circumstances, when private resources are not available to accomplish a necessary objective beyond the scope of in-house capabilities. Their termination is governed by the organic statutes of the individual organizations. These rules should make it even less likely that any additional Government-financed nonprofit organizations need be created. While these organizations are in existence they will be treated by the Department on arms length basis, as the rules prescribe." [12]

The publication of DOD Directive 5500.10 resulted in an effort by the AF to amend existing contracts to embody the terms of the directive. One of the ESD contracts amended was with the ITT Communications Services, Inc. (ICS), a wholly owned subsidiary of International Telephone and Telegraph Corp. (ITT). Under this contract, ICS provided management, systems engineering, design and development of the 480 L program, a global AF communications system. Within the DOD, a separate contract was written by the DCA with ITT Intelcom, a wholly owned subsidiary of ITT, to provide technical support in nuclear detection systems, the national military command system, countermeasure techniques, and other defense electronics areas. This

contract also embodied the provisions of DOD Directive 5500.10.

In November 1964, ITT announced the sale of ICS and Intelcom to Computer Sciences, Inc. Mr. Harold S. Geneen, president of ITT advised that the two activities were sold "to avoid the possibility of a conflict of interest with the business of other ITT companies engaged in the supply of military communications equipment to the U.S. Government." 13

Strong industry opposition and possible difficulties with the restrictions of the directive were recognized by DOD spokesmen of this group. However, these individuals considered that the initial impact was wearing off and that industry was acclimating itself to the new rules as defense and space production contracts declined. The award of a major contract to Space Technology Laboratories (STL) of Thompson Ramo-Woolridge to provide systems integration and developmental test support for the Navy's anti-submarine warfare systems project (ASW) was cited to prove their point. An announcement of this award was noted in an article in Missiles and Rockets, which stressed the fact that an unusually tough hardware exclusion clause had been accepted by STL:

> "Prohibiting a company from bidding on components or systems for which they have served as a systems engineering or consultant to the government agency is not new in itself-Aerospace Corp., working for the AF, Intercom (sic. Intelcom) working for the Defense Communications Agency and Bellcom

and the General Electric Apollo Support Operations for NASA are all examples of companies that have accepted such clauses. Most of these, however, are special children of the parent organizations, specially created to perform the specific job. Hardware exclusion, as a rule, does not apply to other members of the same corporate family.

"In the contract negotiated with STL, however, the hardware exclusion clause extends not only to the actual group doing the ASW work but to the parent company, its affiliates and divisions. Thus no unit of TRW will be able to bid on Navy ASW hardware." 14

The overall position of this group in the DOD was summarized in an article in the December 21, 1964 issue of Aviation Week and Space Technology. Mr. Yarmolinsky, according to this article, maintained that DOD Directive 5500.10 permitted profit making corporations to compete for SETD roles if given the opportunity. This was not to imply, however, that MITRE and Aerospace Corporations could be phased out immediately. The article continued that Mr. Yarmolinsky considered "their 'immediate future' assured because of their competence in the essential work they are now carrying on." In the long run , however, "the need for these few organizations should 'sharply diminish' as industry becomes more confident of its ability to perform under the new rules, and Defense Department strengthens its own in-house capability." He considered their demise in their present government role inevitable and "suggested these three possibilities - abandon nonprofit status and 'go commercial'; apply their

resources to government work in non-defense fields, or disband, with cohesive teams arranging for other employment." [15]

Industry Looks at the Nonprofits:

In order to determine how industry viewed the SETD nonprofits today, a series of interviews were held with people in companies that had worked on projects in which MITRE and/or Aerospace had SETD responsibilities. Most of the interviews were with the key manager or chief executive of the company; in some cases, there were a number of interviews in the company ranging from executive level down through line project managers. The sample of eight companies is not considered exhaustive; however, it is a reasonable sample from which to evaluate industrial convictions of the nonprofit role. Although the technique employed was the personal interview, a questionnaire was used as a guide to lead the discussion into avenues considered of prime importance and to insure that the same questions were asked each individual interviewed.

The use of a personal interview as the principal method of material gathering enabled the investigator to develop a "feel" for the trials and tribulations of companies dependent upon the defense business. One of the executives interviewed used this sentence to describe the system: "It's a helluva card game, but it's the only one in town." Industry-

government relationships was a subject near and dear to the hearts of everyone interviewed and this method permitted discussion of points and clarification of issues that might become clouded or distorted through use of the written questionnaire only. The give and take of the interview provided a better understanding of the multifaceted relationship existing between government and industry in a constantly changing environment.

Legitimacy of Nonprofit Role:

A series of questions were first asked to determine if the SETD role performed by the nonprofits for the AF was considered a legitimate role. As indicated in Chart 17, there was a diversity of opinion. Those who denied the legitimacy of the nonprofit corporations were vociferous and outspoken in their opinions. They generally saw no place in the industry-government scheme of things for the nonprofit. On the other hand, those who saw a need for the nonprofit generally qualified or hedged their reply. Three answered that as long as the AF used an associate method of contracting, nonprofits were required as integrators and referees for the associates; however, they seriously questioned whether the associate contractor route was the best approach to AF R&D today.

CHART 17

LEGITIMACY OF NONPROFIT ROLE

	Yes	Qualified Yes	No
Is the nonprofit role legitimate?	2	3	3

"Yes" Answer Basis	Yes	No
Objectivity	4	1
Unique Competence	0	5
Elite Skills	0	5
Access to Privileged Information	2	3
Flexibility	3	2

None of the individuals interviewed considered that nonprofits represented a "unique competence" or contained "elite skills" as claimed in official Air Force documents. The comments on the calibre of people employed by the nonprofits ranged from well qualified to "I wouldn't hire 50% of the men working there." The most outspoken criticism of the nonprofit capabilities came from the executive level and the degree of criticism dropped materially as one spoke to line managers who had intimate dealings with the scientists and engineers of

MITRE and Aerospace. If one measured technical and management competence on a scale from 0 to 1, from incapable to highly capable, it was noted that the executives tended to place overall capabilities at the low end while line managers saw the nonprofit competence as being much higher.

Those that considered the nonprofit role legitimate stressed the need for government or its authorized agent to be objective. In this regard, all considered that the nonprofit fit this characteristic. Only one company was willing to evaluate the impact of DOD Directive 5500.10; however, this company had attempted to perform contractually under a hardware restrictive clause and found that the dollars for hardware far outweighed the dollars that were available for contractual R&D.

Two of the companies considered that the access of nonprofits to privileged information an important attribute. In both cases, the companies employed marketing engineers in Washington and at the different AFSC divisions who were responsible to feedback military planning and technical interest items to the home office. While this espionage system was effective, information feedback tended to be delayed or distorted through handling. The people interviewed envied the role of MITRE and Aerospace engineers who had ready access to up-to-date planning data and intimate contact with the military customer. It was noted that the DOD use of

preprogram definition phase contracts with a small number of capable contractors would allow some industrial groups to be briefed by the military on advanced plans and permitted access to classified documents.

One of the companies opposed to the nonprofits debunked the objectivity issue and insisted that not only corporate objectivity must be considered but also the objectivity of the people in the nonprofits and their use of industrial privileged information after they terminated their nonprofit employment. He advised that he could cite actual situations where nonprofit employees left the company and carried with them privileged information that was passed on to their new employers. He contrasted this with profit making consultants, such as Arthur D. Little, Inc. who worked for competing major industries at the same time and their integrity and trustworthiness in safeguarding privileged information was unquestioned. He therefore, considered industry more capable of maintaining secrecy in handling proprietary information than nonprofits.

Air Force Capability:

The industrial opponents of nonprofits considered that MITRE and Aerospace Corporations usurped both government and industrial functions. All of the group interviewed doubted the validity of

Gen. Schriever's position that the AF gained greater management control through using the nonprofits. These people considered that the AF had lost control Comments were received ranging from "consultants should not be used to direct you", to "they are bigger and stronger than their customers and have access to higher Air Force levels than the Commanders of the AFSC divisions they are supposed to support."

All of those interviewed were asked to evaluate whether the AF capability to manage SETD nonprofits had increased or decreased in the past two years. Only two of the eight companies considered that AF capabilities had increased. Although most contended that it depended on the personalities involved, six of the companies stated that the overall military capability had declined. They attributed the decline to the separation of good, experienced senior people and their replacement with formally educated but systems inexperienced younger officers. The latter were thrown into the middle of $20 to $100 million programs and in self defense began to lean on the nonprofits for continuity, stability and protection. In some instances, they asserted, a strong military figure arrived on the scene anxious and willing to be the decision maker. In general, he found that he was looked upon by his military superior as technically inferior to nonprofit personnel. Since mistakes in these programs were so costly and since he found fighting the system

difficult, the military man considered it advantageous and "safer" to play a more subservient role and to let the nonprofit control the decision making. The result, according to this industrial group was a noticeable weakening of the military position to control the nonprofits.

General Systems Engineering:

In his testimony before the Holifield Committee in 1962, Dr. Getting commented that "industry during the past decade had increased greatly its technical competence in the missile and space fields. As a result, it should no longer be necessary for us to get into as much detail of a contractor's engineering effort as previously was required." The change in the official documents to the expression, "general systems engineering" (GSE) rather than "systems engineering" was designed to reflect Dr. Getting's position. Industry maintained that the actions of the SETD nonprofits belied the words. All of the companies complained that there was greater interference in their business by the nonprofit than ever before. All of those interviewed were extremely critical of the failure of the nonprofits to know when to stay out of the contractor's hair. The nonprofits were getting involved in areas that were basically production rather than design problems, areas in which there was no question of the superiority of industrial competence.

Instability of Nonprofit Managers:

One of the key industries in the space business was extremely critical of nonprofit interference and of the failure of nonprofits to stabilize people on key projects. Nonprofits maintained that one of their strengths was their stability of personnel and low turnover rates. This company maintained that although the engineers did not leave the employ of the nonprofit there was unusual shifting of key project people from one job to another. In less than a year on a major program in which they were an associate contractor there had been three shifts of chief project engineer. This led to a continuous series of familiarization briefings for the new nonprofit manager and more frequent phasing group meetings to review "old" problems. The result was that the company found that 20 or 30 of their engineers were always busy to acquaint nonprofit newcomers with the program. A study conducted by this company revealed that more than 20 man-years of engineering time was devoted to familiarization briefings of new military or nonprofit personnel, a costly and program delaying effort.

Nonprofit Vested Interest:

Even those that considered objectivity a key factor in favor of nonprofit use were critical of the tendency of these activities to favor in-house ideas in which they had a vested interest rather than outside ideas that might be beneficial for

for the overall system. While it was agreed that it was an inherent characteristic of individuals and companies to want recognition, the point was made that because nonprofits were not recognized for ultimate system performance they "pushed" their technical ideas to build up a reputation. This unique personality of the nonprofit then manifested itself in ways that adversely affected total system performance. Examples were given of cases where the nonprofit made a valuable contribution to the state-of-the-art in subsystem development. This subsystem was always advocated and a continuous modernization and upgrading program was initiated in this area because of nonprofit interest. The point was made that evaluation of the contractor's performance was measured in terms of compatibility with the nonprofit subsystem rather than on a quantitative analysis of the contractor's contribution to the total system. Some of the industrial group insisted that the nonprofits discouraged the military from supporting further development of industrial subsystems that conflicted with nonprofit vested interests.

Industry Cooperation With Prime Contractor:

One of the key arguments for nonprofit use when a broad base of industrial technical competence was required, was the AF claim that industrial concerns would hesitate to divulge information to a competitor. As a result the argument was made

that a prime contractor approach discouraged subcontractors and industry, in general, from making a major contribution to the program. The response of the companies to the following questions is enlightening:

(1) Can industry, through a prime contractor method or some other contractual arrangement, provide objective SETD for major weapon system development?

(2) Would your company be willing to cooperate (more, less or the same) with another contractor having SETD responsibility as compared to the nonprofit?

Seven of the eight companies responded "yes" to the first query. The one objector considered that SETD was a government responsibility that could not be delegated to either a profit or a nonprofit corporation. The other companies advised they would be willing to cooperate with a prime contractor to the same or a greater degree than they would with the nonprofit. Two of the companies qualified the degree of cooperation with statements that it depended on the contractor involved and their past experiences and dealings with the contractor. There was a noticeable tendency to minimize the value of proprietary information in today's environment. The companies maintained that technology was advancing so rapidly that the life span of

new ideas did not seem to exceed six months. They recognized that to stay in business they had to continuously divulge ideas to the rest of industry. They would prefer divulging ideas to a prime contractor because of their ability to talk a "common" language and because prime contractors had greater flexibility to contract than the government. Thus in the "rat race" of the defense business today, the industrial group sampled was more willing to return to a prime contractor way of doing business than to continue with the AF approach of associate contractors. This position was not only based on their growing competence, their belief that a "prime" was capable of acting as integrator as well as or better than the nonprofit because of their "closeness to the problem", but also as a matter of contractual "self interest."

Motivation of Nonprofits:

There was a wide range of ideas expressed as to the motivation of a nonprofit corporation which was not faced with the drive of competition or the motivation of profits. How important is competition? Here the companies were almost unanimous that the competition in the aerospace and electronics business today was a vital force in their drive to stay ahead of the state-of-the-art. They considered that technical innovation resulted from their continuous search to do the job better, to stay ahead

of the competition. Thus, they looked at the nonprofits as being "nonmotivated", as a group that "made things conform to convenience", as "academic people that were unable to manage a program calling for output". One company called them "sterile" insofar as innovation was concerned, and another used the technical phrase "narrow banded" to describe their interests.

On the other hand, the motivation of profit to military R&D brought interesting responses. One company was upset by the continued use of the word "nonprofit" to describe MITRE and Aerospace Corporations. In their view the word conveyed the erroneous connotation that this was a cheaper way of doing or managing R&D. They preferred the adoption of the word "non-dividend" to replace "nonprofit". The emphasis placed on the impact of the profit motive varied inversely with the role the individual played in the organizational hierarchy. Key executives emphasized the profit motive as an important driving element; line program managers tended to disregard or minimize profit. The program managers contended that SETD technical recommendations whether provided by profit or nonprofit organizations, generally were given by people who were rarely cognizant of the profit aspects of their recommendation.

This position was well illustrated during an interview with an AF officer, who had been actively involved in the Minuteman

program office. In describing the military, STL and contractor organizational structures that existed to support Minuteman he described the situation where the STL engineers would urge an expensive technical approach and would receive overwhelming associate contractor and military support at the engineering levels. The concerted engineering staffs "ganged up" and refused to budge from their position even when faced with the trade off analysis of a great cost versus small technical improvement. His point was that military and contractor engineers emphasized technical objectives of reliability, accuracy, and technical goals rather than cost or profit. Dollar decisions were made at a higher management level than that of the scientist and engineer actually responsible for a small piece of the total project.

Proposed Role of SETD Nonprofits:

From a long range standpoint, two of the eight companies saw no need for the nonprofit in any aspect of R&D management. They urged the early phase out of nonprofit responsibilities and the dissolution of the corporations. The other six companies wanted to limit the future nonprofit role to assisting the AF in advanced planning and conceptualization of weapons. They would then act as a bridge between military needs and changing technology, advising the AF and assisting them in writing the requests

for proposals (RFP) for industry action.

One company suggested that the nonprofits retain people in the field with operating military activities so that they could better understand military field problems. They could then provide qualified technical evaluation at the basic requirements stage that would be channeled upward through R&D channels. This approach was in sharp contrast to the present red tape bound system of trying to push change through military operational channels before they finally arrived at the R&D side for analysis and feasibility. Today, it takes years of paperwork and review to arrive at this point, and even when the problem was transferred to the R&D people, they had little understanding or "feel" for the operational problem. This proposed system would be similar to one instituted in OSRD days when scientists lived with and participated in field exercises.

The R&D part of the budget program package system was divided into six categories: research, exploratory development, advanced development, engineering development, operational systems development and management and support. Today, within the AF management approach to R&D, the nonprofit played a role in each of the six categories. The six companies that see a continuance of SETD nonprofits would restrict their role to one category, exploratory development. The companies opposed the

nonprofit need for extensive laboratory facilities and argued that basic and applied research was the legitimate function of universities and industry. Not only was this a malassignment of responsibility but the allocation of funds to the nonprofits for specific research problems denied investigation of such problems to universities and industrial laboratories. In this way it denied the knowledge to the innovative organizations that could make the best payoff use of the investigations, this group contended.

Once the AF with the help of nonprofits determined the feasibility of new technology and defined development objectives in broad general terms, industry would be assigned the responsibilities for advanced engineering development. The AF, according to this industrial group, would exercise overall management responsibility over the contractor's efforts and would work directly with the contractor in operational systems development and preparation for eventual military operation, maintenance and support of the operational weapon system.

Industry considered that the AF adoption of such a management approach would permit a substantial reduction of MITRE and Aerospace personnel and physical facilities. The corporations could then be reduced to between 500-600 scientists and engineers, about the level of RAND Corporation. By attaining

such a personnel level and by restricting their AF role, industry considered that the nonprofits would escape constant Congressional criticism and review. At the same time the AF would make the best use of the scientific and technical talents found in industry, the universities, and the military.

Aerospace and MITRE Look at Themselves:

Aerospace and MITRE were creations of the AF. More than 95 percent of their funds were obtained from AF work. They were prohibited from competing for work and coordination with the AF was required before they were permitted to accept assignments from other governmental agencies. At the same time, the AF recognized their responsibility to guarantee the nonprofits stability and well being.

Under such a contractual arrangement it would be foolhardy for either Aerospace or MITRE to publicly indicate dissatisfaction of their role. Their future, as previously indicated, was already clouded by DOD actions to limit their size and allow industry to compete with them for system engineering and technical direction jobs. Congressional and industrial pressures were unrelenting; the General Accounting Office persisted in a belief that SETD tasks performed by the nonprofits should be performed in-house by the AF. The nonprofit official and public relations view of their role was necessarily that expressed by

the AF and described in part 1 of this chapter.

There was no doubt, however, that beneath the surface of agreement with the AF, there were serious differences of opinion. The problem they faced was how to reflect this disagreement. In the current environment, failure to show strong agreement with the AF might be tantamount to a death warrant. On the other hand, continuation of the existing course might prolong the agony but would eventually lead to their destruction.

The nonprofits paid a great deal of attention to the criticism swirling around them. There were times when they indicated that they considered it of little value to respond to their critics. Unfortunately, the AF was unable to sit back and allow the charges against them to go unanswered. Whether they liked it or not, the nonprofits found themselves spending considerable time and effort justifying their existence.

The nonprofits recognized that the environment of the 1960's was very different than that of the 1950's, the era in which they were conceived. They recognized that program decision making then unilaterally made by the AF, was now being done by DOD; none of the programs today had the sense of urgency and priority of ballistic missiles; the freedom from bureaucratic red tape that existed in the early days of the missile program had long disappeared; industry had developed a systems capability

that was strong, capable and anxious to tackle all jobs; and hostility to their effort was not restricted to industry and Congress but also found within the DOD and the military services. Their only strong advocate was their creator, the AF. However, they were concerned that the AF persisted in using the arguments of the 1950's to justify their existence.

Extensions of Government:

The nonprofits considered the jobs they performed as an extension of government functions that were the responsibilities of government and not industry. This position was expressed in 1961 by Dr. Allen F. Donovan, Senior Vice President for Aerospace Corporation, in an interview reported by the trade magazine, Aerospace Management.

> "The question is basically: How do we in a capitalistic system provide the government with certain types of technical skills? What does government want? Creative people work best in certain environments, typically a university. The better scientists and engineers prefer to work where they can present constructive criticisms, where their function in society can be understood.
>
> "Aerospace Corporation provides the right atmosphere for creative scientific and engineering people wanting to advance technically with the rapidly changing technologies. The bulk of these people will not work in the military or civil service. The purpose of the military has been to preserve the status quo. This is basically contrary to the scientific spirit. Technical objectivity is very difficult to achieve anywhere, and you do not have to make a profit to have it."

The nonprofits saw no immediate change in status, neither growth nor severe reductions were forecast. This position was based on a belief that no one was prepared to take over their job. The AF had been unable to buildup its in-house capabilities and claimed that conditions were getting worse; nothing had come of the Bell Report recommendation to consider the establishment of a new kind of a federal institution that would replicate the more positive attributes of the nonprofits; and means had not been developed to permit industry to assume the nonprofit role. DOD Directive 5500.10 might be considered an approach in the right direction, they claimed, but it did not satisfy the objectivity demands of government nor the "sterility of competition" demanded by industry.

Bureaucratic Hardening of the Arteries:

The nonprofits conceded the growth of industrial systems capability; however, this fact did not mean that the expertise and competence they possessed was of less importance. The nonprofits attracted high level people from both an educational and experience standpoint; they were capable of doing important work in an era of rapidly changing technologies.

The nonprofits complained that the stresses and strains in the system posed by their critics who are interested in dissolving

thim led to a "bureaucratic hardening of the arteries". In order to "sanitize" the system to satisfy their critics, some nonprofit personnel indicated, the AF imposed restructions, policies and procedures that made it difficult to "recognize the nonprofit from another government agency." Every interview with nonprofit personnel eventually came to this major point of contention: they were being stifled from making the scientific and technical contributions they were capable of providing. The nonprofits considered the administrative details a distasteful burden and felt that they were floundering in a sea of restrictions, much like the situation described by Admiral Rickover in a speech given in 1958:

> "We think every organization profits by introducing what we term 'business methods'. But a businesslike attitude makes for efficiency only in purely routine matters. It is disastrous when applied to creative people whether they work in an educational institution, research center or a government department.
>
> "I fear that we have gone far toward lowering the output of our brain-workers by over-organizing them. We are drowning in paperwork. We are talking ourselves in a standstill in endless committees - those pets of the administrators. We are losing the genius for improvisation ... We have been diluting responsibility for making decisions by piling layers of supervisory administrative levels, pyramid fashion, on top of the people who do the real work." [17]

The nonprofits stated that they reorganized and aligned their manpower to fit the needs of the three divisions of the

AFSC they supported. The AF wanted them to assume a strong project oriented position and they acceded to the military requests even though they knew it was costly in manpower and dollars and diluted their technical capabilities. This "fractionalization of effort" to support individual projects rather than total workload, they contended, resulted in a rapid increase in personnel. Simultaneously, it led to an increase in administrative and procedural machinery to accommodate the contractual complexities of the effort. The nonprofits recognized that, to a large extent, they were providing "warm bodies to do AF work". Their growth was a key element of Congressional and industrial criticism; however, they stated they tried unsuccessfully to combat this growth by asking the AF to assume more realistic policies and practices.

Many of the original members of the nonprofits, who joined their companies from STL and MIT, were dissatisfied with the constraints placed on them by the AF. They advised that the "creative environment" they had in their previous environment and which was to be retained in the SETD nonprofits was "more fiction than fact."

Aerospace and MITRE worked for DOD, NASA, FAA and other Federal agencies, but to a very limited degree. The nonprofits

have not attempted to market their services and as indicated at the start of this chapter they were prohibited from accepting assignments from other governmental agencies without AF coordination. Nonprofit executives advised that when they suggested the need to change this restrictive policy, their Trustees took the position that it would be foolish to leave AF sponsorship and security without having another "bird on hand". As one individual explained, the Trustees considered that "if we are as good as we think we are someone higher up in the chain of authority will recognize us and call on us to do a more important task." Unfortunately, these executives stated, the work performed by MITRE or Aerospace could not be considered "monuments to our greatness" in the same way that R-W could point to their "monuments of Atlas, Titan, Thor and Minuteman". As a result, they claimed, neither NASA nor DOD was clamoring for their services.

The 1964 annual report showed that Aerospace had an income from contracts including fees exceeding $79 million; MITRE had total revenues of over $38 million. An initial reaction after reviewing the continuous growth of these companies, their privileged and favored-son position that permitted growth without being involved in the rat race of defense procurement might well be: What are these people complaining about?

Within the nonprofits there were technically strong and dedicated personalities who considered that they had an important role to play in weapon system development. They stated that unless they found a way to resist the AF policies to "institutionalize" them, they would not exist to accomplish that scientific work required in a period of national emergency. As long as the issues - that the nation had reached a technological plateau in weapon development or that the political situation precluded continuous strivings for technological superiority in weapons - were questionable, these executives emphasized that the SETD nonprofits represented a valuable national resource that should be sustained.

CHAPTER VI

EVALUATION

> "Changing ideas, circumstances, and understandings have repeatedly presented challenges to government for which past activities and methods appeared inadequate or in - appropriate. For good or ill, modifications have continually been made in what government has done and how it has gone about it. Typically, such changes have occurred as a composite outcome of the political process - the fruit of a host of forces at play during a particular time - rather than as a result of a well-reasoned, deliberate appraisal of what their implication might be." - Carl F. Stover [1]

Ballistic Missile Success:

The AF in developing a management system for the ballistic missile program emphasized, as no one before that time had done, the concept of systems management and brought to that concept three important and radical techniques: associate contractor method, a separate corporation to perform systems engineering and technical direction, and concurrency. The host of forces at play at the time, the national priority, the technological complexity, the urgency of getting an operational system in being as soon as possible, justified the radical innovations initiated by the AF at the WDD, later renamed the BMD in California.

If one was to define the business of WDD and its commander it would have been to provide the nation with operational

ICBM's at the earliest possible date. The system employed by the AF was eminently successful. Highly complex missiles were developed, produced and installed; military systems of logistics were established; and military personnel were trained to use the weapon system. Investigation supported the AF position that no other system then employed, whether a government in-house arsenal, an industrial prime contractor, or assignment to a university laboratory, would have been as successful in satisfying the total requirements of development, installation, and operational readiness.

The forces at play during that particular time under those particular conditions called for the AF approach. The recommendations of the von Neumann Committee and the missionary zeal of Gen. Schriever in bringing reality to these recommendations were clairvoyant and worthy of the highest praise.

Institutionalization of Success:

Dr. Henry Kissinger stated that "nothing stultifies military thought as much as a victorious war, for innovation must run the gauntlet of inertia legitimized by success."[2] The war for prime military roles and mission was won by the AF in the 1950's. By the late fifties, stultification had started and innovation discouraged by the "institutionalization" of the "successful" system. In its simplest form, the concept was that if management

techniques worked for ballistic missiles they could obviously be employed for other efforts of the Air Research and Development Command (ARDC) and later the AFSC. Little consideration was given to the fact that the forces at play were different, that conditions had changed. The military leaders failed to make a "well-reasoned, deliberate appraisal of what the implications might be." There were people in the BMD, as indicated in Chapter III, who saw the dangers of "institutionalizing" the WDD system. Their protests, however, were to no avail and it was impossible to stop the movement to jump on the "Schriever bandwagon of success".

At top management level within private industry the chief executive generally was granted wide latitude and freedom of action in conducting business affairs as long as the objectives established by the board or the stockholders were met. These objectives were normally defined in terms of profit. In a public position of trust, this freedom of action was subject to many more restrictions and the objectives clouded by secondary political and economic considerations. However, during periods of stress, whether actual war or in times of national emergency, the chief executive of both public and private institutions was judged on his ability to attain objectives. As soon as the emergency was over, however, the public official might find

himself castigated and criticized for the methods employed, manpower and dollar costs associated with getting the job done - matters that were considered secondary during the emergency.

Thus, in the initial stages of the ballistic missile program no one argued against the concept of concurrency. Concurrency gave you things in a hurry but it was a very expensive way of developing a system. The dollar overruns associated with the early ballistic missile program were indicative of the added costs incurred by the concurrency concept. At the time the costs were incurred, few persons complained; however, as soon as an umbrella of strength was provided by the development of a strategic missile force, urgency was no longer a prime consideration. By 1958, Congressmen, industrialists and rival military chiefs were taking potshots at Gen. Schriever and the WDD methods. Charges of waste and mismanagement were hurled at the ballistic missile program. The reaction of the AF to this criticism was to place strong administrative and fiscal controls on the R&D management.

Myth of Freedom from Red Tape:

Many political scientists stressed freedom from red tape and bureaucratic administrative procedures as key factors in the development of nonprofit corporations. Dr. Don K. Price noted that during his early years of government service in

WWII he "used to propose facetiously that certain government departments could be organized and managed efficiently only if they were officially abolished as such and then privately incorporated in Delaware, but at that time I did not have the imagination to see that almost exactly this procedure would be followed."[3] A similar idea of circumvention of established procedures and systems by the scientific community was expressed by Dr. Robert L. Wood:

> "But the institutionalization of the first ad hoc think groups into permanent corporations, the perpetuation of the great governmental laboratories and the continued preference for a university environment in which to conduct sponsored research attest to the substantial modifications which scientists have made to conventional concepts of administrative theory. In the name of protecting scientific integrity they have secured for themselves conditions of administrative discretion which contradict ancient principles of hierarchy, chain of command and span of control. With powerful ideological assistance from the American free enterprise tradition, scientists and engineers and universities and defense industries have contributed mightily to the destruction of the governmental agency and business corporation as meaningful entities in the development and execution of public programs. The present array of research and development halfway houses born of system analysis are monuments to their ingenuity and to their success in escaping the established modes of organization."[4]

This simple model of the nonprofit institution as being the result of the ingenuity of the scientists, failed to give proper emphasis to the other forces at work that were described in Chapter II. The force that breathed life into the SETD

corporations, whether profit or nonprofit, was the military. The military concern in the 1950's - to provide an operational ballistic missile at the earliest possible date - was one that enabled them to extend the type of freedom to the SETD corporation that the scientists considered desirable. Once the missile was operational and the sense of urgency gone, internal and external pressures were exerted on the AF, which caused them to change policies. They were no longer willing or able to allow their contractors the same freedom of action and the system rapidly became "institutionalized."

The R-W Corporation and the MIT Lincoln Laboratory functioned during the period of greatest productivity, of major innovation in ballistic missiles and command and control systems. Their technical decisions were made in a heady atmosphere of "freedom" from administrative and budgetary controls. Admittedly, "freedom" must be qualified to indicate that some restrictions existed; but they were relatively minor when compared to the administrative red tape that were applied to MITRE and Aerospace.

These corporations were never given the freedom of action attained by the predecessors. From the earliest days of both MITRE and Aerospace Corporations the sense of urgency that protected their parent from being criticized for secondary

political and economic considerations no longer existed. From birth, these companies shared the goldfish bowl of AF dollar requirement to support R&D and they were looked at by Congressional committee members not as exotic tropical fish requiring special diet and favorable conditions but as common five and ten cent store goldfish. The criticism and pressures of Congressional committees caused the AF to react by applying more and more administrative controls on Aerospace and MITRE. The mother became overprotective and, in so doing, she may have smothered her infant.

Research and Development Growth Model:

Professor Edward Roberts of MIT, who has been engaged in efforts to relate the elements of R&D to some basic framework stated:

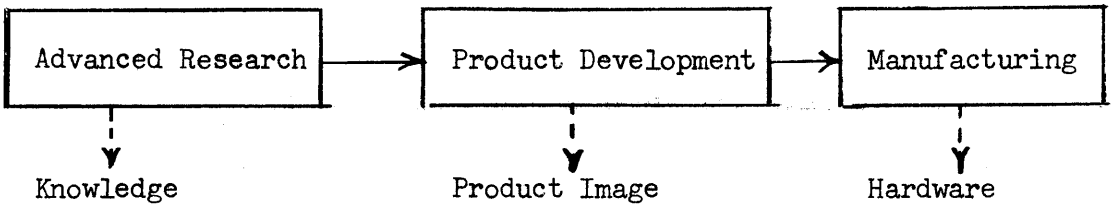
> "The apparent presumption that there is no orderliness to research and development keeps people from looking for it. If government and industry could be convinced that a framework basic to the research and development process does in fact exist, no doubt several alternatives could soon be discovered."[5]

One of the investigations to increase understanding of the R&D process was described by Gillett Welles, III, a graduate student working with Dr. Roberts, in his unpublished Master's thesis. He developed a conceptual framework for viewing the process and identification of the important

determinants of success for a R&D organization. His investigation revealed that the rapid growth of a R&D organization had the effect of diluting the knowledge held by the organization and led to a substantial reduction of technical effectiveness.

FIGURE 5

Basic R&D Organization



The "primary functions of the R&D organization is to exert technical effort toward the requirements of awarded contracts and to deliver the desired results to the customer within a reasonable period of time".[6] The fountain of knowledge that produced the idea that led to the contract lay in advanced research. Once a R&D organization began to expand, however, dollar reward was tied to the manufactured end product. Since the work performed in advance research was not immediately effective toward the immediate work requirements, the organization reduced the engineering level applied to this area and pushed their engineering people to product development and

manufacturing liaison. This shift from advanced research, while attaining immediate results, left a vacuum of new ideas or advanced concepts on which the company could build. Welles found that rapid expansion had "the effect of causing a decline which persisted for a period of seven to eight years during which the organization was unable to take advantage of any new opportunities."[7] Unless management was wise enough and strong enough to keep growth under control the R&D organization found itself in serious difficulties.

The problems inherent in this description of growth of a private R&D organization appeared to be applicable to those faced by the AF and its creations, Aerospace and MITRE, even though the latter activities were not involved in the production of hardware. As previously indicated, the military services had immediate operational problems and their goals emphasized correction of these problems. In their rapid growth and the need to get military hardware in the field the AF R&D program emphasized short range objectives; partly because such goals were more easily visualized, partly because success seemed more certain, and partly because such projects got financial support.

R&D, by its very nature, must be directed toward objectives often in the future, and as indicated by the Welles' study, pursuit of this goal required strong management support of

advanced research. Pressures within the military pushed advanced planning in the background. Military personnel within ESD, BSD, and SSD viewed the "payoff" as producing working hardware and the SETD nonprofits found themselves projectized in system program offices engaged in hardware problem solving. While the companies recognized the need for "solving unsolved problems or doing new things with new techniques", as Welles' defined the aims of advanced research, Aerospace and MITRE found that, all too often, initiation of such work was delayed until the need had become so great as to be considered an emergency. Instead of reacting to the opportunities of weapon technology, the SETD nonprofits were kept busy reacting to the problems of what one observer called "premeditated emergencies."

Myth of Special Need:

The most popular explanation of SETD nonprofit creation was "special need". In Chapter II, quotations by Mr. C. W. Halligan and Gen. James McCormack Jr. were used which emphasized their contention that Aerospace and MITRE were created to meet a special need which could not be fulfilled by government, industry or universities. The analysis in this study was not intended to refute this contention; however, the facts presented were sufficient to indicate that this position was overemphasized. In 1958, there were industrial means to do the MITRE job; in 1960

there were industrial means to do the Aerospace job. The "special need", as previously indicated, existed in the years prior to the creation of either MITRE or Aerospace. At that time "special need", as indicated in Chapter III, was characterized by these traits: (a) projects of national importance and highest priority, (b) extreme urgency, (c) giant technological step, (d) radical impact on military operational techniques, and (e) concurrency of development, production and operational preparation.

The initial inquiry of this study was directed at determining what happened to a R&D organization, such as the SETD nonprofits, conceived and established to perform a specific task after the mission was accomplished or greatly reduced in scope or importance. This study revealed that the SETD nonprofits were never established to perform a specific task; that their charters of origin and their initial contracts were broad and general in nature to provide "full resources of modern science and technology" to the military problems; that their creation was devised by the AF as a legal "gimmick" to assure military control of R&D and AF technical competence to retain their hold on ballistic missile, space and command and control missions.

Thus, "special need" neither existed at the time of creation of Aerospace and MITRE Corporations nor exists today. The

projects and tasks assigned to the corporations from time of birth to the present have not met the criteria outlined above. The AF use of these corporations emphasized short range and immediate technical objectives at the expense of advanced research and made it virtually impossible for these activities to be the creators of new technology for military use.

In an interview published in 1961, Dr. Donovan, Vice-President of Aerospace Corporation stated:

> "For the future, much depends on the international situation and growth of space technology coupled with the Air Force use of space. We were created as an agency to help the Air Force, if the need for us grows we will accordingly grow stronger, if the need declines we will shrink or go out of existence. After all, we can be dissolved much easier than any company with a group of shareholders."[8]

Under the terms of their contract with the AF, the nonprofits can be dissolved and their assets become the property of the AF. Dissolution cannot be accomplished as easily as described by Dr. Donovan. The corporations have established roots and vested interests. Like any activity, either public or private, they desire to grow and gain power, and, if this is not possible, they will fight to exist. Dr. Price described the temptation in this way:

> "We do well to recognize that a government bureau is tempted to be more concerned with its own status and power than with the purposes of national policy. But if we entrust these purposes to scientists and industrialists we do not sterilize that political temptation. We only let it begin to work directly on the industrialists and scientists. If public ownership is no guarantee

of unselfishness, neither is private ownership."[9]

Today, under AF contract as "captives of the AF", the SETD nonprofits exist as appendages of bureaucracy. They look like, act like, and perform like AF activities. As a national resource of scientific and engineering skill and expertise they are withering under the ground rules that have been imposed on them by the AF. The major concentration of technical effort is on projects of secondary need and priority. The AF is using them as a source of manpower rather than as a resource of great capability to be focused on selected and highly sophisticated tasks. Their use as a catchall for all kinds of jobs has had an adverse effect on their ability to carry out vital work.

Changing Forces:

It must be recognized, however, that the problems facing the SETD nonprofits are symptomatic of a basic difficulty facing the AF R&D program. After WW II through the Eisenhower administration, the emphasis on massive retaliation and strategic deterrance made the AF the top dog among the military services. It received the most money for R&D and during an era of weak DOD and JCS direction it exercised unusual freedom in action in deciding how the program would be managed. Today, the strategic retaliatory force is in being and the emphasis has shifted to the needs of limited warfare and the mobile and less vulnerable

Polaris nuclear missile capability.

The AF finds itself in a period of transition looking for new roles and missions in areas dominated by the Army and Navy. At the same time R&D decision making and control has been lodged at DOD rather than at service level. As a result, it is highly doubtful that the AF will be given sole responsibility for a major program of national urgency and priority in space, ballistic missiles, or command and control. Thus, even if the SETD nonprofits were provided the ideal climate and freedom in which to flourish it is questionable that the AF could assign to them vital and highly sophisticated tasks that demanded their expertise and talents.

In the 1950's the services had, within the limitations of budget and over-all policy, a great deal of autonomy. Weapon development and procurement were largely decentralized to the services. In this way, the sole responsibility for the ICBM program and the SAGE development was assigned to the AF, and there was no question about the latter's authority and responsibility for decision making on these programs. Today the picture has changed drastically. Decision making on major R&D programs has been centralized at DOD level. As Hanson Baldwin indicated in an article in Foreign Affairs, the

Office of the Secretary of Defense is "far more than a policy-making and coordinating agency, as it was originally intended to be under the National Security Act of 1947; it administers, operates, contracts, develops, procures and commands."[10]

The posture statement by Mr. McNamara before the House Armed Services Committee on the fiscal year 1966-70 defense program reiterated that no major changes in force structure were contemplated. Thus, the Secretary implied in words and program actions that defense armament was in a state of evolutionary rather than revolutionary development. The buying pattern would be toward product improvement and hardware modernization rather than new weapons. The previous discussion revealed that the AF and the SETD nonprofits were not engaged in programs of national priority and urgency today, and the recent posture briefing by Mr. McNamara implied that in the immediate future there was little liklihood that the AF would be assigned R&D responsibilities for any new system that could meet the criteria of "special need".

There was a growing recognition within industry that the defense market was no longer a growth market. The recent study by Arthur D. Little, Inc. (ADL), "Strategies for Survival in the Aerospace Industry", forecast an overall defense market decline of 15 percent in the next five years and urged industry

to seek R&D funds rather than production contracts. The report stated:

> "The Aerospace industry still has a sizable market, but the pattern has changed significantly. For example, in 1954 it was predominantly a producers market, but in 1963 the dollar expenditures devoted to research and development equalled those allocated to production; by 1969 the total aerospace research and development budget will be 60% greater than that earmarked for production."[11]

High level industry spokesmen reacted violently to the ADL Report. Comments of "overly pessimistic", "superficial" and "unrealistic" were noted in the trade publications; however, the array of statistics and data supported the ADL conclusion that a fundamental change in the defense market had taken place and that there must be a corresponding change in the overall industry structure.

This investigation supported the industry position that their capabilities in systems technology and management had increased substantially. As previously indicated in the ten year period between 1954 and 1963, the industry invested more than $2.6 billions in expansion and modernization and almost all of this capital expansion went toward new research facilities.

Organizational Conflicts of Interest:

Mr. McNamara's posture briefing, the ADL report, the

Stanford Research Institute study can lead to a supposition that large segments of the aerospace and electronics industry may divorce themselves from production and consider their business to be R&D systems management. Under such circumstances, the position expressed by Mr. Yarmolinsky and described in the previous chapter, that industrial objectivity was attainable by contract, would become more meaningful.

In this regard, it may well be that DOD Directive 5500.10 will require revisions and changes to satisfy government, the industrial community as well as the company that undertakes a systems management SETD role. During the interviews with industry, the STL role for the Navy in the anti-submarine warfare program was discussed. Industry was cautious about objecting to a contract that was just starting but they were concerned about the privileged position STL would have in such a potentially large program. They were impressed by the hardware ban restrictions reported by Missiles and Rockets and quoted in the previous chapter. When STL was interviewed, however, they claimed that the Missiles and Rockets article had overstated the hardware exclusion clauses of the contract. They indicated that an STL press release dated December 7, 1964, clarified their contractual restrictions.

"In accordance with DOD policy covering conflict-of-interest, the contract contains a special clause which precludes TRW corporation from the supply of specific ASW hardware where related comprehensive tasks in system analysis and system engineering have been assigned. However, these restrictions are not imposed for other ASW hardware items where the related assigned tasks are less comprehensive."[12]

Many industry executives would be very dissatisfied with the STL contractual interpretation of conflict of interest. This was not to belittle the efforts of those who considered DOD Directive 5500.10 a means by which industry could compete for work performed by nonprofits today. It may well be that this is the way of the future; that as defense R&D funds decline or level off, industry will be willing to accept the restrictions and learn to live with the directive. The indications, however, are that revisions and changes will be required to clarify ambiguities and misunderstandings that exist today.

New Role Is Required:

The AFSC fiscal year 1967 program for MITRE and Aerospace Corporations will soon begin to run its annual obstacle course through DOD and Congress, and its progress promises to be more tortuous than in the past. Congressional opposition to SETD nonprofits has not abated and criticism is now coming from an increasing number of fence straddlers and even former supporters who think it is time to put the program on a new footing, or

perhaps, terminate it completely.

The DOD, hoping to appease Congressional, industrial, and other governmental agency critics has adopted a temporary policy of status quo, maintaining the key nonprofits at their present levels and possibly permitting industry to compete with them for contracts. Dr. Eugene C. Fubini, deputy director of defense research and engineering, who was assigned the task of deciding what the nonprofit role should be, was quoted as follows:

> "It is true we can use profit-making organizations to do technical direction and systems engineering. But this does not mean that in all cases all the work should be pushed toward industry. In the nonprofits, we have a valuable national resource which already exists. We see no reason to eliminate it simply because it is not for profit. There is a need for controlling the non-profits ...
>
> "We do not want them to grow too much or to decrease too gast. We would like them to stay generally at the present level. This leveling will be obtained by maintaining a high quality rather than a high quantity of work."[13]

When the ballistic missile program began the nature of the total job and the characteristics of industry warranted the use of a SETD activity on contract to the AF. But "forces at play" changed in the 1960's. The program was permitted to evolve year after year, from the early ballistic missile needs

to serve different objectives under very different circumstances.

The result has been the conversion of organizations with unusually strong scientific and engineering resources and first class potential to a sterile, uncreative, and controversial R&D activity. Perpetuation of the status quo will not improve the situation; it can only lead to further deterioration. Change is required, but any change that is made by DOD must not result from appeasement or reaction to pressures and criticism but "as a result of a well-reasoned, deliberate appraisal of what their implications might be."

In the previous chapter, Dr. Brown was quoted as saying that "government policy, like science itself needs to be conceived and pursued with some regard for its totality as well as its parts." The role of the SETD nonprofits, if a role exists, must be considered in terms of the overall defense R&D program. The outline of such a program is briefly contained in the final chapter.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

The initial inquiry of this study was directed at determining what happened to a R&D organization, such as the SETD nonprofits, conceived and established to perform a specific task after the mission was accomplished. The study revealed that the raison d'etre of SETD nonprofits - that they were created to perform a special need which could not be fulfilled by government, industry, or universities - was not supported by historical facts. Special need existed prior to the creation of either MITRE or Aerospace Corporation.

The rapid growth pattern of these organizations, created after the major technological advances in ballistic missiles and SAGE had been made, indicated that scientists and engineers working in private institutions establish roots and vested interests and become more concerned with their "own status and power than with the purposes of national policy." The expansion of MITRE and Aerospace Corporations did not take place at the interface of advanced and innovative technology but at evolutionary rather than revolutionary developments in ballistic missiles, space, and command and control systems.

The "special status" position of MITRE and Aerospace Corporations to the Air Force provided a degree of financial security and

stability but subjected them to restrictive budgetary and administrative controls. This position, for all practical purposes, made them captive to the Air Force. The Air Force use of these corporations emphasized short range and immediate technical objectives at the expense of advanced research for longer range weapon technology. The SETD nonprofits have not appeared to protest too strongly against military policies and procedures that have seriously prevented them from making the scientific and technical contributions they consider themselves capable of providing.

Although, some of the SETD nonprofit executives stated that if there was no legitimate need for their services they should be dissolved, their passive acceptance of restrictions, controls and assignments of secondary need and priority belied this position. Like any activity, either public or private, the SETD nonprofits desire to grow and gain power, and, if their existence is threatened will fight or passively accede to restrictions that may limit their value but will enable them to exist.

It must be remembered, however, that the basic objective of defense R&D is national security. As indicated in the Introduction, when the question is raised - What kind of R&D program will enable us to reach this objective? - even within the DOD numerous answers will be found. There are some who argue strenuously that a

plateau in technology has been reached, that the technological revolution is over; others contend that the pursuit of military technology will increase world tensions and that political salvation is dependent upon disarmament or arms limitation.

I contend that the military technological revolution is far from over and that long range scientific research on military problems must continue.

Point 1. National security may be dependent upon breakthroughs in weapon technology; therefore, innovative and creative research and development must be encouraged.

This study proved that the evolutionary process of SETD nonprofit development within the Air Force emphasized short range and immediate technical objectives and deemphasized that effort that offered the greatest potential for innovative and creative scientific and technical development. The captivity of the SETD nonprofits to the Air Force makes it difficult for their research staffs to explore freely and objectively and even more trying to initiate research projects for conceptual phase investigations of new and, therefore, unpopular ideas.

Today, the SETD nonprofits used by the Air Force have been converted and absorbed within the military bureaucracy. They are used primarily as a source of "warm bodies" collecting jobs of lesser importance, jobs that add little to innovative or

creative defense R&D.

Point 2. The Air Force contracts with Aerospace and MITRE Corporations should be discontinued on or before July 1, 1968. This date should permit phasedown and/or realignment of Aerospace and MITRE as well as a reconstruction and realignment of Air Force in-house capabilities.

The situation and conditions during the early days of the ballistic missile program supported the use of the SETD organizational form. These conditions do not exist today. A major change has been the development of systems management capabilities of private industry. One notes that major federal R&D efforts; e.g., NASA with their responsibilities for space R&D, FAA with their responsibilities for air traffic control R&D, and the Department of Commerce with their responsibilities for urban transportation investigations have not employed a SETD concept. These agencies employ a strong core of government scientists and engineers to manage R&D conducted primarily by private industry.

Point 3. There is no legitimate need for nonprofits performing systems engineering and technical direction in defense R&D today and in the foreseeable future. Industry can and should be assigned the major responsibilities for advanced and engineering development but under government technical management and control.

Since the end of World War II, defense R&D including long range military research has been under military control. The military services have controlled the selection of projects that

will be studied and determined funding levels. Serious doubts have been raised as to the amount of innovation attained, even with the considerable number of dollars the nation has expended in the military R&D program. This study does not provide an answer to the overall question of the effectiveness of the R&D system; however, it shows that within the Air Force the military emphasis is directed toward solving immediate weapon problems at the expense of R&D breakthrough opportunities in weapon technology. This natural emphasis on the part of the military, clearly outlined by Dr. Bush in 1946 and discussed in Chapter 2, raises the question:

> Question 1. Is there a need to reopen the issue pointed out by Dr. Bush that long run military research requires a permanent civilian controlled organization, funded independently, that has liaison with the military services but is free to initiate military research projects on its own?

Since World War II, numerous organizations and management structures have been created to perform defense R&D. As indicated by Dr. Stover they were the result of a "host of forces at play during a particular time - rather than as a result of a well-reasoned deliberate appraisal of what their implications might be." The Bell Committee was established in 1961 by President Kennedy to review the experiences of government in contracting federal R&D and to determine guidelines or criteria that might be used in deciding how future programs should be conducted. The

report, although interesting, did not provide answers as to "what method, when and why" one organizational method might be better than another. The result is many pieces but no totality to the defense R&D, and raises the question:

> Question 2: Is there a need to reopen the issues raised by President Kennedy in establishing the Bell Committee to develop criteria that should be used in "determining whether to perform a service or function through a contractor or through direct Federal operations"?[1]

Any effort to restudy the issues of the Bell Committee inquiry would do well to consider the use of MITRE and Aerospace Corporations, not in a SETD role, but within the R&D structure. The SETD nonprofits represent a collection of capable and talented scientists, engineers and R&D managers who have the flexibility to be applied to problems of national interest.

Point 1 recommended cutting their umbilical cord to the Air Force, it does not mean that these activities must or should be dissolved. Their proper role may be with other defense establishments or possibly within the larger federal R&D picture. The question raised is:

> Question 3: Can the DOD find defense tasks of national importance that can best be done by MITRE or Aerospace Corporations?

If such tasks exist, MITRE and Aerospace Corporations should

be retained within the defense structure under contract to perform a specific job or task and not in a "special status" relationship with a military service or department. If such tasks do not exist, defense ties should be broken and the SETD nonprofits dissolved or permitted to seek other governmental R&D tasks of national need.

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