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**THE EARLY HISTORY  
OF  
THE MITRE CORPORATION:  
Its Background, Inception, and First Five Years**

*Volume One of Two Volumes*

**Howard R. Murphy  
State University College  
Oneonta, New York**

D R A F T

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June 30, 1972

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This draft has been prepared to facilitate the solicitation of informed comments prior to the preparation of a final draft.



A WORD TO THE READER OF THIS DRAFT  
OF THE HISTORY OF THE MITRE CORPORATION TO 1963

Before I returned to academic life in 1965, I was for a few years a member of the Electronic Systems Division's staff of historians, and it was then that I learned of the existence of The MITRE Corporation and came to be impressed with its importance as an example of an interesting and probably significant institutional innovation -- neither a private business nor a government agency nor a university, although reflecting some features of all three. Therefore, when Mr. Clare W. Farr told me in the summer of 1966 that MITRE was casting about for a suitable means of having its history written, I was powerfully drawn to the project because it offered an opportunity to develop what had become a strong intellectual interest of my own. After some exploratory research to satisfy myself that it was indeed feasible, I offered to undertake it. The Corporation supported me generously with financial and administrative assistance, and gave me wide freedom in the use of its documentary resources and in access to key personnel, but the plan and conception of the history here presented in draft form, and the opinions expressed therein, are, of course, my own.

In the pages which follow, I have treated the background and inception of the Corporation and the first five years of its career. Because the situation that led to its creation in 1958 is not intelligible without an understanding of the problems then surrounding the SAGE air defense system and without some appreciation of the spirit that animated the group of engineers in the Lincoln Laboratory who had developed SAGE, I found it necessary to begin my treatment with some observations on the Valley Committee in 1950, the formation of Lincoln in 1951, and the inclusion in Lincoln of the older MIT

Servomechanisms Laboratory group who had developed the Whirlwind computer. I have not gone beyond 1963 because that year seems to me to mark the natural culmination of the themes that constitute the story that I have to tell, and because the post-1963 history of MITRE seems to me to involve some quite different themes that can be best handled in a separate work.

In developing the details of this history, I have relied primarily on documentary material drawn from various sources. A great deal of it came from MITRE itself. In addition to the considerable quantity of material which I found in the Corporation's archives, I have had access to the Reports of Operations and the Interim Reports which the Corporation's management periodically prepared for the Board of Trustees, although I have not seen the actual minutes of the meetings of the Board or of the executive committee of the Board. I have also had access to papers in the files of the Electronic Systems Division's historical office, much of which I had personally assembled when I was a member of that office, to the minutes of the Lincoln Steering Committee, to an invaluable set of papers that Dr. Julius A. Stratton was kind enough to let me use, and to a few documents from other sources.

In addition, I have gained some useful insights and background information through interviews with various persons who figured prominently in one part of the story or another -- including some MITRE trustees or former trustees, some members of the MITRE staff, and a few outsiders. Most of these interviews occurred in the summer of 1968, and in most cases I was accompanied by my associate in this enterprise, Dr. Kent C. Redmond, Professor of History at Fairleigh Dickinson University, Madison, New Jersey. A few of the interviews after 1968 were conducted by Dr. Redmond in my behalf. Dr. Redmond, I should add, has written no part of this history, but has perused the same documents that I have seen and has read and commented

on each chapter as it was written. My insights have been usefully honed through our many informal discussions of the questions of interpretation that I have had to confront in the course of my labors.

I reiterate that what is presented here is a draft. Although I have been diligent in my research, I have no doubt that some significant pieces of information have eluded me. As for my interpretations, I have tried to be fair without being bland, but it is entirely possible that some readers may feel able to suggest different and perhaps better lines of interpretation on certain points, and some of them may wish to supplement what I have written. Therefore I solicit comments from all readers to whom a copy of this draft is sent. As a conscientious scholar I cannot make changes counter to my honest convictions, but I fully expect to receive new information and new thoughts which will leave me with the feeling that some passages should be modified in the interests of sound scholarship.

MITRE personnel who read this draft may find it convenient to send their comments to me in care of Mr. Andrew Bayle, who has succeeded Mr. Farr as the Corporation's agent for administering this historical effort. Others may prefer to write to me directly at the State University College, Oneonta, New York. In any case, I await comments with eager anticipation.

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Associate Professor of History  
State University College  
Oneonta, New York 13820  
June 30, 1972



## INTERVIEWS FOR MITRE HISTORY

<u>Person Interviewed</u>	<u>Date</u>	<u>Present at Interview</u>
<u>Members or former members of the Board:</u>		
Brace, Lloyd D.	July 18, 1968	Murphy, Redmond
Coolidge, Charles A.	July 16, 1968	Murphy
Douglas, James H., Jr.	Sept. 27, 1968	Murphy, Redmond
Everett, Robert R.	July 8, 1968 Dec. 18, 1970	Murphy Murphy, Redmond, Farr
Halligan, Clair W.	Aug. 3, 1967	Murphy, Farr
Huddleson, Edwin E., Jr.	Sept. 27, 1968	Murphy, Redmond
Killian, James R.	July 18, 1968	Murphy, Redmond
McCormack, James	Aug. 5, 1968	Murphy, Redmond
Sprague, Robert C.	Sept. 6, 1968	Murphy
Stratton, Julius A.	Oct. 11, 1968 Dec. 15, 1970	Murphy, Redmond Murphy, Redmond
Webster, William	July 22, 1968	Murphy
<u>Members of the MITRE staff:</u>		
Attridge, Walter S.	Aug. 18, 1970	Murphy, Farr
Jacobs, John F.	Aug. 1, 1967	Murphy
Lee, Joseph D.	July 9, 1968	Murphy
Summers, John K.	July 24, 1967	Murphy
Zraket, Charles A.	Aug. 9, 1967	Murphy
<u>Others:</u>		
Baker, William O., Bell Telephone Laboratories	July 30, 1968 June 30, 1970	Murphy, Redmond Redmond
Becker, William J., Hqs. USAF	Aug. 5, 1968	Murphy, Redmond
Floe, Carl F., MIT	July 19, 1968	Murphy, Redmond



INTERVIEWS FOR MITRE HISTORY (concluded)

<u>Person Interviewed</u>	<u>Date</u>	<u>Present at Interview</u>
<u>Others: (cont'd)</u>		
Gould, Maj Gen Gordon T. ,	March 30, 1971	Redmond
Overhage, Carl F. J. , MIT	Sept. 27, 1968	Murphy, Redmond
Thayer, Gordon N. Amer. Tel. and Tel. Co.	Aug. 2, 1968	Redmond
Valley, George E. , MIT	July 30, 1968	Murphy

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## CHAPTER ONE

### MITRE: THE CULMINATION OF A MODERN SAGA

In January 1958, in the house of a Massachusetts Institute of Technology vice president on Brattle Street in Cambridge, Massachusetts, there occurred a meeting of crucial importance in the story about to be unfolded. Mr. James H. Douglas, Jr., then Secretary of the Air Force, had come to Cambridge to consult with Dr. Julius A. Stratton, who had recently become Acting President and would soon become President of MIT, concerning a problem that had arisen in connection with the Lincoln Laboratory, a center for research and development related to air defense which MIT had established a few years earlier, at the Air Force's request, in nearby Lexington. Lincoln, with the Air Force's cooperation, had developed an interesting and imaginative approach to air defense known as the Semi-automatic Ground Environment, or SAGE -- an outgrowth of an idea that traces back to a conception advanced by a committee headed by MIT Professor George E. Valley in 1950. The heart of SAGE was a large computer capable of processing a vast quantity of radar data drawn from geographically scattered radars so as to yield an up-to-the-minute display of a moving situation in the air space over a wide area. But, although it had been proved by the time of this meeting in Cambridge that SAGE would work, a great deal had to be done before it could be integrated with air defense weapon systems so that the Air Defense Command could use it, and MIT had reasons for not wishing the Lincoln Laboratory to do this remaining work. The Air Force, for its part, was reluctant to trust the remaining work to anyone except the group of system engineers in Lincoln who had developed SAGE, wrestled with its technical problems, knew what was necessary in order to integrate weapon systems with it, and, unlike many

of their contemporaries, had complete confidence in it.

The compromise to which Douglas and Stratton agreed was to detach the SAGE engineers from Lincoln and reconstitute them as a separate organization -- probably a non-profit corporation, although the kind of non-profit corporation was not yet determined. MIT would explore various means of accomplishing this and, after determining the precise form that the new organization should take and arranging for its sponsorship, would cause it to be created, while the Air Force would stand ready to give it a contract for the desired work. The preferred course was to induce some private industry or combination of private industries to assume the responsibility and establish a non-profit subsidiary, but, since no private industries were interested in cooperating in this way, Stratton decided the following June that he had no choice but to arrange for the creation of a membership or nonstock corporation patterned after that interesting and sometimes controversial institutional form that H. Rowan Gaither had invented ten years earlier when he devised the RAND Corporation as a new vehicle for Project RAND, previously conducted under the auspices of Douglas Aircraft. Thus it came about that the MITRE Corporation was incorporated in Delaware on July 21, 1958. Both Gaither and Stratton were among the original members and trustees, although Stratton would resign in less than two years, and Gaither was the first chairman of the board of trustees. Clair W. Halligan came from the Bell Telephone Laboratories to be the Corporation's president. Robert R. Everett, then the leader of the SAGE team (and destined several years later to become the President of MITRE), made the transfer from Lincoln on October 1 along with a few of his associates, and the transfer of the bulk of the team occurred on January 1, 1959.

Thus occurred a metamorphosis of an interesting and in some ways unusual team of electronic system engineers. Actually, it was their second metamorphosis. Their true beginning lay in the MIT Servomechanisms Laboratory of the nineteen-forties when, as young men, and then under the leadership of Jay W. Forrester, they accomplished that signal stride in the evolution of electronic digital computers known as Whirlwind. They had already undergone one metamorphosis when they became Division 6 of the Lincoln Laboratory in 1952. Some of their original number left the group from time to time, and, especially during their Lincoln period, several new, and mostly young, engineers joined them. But, despite these changes, they were still essentially the same group, still infused with the same attitude toward work and the same remarkably high and remarkably durable esprit de corps. More than such groups usually do, they repeatedly showed themselves to be animated by what Thorstein Veblen called the "instinct of workmanship" -- the desire to do a good job for its own sake. It was primarily this quality in them that made the story of Project Whirlwind the exciting story that it was,<sup>1</sup> and without it one may doubt whether the Valley Committee's idea could ever have evolved into the technical triumph reflected in SAGE. Throughout both their Whirlwind and their Lincoln days they had been used to working with a minimum of petty bureaucratic surveillance, and so far they had been amazingly persistent and successful in their habit of doing things according to their convictions.

Of the several themes that make up the fabric of the history which follows, the one with perhaps the greatest human interest is the slow but inexorable change that overtook these engineers once they had joined MITRE. It is partly in order to present this evolution in perspective that the story has to begin with the creation, not of MITRE itself in 1958, but of the Valley



Committee in 1950, and summarize the story of SAGE and of MIT's policy crisis, without which there never would have been a MITRE Corporation. In 1958, while MITRE was in process of formation, these men were, as usual, mostly immersed in their work, but they were also aware that SAGE could be significantly improved and could be adapted to other tasks besides air defense, and some of them had begun to think of other possible systems that would be different from but conceptually kindred to SAGE. They were never able to do more than a part of the new work which they then envisioned, and eventually had to do a great many other things which they had not envisioned. They never entirely lost their initial esprit de corps, which proved to be hardier than might have been expected, but by degrees the Air Force was able to weaken and blunt it somewhat -- partly by imposing various kinds of bureaucratic surveillance to which they had been unaccustomed; partly by inducing them to concern themselves with a far wider range of electronic systems than those connected with air defense, including some systems with which they found themselves in conceptual disagreement; partly by forcing them rapidly to increase their numbers in order to handle this new work; partly by giving them to understand that their views were not necessarily welcome, and that their new situation was such that they could no longer persist in developing something that they considered conceptually and technically sound regardless of the opposition of the Air Force officers charged with the administration of their contract; and partly by maintaining a steady pressure on them, which they could not wholly ignore, to apply themselves to a miscellany of trouble-shooting tasks in connection with systems with which they had originally had nothing to do. By 1963 this harnessing of an originally independent-minded engineering team had gone about as far as it was destined to go, and that is one of the reasons for ending the present history in that year.

But there are other themes. MITRE was the third of an eventual total of six quasi-public corporations of the type devised by Gaither. Even from the time of the creation of RAND in 1948, there had been a certain amount of controversy surrounding this institutional innovation, and the addition of five new members of the tribe between 1956 and 1961, most of them with some kind of involvement in system engineering, caused the complaints to become more insistent. Some business leaders resented these new corporations as intruders in a field which they felt rightfully belonged to private business, and some government officials were alarmed because they thought the government was improperly delegating essential prerogatives and responsibilities. In 1961 and 1962 this whole question was taking the time of a Congressional committee and was under review by a high-level study group appointed at the behest of the President. This history is, among other things, a case study of some pertinence here. It should serve to show that both sets of objectors had inadequate understandings of what it was that these new corporations were doing and that neither of them ever understood, or cared, why such anomalous organizations had been created in the first place. Hopefully, a perusal of these pages will prompt some readers to ask the right kind of question about the Gaither style of corporation -- namely, what was there about the era that generated this curious phenomenon? Was it, perchance, that contemporary civilization had, in the decade and a half following the Second World War, generated certain tasks that could not be satisfactorily discharged by any existing type of institution -- the private business, the government bureau, or the university -- and in its groping way was trying to combine some features of all three existing institutional forms into a new kind of institution that could do what needed to be done?

Another thread that appears and reappears as the story unfolds is the evolution of Air Force policy in respect to organizations like Lincoln and MITRE. In the nineteen-fifties the Air Force was able to control Lincoln only loosely and indirectly, with the result that Lincoln enjoyed a comparatively high degree of working freedom and was a stimulating place in which to work (although the old Servomechanisms Laboratory had apparently had an even more stimulating effect on its people). But the Air Research and Development Command (which became the Air Force Systems Command in 1961) had always resented this situation, tolerating it only because it had no choice, and in 1960 succeeded in reorganizing itself in such a way that, as regards MITRE at least, it was able to apply much tighter controls and thus to make MITRE's working environment much more circumscribed than Lincoln's had been -- to the point that MITRE people began to complain that they were working in a "goldfish bowl."

Related to this transition is an interesting change in the character of the "cold war." After Russia broke the United States' atomic power monopoly in 1949, and again after it launched the first sputniks in 1957, the government and especially the Air Force reacted with alarm. There is room for difference of opinion as to the true nature of the danger, since there are reasons for thinking that Russia, whatever its military capability and whatever its ultimate goals, would not have found the desperado tactics of a surprise attack, after the manner of a Hitler in 1939 or a Japan in 1941, particularly attractive from its own point of view. There can be no doubt, however, that the mood in high government circles and in the American public called for heroic and unusual measures and therefore a suspension of "business as usual." Without this mood, it is unlikely that our team of engineers or other teams like them would ever have been allowed the degree

of freedom they managed to enjoy in the nineteen-fifties. But something happened to this mood within a year or two after the sputnik launchings. By about the time of the election of 1960 there was probably as much concern over something called the "military-industrial complex" as there was over any danger of attack by a foreign power, and throughout the ensuing decade high military and civilian officials, although continuing to profess a belief in the danger, were in truth more preoccupied with the techniques of managing and regulating a systems-acquisition empire than with anything else. They would not have behaved that way if their sense of danger had continued to be the almost visceral thing it had apparently been for their predecessors in the preceding decade.

History cannot provide definitive answers to the kinds of questions here adumbrated, but it can powerfully illuminate them. This history of the background, inception, and early career of the MITRE Corporation is therefore no mere recounting of old times that individuals who experienced them may recall with emotions ranging from anguish to nostalgia -- although, of course, it is that among other things. It is also a tale that should shed useful light on several important and insufficiently understood facets of the general history of the United States in the two decades following the Second World War. To that tale it is now time to turn.



## CHAPTER TWO

### AIR DEFENSE AND THE "SAGE" SYSTEM

Our story begins in the context of the air defense problem as seen in the United States, especially by the Air Force, in the years immediately after the Second World War. Before the war the United States had scarcely been aware of an air defense problem: its only conceivable enemies were in Europe and Asia, the oceans were wide, and the range of the bomber aircraft of that era was limited. The Japanese attack on Pearl Harbor had no doubt done something to destroy American complacency in this respect, but that had been a carrier-based attack requiring a hostile navy, and therefore could not have been repeated in the immediate post-war years because there was then no hostile navy to launch it. The war, however, had engendered the atomic bomb, and had so stimulated the evolution of the aircraft that it would not be long before land-based bombers of great range and speed would be able to deliver an intercontinental nuclear attack. For the time being there was still no danger because the United States had an atomic-bomb monopoly, but that situation could not be expected to last. What was feared was that Russia also would soon have the atomic bomb and the kind of aircraft to deliver it, and might then attempt a surprise atomic attack that would devastate several American cities much as Hiroshima and Nagasaki had been devastated. Indeed, it was not inconceivable that such an attack might so cripple and disorganize the country that retaliation would be impossible and the government itself would be overthrown. To be sure, the experience gained from mass bombing raids during the recent war suggested that an alert defender with means at his disposal could usually intercept most of the hostile bombers before they reached their targets, but there

was small comfort in this because the same experience also indicated that at least a few bombers would almost certainly elude the defense, and only one successfully delivered atomic bomb could cause an unacceptable amount of damage. As late as 1956 General Earle E. Partridge, then commander of the Air Defense Command, questioned the ability of United States jet fighters then in inventory to deal with a large-scale attack including nuclear and "possibly thermonuclear" weapons, and estimated that such an attack would bring about forty percent of the country's population and sixty percent of its industry under fire.<sup>1</sup>

Whether the danger was truly imminent or merely hypothetical is, for the moment, beside the point. It was, at any rate, widely believed to be a genuine danger, and not by Air Force officers alone but also by a great many scientists and engineers and not a few ordinary citizens. In December 1947 General Hoyt S. Vandenberg, Vice Chief of Staff of the then fledgling United States Air Force, formally called the problem to the attention of the chairman of the Research and Development Board, Dr. Vannevar Bush,<sup>2</sup> and, a few months later, recalled Major General Gordon P. Saville from an assignment in Brazil in order to put him in charge of an Air Force air defense planning effort. Saville proceeded to create a special staff for the purpose at Mitchel Air Force Base on Long Island, and at some time in late 1948 or early 1949 visited certain people at the Massachusetts Institute of Technology, including President James R. Killian, Jr., and Provost Julius A. Stratton, to solicit their interest and cooperation.<sup>3</sup> Since the air defense problem was in considerable part a radar problem, and since MIT, already a recognized leader in radar research and development on account of the work of its wartime Radiation Laboratory, had an obvious academic motive for wishing to continue to pioneer in that field, it is unlikely that

the members of the MIT community who knew something about the problem needed much persuading, or needed to be told that the means of repelling the kind of attack envisioned had yet to be developed. Thus, by the middle of 1949 at the latest, and probably earlier, certain members of the MIT faculty -- notably, Dr. George E. Valley, Professor of Physics -- began to apply themselves to the technical aspects of the problem. Meanwhile, General Saville's staff at Mitchel was at work defining the requirements that an adequate air defense system would have to satisfy, and at the same time putting together, out of such radars and associated equipment as were then available, that make-shift system that was for a while the country's only air defense system, and that Valley would later describe as "lame, purblind, and idiot-like."<sup>1</sup>

Then, in August 1949, the Truman Administration learned through seismic evidence that the Russians had detonated an atomic device.<sup>2</sup> It did not necessarily follow that they yet had a practicable atomic bomb, but they had made more rapid progress in that direction than most Americans had thought possible, and the days of the American monopoly of atomic power were clearly numbered. The further fact that the Russians were at the same time developing long-range bombers capable of delivering a bomb half way around the world and returning home again meant that they would soon be able to do precisely what many Americans had come to fear -- to destroy New York or Chicago as the United States had destroyed Hiroshima and Nagasaki. In all probability the Air Force would have continued to seek an adequate air defense system anyway, even without the news of August 1949 (not made public, incidentally, until September 23<sup>3</sup>), but that news undoubtedly added impetus to its efforts. Almost immediately, General Vandenberg asked the Joint Chiefs of Staff to consider the problem. In response to an Air Force



request, the Bell Telephone Laboratories investigated the existing system and recommended some immediate improvements, while various high-level agencies, including the Weapon Systems Evaluation Group of the Office of the Secretary of Defense and the Air Force Scientific Advisory Board, addressed themselves in earnest to the quest for a more adequate system.<sup>1</sup>

On November 8 Dr. Valley, then a member of the Scientific Advisory Board, proposed that the board establish "a small group of experts drawn from the New York-Boston area" to look into the matter. Thus was formed the so-called Valley Committee (originally entitled the Technical Air Defense Committee and later renamed the Air Defense Systems Engineering Committee). Five of its eight members were also members of the MIT faculty: in addition to Valley himself, there were Charles S. Draper, head of the Department of Aeronautics and Astronautics and Director of the Instrumentation Laboratory; H. Guyford Stever, then Assistant Professor of Aeronautics and Astronautics; Henry G. Houghton, head of the Department of Meteorology; and W. Hawthorne, a specialist in aircraft propulsion. All five were also on the Air Force Scientific Advisory Board, as was another member of the committee, Allen F. Donovan of the Cornell Aeronautical Laboratory. The two other members were George Comstock of the Airborne Instrumentation Laboratory and John W. Marchetti, Director of Radio Physics Research at the Air Force Cambridge Research Laboratories.<sup>2</sup> The last-named organization, then situated a few blocks from the MIT campus at 224 Albany Street, Cambridge, provided a conference room where the Valley Committee held its first meeting on December 27, 1949, and its subsequent (usually weekly) meetings through 1950;<sup>3</sup> and, in July, created out of its own resources a small temporary staff to conduct such "research, development, and engineering activities"

as the Valley Committee might request.<sup>1</sup>

Although the committee was at work throughout most of 1950, it managed to define its approach by April. The question was how to detect and track hostile aircraft, manned or unmanned, and there were several reasons for doubting whether the existing system that Saville's staff had rather hurriedly devised would be equal to its task in a real emergency (or that Saville's staff thought it would be). It relied on a few large radars that could scan the air space over a considerable distance but, because of mountains and the curvature of the earth, left a great deal of low-altitude air space unmonitored. The Valley Committee favored a large number of small radars so distributed as virtually to eliminate the low-altitude problem, and believed that it might be possible to design a comparatively inexpensive radar that could be mass-produced and that could be left unattended for a month or so at a time. (These were sometimes referred to as "telephone-pole radars," and, as it happened, were never developed.) Even more disturbing was the fact that very little of the existing system was automated. Communications from radar station to control center and from control center to interceptor forces were by voice, and so many steps from detection to interception had to be accomplished by human agency that the whole process was unacceptably slow and offered maximum opportunity for confusion and blunder. Valley and his colleagues wished to automate the entire sequence except for the critical decisions that would have to be made at the control centers. Raw radar data would be automatically converted at the unattended sites into a form in which it could be transmitted over telephone lines to a "data analyzer," of which there would be one for every few radars, there to be further processed and simplified, again automatically, and transmitted by other telephone lines to an "area control center." The area controlled

by a single center might be two or three hundred miles broad -- about the size of the "sector" of the Semiautomatic Ground Environment (or "SAGE") system that would eventually emerge as a result of the Valley Committee's ideas. The center would continuously receive semi-digested data from all parts of its area; would immediately and automatically reduce those data to meaningful information such as the position, speed, and direction of a moving aircraft; would somehow distinguish friendly from hostile aircraft; would display the significant parts of this information in such a way as to yield a readily comprehensible picture of the moving situation throughout the area; and would also be able, at the touch of a button, to formulate the details of any desired command and relay that command immediately to the appropriate interceptor aircraft.<sup>1</sup>

The committee's final report, in October 1950, was written in a philosophical vein. It added no significant technical ideas to those already advanced in the preliminary report six months earlier, and is of interest chiefly because it expressed a point of view about systems -- a point of view which was certainly in harmony with that of the engineers who later developed SAGE and still later formed the nucleus of the technical staff of the MITRE Corporation, and which may have been an influence on them. It asked the reader to think of an air defense system (or any comparable system, for that matter) as an organism, much as a vertebrate animal is an organism. It identified six functional components of an organism, of which five (sensors, analyzers, judgment, directors, and effectors) operate sequentially and the sixth (communications) links the others. A viable organism -- and this might be an individual, a small-scale organization such as a boss and his secretary, a "two-bit mail-order house," "Caesar's army," or something really complex like a national air defense system -- might have a variety of

faculties for the receipt and interpretation of information (sensors and analyzers) and for the execution of decisions (directors and effectors), but must have only one brain or judgment faculty. Efficiency in serving the judgment faculty, moreover, is the criterion by which to evaluate the other faculties. Thus the Valley Committee concluded that "it makes little sense for us to strengthen the muscles if there is no brain, and given a brain, it needs good eyesight," and condemned the existing air defense system as "lame, purblind, and idiot-like."<sup>1</sup> Although all functional components of an effective air defense system needed attention, moreover, the committee was inclined to regard the "command center," the locus of judgment, as the most critical:

While questions of economy entered into our discussions of ideal radars and data analyzers as well as the dominant question of operational capability, only the latter can be considered under this [command center] heading. Our discussion of other organisms shows that important decisions are only made at central headquarters in the light of the big picture. If we believe, as we do, that we should design the Air Defense System on lines proven successful in many other fields, then certainly this important function must be centralized.<sup>2</sup>

It may seem that the committee was belaboring the obvious, but the subsequent history of the development of SAGE and much of MITRE's experience tends to show that the point always needs emphasis.

\* \* \*

What the Valley Committee did was not to elaborate the details of an air defense system, but to form a general conception of what such a system should be and to make such preliminary investigations of foreseeable problems as it needed to make in order to satisfy itself that what it was

proposing was feasible. Could the desired kind of radar be developed, and how might irrelevant and confusing data be screened out? Was it indeed feasible to rely on telephone lines for communication links, and, if so, how might radar information be processed for telephone-line transmission? How might the tremendous volume of data that would pour into the area control centers be assimilated and displayed in comprehensible form, and how might instructions be formulated in a manner suitable for electronic transmission to interceptor forces? In a word, how might the whole train of events from detection to interception, except for the decision of the operator manning the display console, be made automatic and virtually instantaneous? Obviously, it would take a few years of organized research and development to resolve such questions, but the committee had reason to feel that it was on the right track. It was confident that the MIT community had within itself, or could obtain, the needed expertise in radar technology. To create an entirely new communication system especially and exclusively for air defense would be prohibitively expensive, but there seemed to be no insuperable technical obstacle to the use of leased telephone lines. Professor Valley discussed this last point with Donald Quarles, then a Vice President of the Bell Telephone Laboratories, and obtained an informal understanding that the telephone company would cooperate; and General Saville managed to overcome Air Force objections to such an arrangement.<sup>1</sup> As for the data-processing problem, the committee came across a pioneering venture in computer development which seemed to promise a satisfactory solution. Well before the committee submitted its final report, it had every reason to think that the technical difficulties, although formidable, could be overcome.

Electronic computers of both the analog and the digital variety existed in 1950, but computer technology was still in its infancy and there

was as yet no computer industry. The analog computer, although at one time considered for radar tracking, could not have been used for centralized control.<sup>1</sup> Successful digital computers could still be counted on the fingers of one hand, and most of them were mathematician's toys, designed to solve extremely complex equations but not to accommodate the volume of data the Valley Committee had in mind or to process it at the necessary speed.<sup>2</sup> As it happened, however, there was a machine, then in an advanced stage of development, which did offer some prospect of being able to do the job. It was not very far away, and yet came close to being overlooked. Some years later Professor Valley recalled a chance conversation he happened to have with an MIT colleague, Professor Jerome B. Wiesner, toward the end of January 1950, when he fell to discussing his undertaking on behalf of the Scientific Advisory Board and mentioned that he was looking for something that might serve as an information gathering and correlating center adequate to the demands of air defense. Wiesner suggested that it might be worth his while to talk with Mr. Jay W. Forrester, who for the past few years had been in charge of a team of MIT engineers who had been designing, building, and perfecting an interesting and then novel kind of digital computer in the Barta Building on Massachusetts Avenue a short distance from the MIT campus.<sup>3</sup> Valley not only talked with Forrester but was sufficiently impressed to ask for a conducted tour and demonstration of the Whirlwind computer, as it was called -- a "bread board" model, the components of which were distributed around the building in such a way as to facilitate access. The results were encouraging. Within a month or so the committee was satisfied that the discovery of Whirlwind was a long stride toward the solution of the computer part of the problem, and was ready to seek Air Force funding to enable Forrester and his colleagues to continue their work.<sup>4</sup>

Project Whirlwind was a Navy-funded effort which the MIT Servomechanisms Laboratory, under Professor Gordon S. Brown, had undertaken toward the end of 1944. The original objective was to develop a flight trainer and aircraft stability analyzer -- a device for facilitating the training of pilots and also for predicting the aerodynamic characteristics of a new and untried air frame before the air frame was built. Part of the task was to calculate the way various forces would act on an air frame of given characteristics so that a mock cockpit could be made to simulate the resulting motions, and Forrester, a former graduate student whom Brown had asked to take charge of the project, soon concluded that an analog computer would not be practicable and turned to the digital principle instead. He therefore launched his section of the Servomechanisms Laboratory on the designing and developing of a digital computer of larger information storage capacity than had yet been attempted, and one which would operate in "real time" -- i. e. , would process the data fed into it fast enough to permit the analyzer to simulate realistically the motions it was supposed to simulate. Moreover, because the machine would have to sustain such simulation for extended periods without interruption and without error, the Whirlwind people found themselves involved in a great deal of painstaking effort, unavoidably expensive and time consuming, to make the components of their computer, especially the critically important vacuum tubes, as reliable as possible, and also to incorporate error-detecting devices into the design of the computer.<sup>1</sup>

So engrossing did this digital computer become that by 1947 or 1948 the trainer and analyzer machine was virtually forgotten and Forrester and his colleagues were frankly engaged in pioneering toward a "general purpose" computer -- to the increasing distress of the Office of Naval Research, which grumbled about the mounting expense and the apparent endlessness of the

project, continued for a while to allot sums which it regarded as enormous even though they were substantially less than what Forrester had requested, and then, in 1949, began to force the project back to what it regarded as a more reasonable level of expenditure.<sup>1</sup> The Whirlwind people, meanwhile, were already aware that their computer, if ever perfected, would have many potential uses besides the ones for which the Navy considered that it was paying, and as early as 1947 had begun to prepare occasional reports outlining some of these other uses in the hope of attracting financial support from sources other than the Navy. In conjunction with radar, for example, a Whirlwind-like computer could track moving aircraft, and thus could be applied to air defense or to air traffic control.<sup>2</sup> In the one case, it would be a matter of detecting and tracking an aircraft or other moving object in the sky so that something else could be set on collision course with it; in the other, of doing the same thing in order to be able to issue navigational instructions to avoid collision. Much the same equipment and techniques would be necessary for either purpose. Indeed, as the MITRE Corporation was destined to argue about a decade later, there was no good technical reason why a single system might not serve both purposes at once. When Valley was introduced to the Whirlwind computer in January 1950, therefore, he encountered a group of engineers who were already somewhat acquainted with the data-processing part of his problem. They did not have a ready-made air defense computer, but they had already accomplished a great deal of pertinent research and development that would not have to be repeated, and the bread-board machine they had constructed in the Barta Building later proved useful as a part of a test facility for developing the air defense system that emerged from the Valley Committee's recommendations.

Forrester was destined to play an important part in the development of this air defense system, later known as SAGE, and so was most of the



team of engineers with whom he had surrounded himself -- including his principal assistant, Mr. Robert R. Everett. He would drop out of the story about two years before the creation of the MITRE Corporation, but Everett would join the Corporation in 1958 as its Technical Director, eventually becoming its President, and would bring with him the Corporation's original nucleus of technical personnel, several of whom had begun their professional careers, as he had, in the Servomechanisms Laboratory and would later look back on their Whirlwind experience with some nostalgia. Project Whirlwind had been no ordinary experience. From the viewpoint of some members of the Mathematics Branch of the Office of Naval Research, which funded it from 1947 to 1950, it was an exasperating story suggesting that Forrester and his associates either did not fully understand what they were doing or were financially irresponsible or both. To these Office of Naval Research people it seemed that the Navy ought to get what it was paying for, an aircraft stability analyzer and flight trainer, without undue expense or delay; but the original cost estimates had proved far too low, revised estimates were also insufficient, and the anticipated completion date kept receding into the future. Forrester, it seemed, had no serious intention of producing the analyzer and trainer, or at any rate was not behaving as though he recognized an urgent moral obligation to produce one, but was simply playing with an intricate toy at public expense. To make matters worse, he had succeeded for several years, with the assistance of Mr. N. McL. ("Nat") Sage, director of the MIT Division of Industrial Cooperation, in frustrating every effort of these stewards of the taxpayer's substance to bring him into line, and even in answering their questions in such a way as to make them feel like fools. But Forrester himself and his principal associates saw things in a very different light. They believed, in the first place, that it would not be possible to analyze the aerodynamic characteristics of a new model of aircraft with

the desired degree of precision and certainty, or to perform any other task of comparable complexity, until their computer or something like it was completed. Far from wasting either time or money, they considered that they were doing what someone would have to do sooner or later, and doing it in what they confidently believed would prove to be the most intelligent way. If Forrester was less than contrite about the fact that he was making the Navy pay for more than it had asked for, it was because he had persuaded himself that, in the process of helping the Navy solve certain specific problems in which it was then interested, he was also, in effect, solving hundreds of other data-correlating problems, some of which had not yet been thought of but soon would be -- all this at a substantial net saving to the taxpayer in the long run.<sup>1</sup>

Now, it is a good feeling to see oneself as doing things, not because they are required in a contractual statement of work, but because they are intrinsically sound from a professional point of view. Most people like to be able to think that they do what they do because it is right rather than because it is required of them by some agency of which they are not a part, and whoever helps them to form this self-image gives them an esprit de corps that can make them collectively a truly formidable force. Forrester apparently had some such effect on the Whirlwind team, and the Whirlwind team seems to have similarly affected the larger group that created SAGE and, still later, joined the MITRE Corporation. Thus, Project Whirlwind is important to the story of MITRE not only because it made an important contribution to SAGE, which in turn provided the context for the creation of MITRE, but also because it was the germ of that group character that gave MITRE its initial distinctive flavor.

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In December 1950, only a few weeks after the Valley Committee submitted its report, General Vandenberg wrote to President Killian formally requesting MIT to establish a permanent laboratory for research and development relating to air defense.<sup>1</sup> A month later the Air Force Scientific Advisory Board seconded this request and also asked MIT to set up a short-term study group comprising the country's best scientific talent to appraise all facets of the air defense of North America and make suitable recommendations.<sup>2</sup> It was not only the Valley Committee that had prompted these moves, for the Weapons Systems Evaluation Group had seen simultaneously and independently studying the air defense problem and had come to much the same general conclusions. By the winter of 1950-51 there was not much doubt at the highest levels of the Air Force that WSEG and the Valley Committee had pointed to the most promising line of attack, or that MIT was the place where it could be most effectively pursued; and MIT acceded to both requests. The study effort, Project Charles, was under way in February and produced a voluminous classified report the following August. The MIT community was heavily but not exclusively represented on its panels, and its chairman was Dr. F. Wheeler Loomis, then on leave from the University of Illinois.<sup>3</sup> Meanwhile, the MIT Board of Governors addressed itself to the matter of a permanent air defense laboratory to be funded by the federal government but staffed and directed by MIT. It was agreed that the laboratory should be built on federally owned land in Lexington on a hillside overlooking Hanscom Field, that it might accept work under contract from any of the three armed services (i. e., it would not be completely tied to the Air Force), and that it would be guided by a Joint Service Advisory Committee representing the three services. Thus, the first charter of what was initially known as

Project Lincoln was mutually accepted and adopted in July 1951, and the project itself, with Dr. Loomis as its initial director and Professor Valley as one of the assistant directors, began to be organized in temporary quarters in Cambridge while its permanent home in Lexington was under construction.<sup>1</sup> The first of the Lexington buildings was completed and occupied in April 1952, at which time the project was officially redesignated as "the Lincoln Laboratory, Massachusetts Institute of Technology," but it was not until 1954 that the organization could concentrate all of its elements in Lexington and dispense entirely with temporary quarters in Cambridge.<sup>2</sup>

The Lincoln Laboratory was never solely concerned with the detection and tracking of hostile aircraft and the guiding of interceptors to their targets. Especially from the mid-nineteen-fifties on, it also addressed itself to other problems that had some bearing on air defense, such as the development of radars and radar techniques for the penetration of outer space and thus for the detection and tracking of ballistic missiles. As early as the summer of 1952 it sponsored the Summer Study Group, which concluded that, in addition to the system proposed by the Valley Committee, there was need for advance warning of bombers approaching via the Arctic, and which therefore recommended that chain of radar stations extending across the entire Arctic fringe of the continent that materialized a few years later as the Distant Early Warning Line.<sup>3</sup> At first, however, most of the Lincoln organization, including the whole of Division 2, "Aircraft Control and Warning," headed by Valley, concentrated on the immediate problem, which included both the engineering of "quick fixes" of the existing air defense system and the development of the more ambitious system that the Valley Committee had contemplated.<sup>4</sup> In order to test the feasibility of data transmission by telephone lines, it leased a number of long lines (including one from Lexington to San Francisco and

back again via Dallas) and proved, to the telephone company's embarrassment, that there would have to be some improvement of long lines as well as development of coding and decoding devices before radar data could be transmitted in this way to a central computer.<sup>1</sup> Division 2 erected and operated some twelve radars within about a hundred miles of Cambridge, including a long-range radar near South Truro on Cape Cod, to detect and track Strategic Air Command bombers on simulated attack missions within an area approximately equivalent to that of the later SAGE "sectors." The data were transmitted to the computer in the Barta Building, which thus served as a makeshift direction center.<sup>2</sup> This "Cape Cod System," as it was called, had been proposed originally by Project Charles as a test bed to assist the development of an air defense system. In its original form, it was in full operation by the autumn of 1953.<sup>3</sup>

Even as Project Lincoln was being organized in 1951, the Whirlwind group began not only to adapt its existing computer to the requirements of the Cape Cod System but also to design what it at first called the "Whirlwind II" computer for the air defense centers. For the latter purpose it secured the assistance of the International Business Machines Corporation in 1952, and, a year later, caused IBM to be awarded a contract for the production of the computers that would eventually be installed in the air defense centers.<sup>4</sup> Since this Whirlwind enterprise was already quite effectively organized, there did not at first seem to be any need to create a computer division in Project Lincoln. At about the time of the inception of Project Lincoln, moreover, MIT had detached Project Whirlwind from Professor Brown's Servomechanisms Laboratory and made it a "laboratory" in its own right, the Digital Computer Laboratory, with Forrester and Everett as director and associate director respectively, and there was something to be said for letting well enough

alone. But, because the work of the Whirlwind group and the new Lincoln group needed to be closely coordinated, the Project Lincoln Steering Committee found it necessary by October 1951 to ask Forrester and Everett to attend its meetings, and, before the end of the month, decided that it might be better after all to transfer Forrester and Everett and the greater part of their staff (the part which had already begun to work on the new computer) to Project Lincoln, there to constitute Division 6, which was accordingly created as of the first of the new year.<sup>1</sup> There continued to be an MIT Digital Computer Laboratory to operate the original Whirlwind and to discharge the remaining contractual obligations to the Office of Naval Research, and Forrester and Everett continued to be in charge of it at the same time that they were head and associate head of Division 6. Since Division 6 did not move to Lexington until 1954, the entire Whirlwind team, although now organizationally divided, remained together in Cambridge for another two and a half years, and never entirely lost its sense of group identity.<sup>2</sup>

During the course of 1952 Project Lincoln (the "Lincoln Laboratory" after April) carried its labors to the point that it was confident of being able to overcome technical difficulties and develop the electronic ground environment it had set out to develop. Toward the end of the year Divisions 2 and 6 began to draft a formal proposal for what they called a "transition system" for air defense pending the development of the ultimate system they had in mind, and the Laboratory issued their proposal as Technical Memorandum 20 on January 2, 1953.<sup>3</sup> Like the Valley Committee, the authors of TM 20 wished to divide the country into "air defense sectors," and, although they did not indulge in similes, they intended that each sector should be able to react as, so to speak, a single organism. Except for coding for telephone line transmission, they did not propose to process data at radar sites, but

rather to pass it on automatically and in toto to computers in central locations where the significant processing and analysis would occur. They did not, however, call for the Valley Committee's "telephone pole radars" or any like means of achieving complete radar coverage of a sector from a large number of closely spaced radars. Instead, they recommended, as an interim expedient, a few large radars of an existing type, supplemented by low-altitude "gap-filler" radars, arguing that

The Charles Report recommendation that new radars are needed for coverage above and below the altitudes covered by present sets does not mean that new radars are necessary before the filter and control equipment in the Transition System can be effectively used. Improved data processing and improved radar sets are two very separate improvements in the Air Defense System. We can have the better data processing without new radars. We cannot, however, have many closely spaced radars without improving the means of superimposing and coordinating the data from them. The improved data center must come first.<sup>1</sup>

Since the destruction of a data processing center or even the temporary malfunctioning of its computer could cripple the system throughout a sector, TM 20 also recommended three computers per sector, each in a different location and capable of handling data from all parts of the sector, adding that

In emergencies normal operations can be sustained with two computers, and effective but somewhat reduced performance with one. Only narrow-band phone-like connections are needed between computers, so that the centers can be separated for security against damage.<sup>2</sup>

But the Air Force had still not committed itself to any of this, and there were rumors that it had decided to adopt a competing approach to the air defense problem then being developed at the University of Michigan's

Willow Run Research Center. The Willow Run system (officially entitled the Air Defense Integrated System for Surveillance and Control, or ADIS) had been initiated in 1951 under a Wright Air Development Center contract, and was the outgrowth of still earlier work at Willow Run. It was a decentralized system which, had it been completed, would have made each radar site a separate data processing and weapon control center -- precisely what the Valley Committee had considered an unworkable solution.<sup>1</sup> President Killian decided to bring the question to a head.<sup>2</sup> Writing to Secretary of the Air Force Thomas K. Finletter one week after the publication of TM 20, he asked for a technical review and evaluation of the Lincoln program and indicated that, if the Air Force was not satisfied, MIT would be happy to withdraw from the whole effort. Within a matter of days Finletter, although then a "lame duck" Secretary, wrote a reassuring reply, and the next few months produced a definite decision in favor of Lincoln. On May 5, 1953, the Air Research and Development Command announced that only the Lincoln Transition System would be pursued and that support of the Willow Run effort would be discontinued.<sup>3</sup>

In thus deciding in favor of Lincoln and against Willow Run, the Air Force was indicating a general confidence in Lincoln but was not necessarily committing itself to all of the details of the Transition System. On May 28, about three weeks after the decision was announced, General Nathan F. Twining, then Air Force Vice Chief of Staff, wrote to Dr. Mervin J. Kelly, President of the Bell Telephone Laboratories, asking for BTL's help in the technical review of the Lincoln program that Killian had requested, and also for some broader technical advice concerning the development and installation of an evolving air defense ground environment.<sup>4</sup> BTL was inclined to favor a compromise between the extreme decentralization of the Willow Run system (to which, however, it did not specifically refer) and what it



regarded as the dangerously excessive centralization of the Lincoln system. Its report of December 17, 1953, apparently in response to Twining's request, was comparable to the Valley Committee reports in that it attempted a fresh look at the whole ground environment part of the air defense problem. While it did not employ Valley's "organism" simile, it did identify sequential functions -- which, however, were not identical with Valley's sequential functions. What it called "observation" apparently corresponded to Valley's sensing and analysis functions together (not only the collection but also the analysis and interpretation of radar data), and it held that this observation function in its entirety should be performed at the radar sites. It agreed that the "command" function, which may be equated with Valley's "judgment" function, belonged in a computerized data-processing center, but would have fed that center with data already screened, partially processed, and much reduced in volume at the radar sites. Its "guidance" function obviously corresponded to Valley's direction function (i. e. , the formulation of the details of intercept instructions), but it would have had this function performed, not by the data processing center, but by the interceptor squadrons at their respective bases.<sup>1</sup> By the time this report was received, Lincoln was already at work developing its Transition System, evidently with full Air Force approval, but the report nevertheless recommended that "Lincoln should undertake at a high priority the development of a decentralized or smaller Transition System." Lincoln, however, was not inclined to change its course, nor, apparently, did the Air Force wish it to do so.<sup>2</sup>

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In 1953 the thought was that the combination of large radars, gap-filler radars, leased telephone lines, coding and decoding devices, and real-time digital computers contemplated in Technical Memorandum 20 and called the

Transition System would serve as a half-way house on the road to something else -- presumably, to the system that had been sketchily envisioned by the Valley Committee and Project Charles. It soon became clear, however, that the latter was a remote and problematical thing, mainly because there was no immediate prospect of developing a new kind of radar especially for air defense, and that the Transition System, which would use existing radars, would be the system of the foreseeable future; and it was apparently for this reason that in the summer of 1954 the term "Transition System" was abandoned in favor of the "Semiautomatic Ground Environment" or "SAGE." <sup>1</sup> The new designation avoided the implication that there was another more advanced system in the immediate offing and recognized that what Lincoln was developing was not a complete air defense system but only a part of such a system; but it, too, was misleading because it suggested, incorrectly, that the projected system would include radars -- which, after all, are as much a part of a "ground environment" as computers and telephone lines. Misleading or not, "SAGE" became the official name of the system, and the Air Defense Command's SAGE Operational Plan, published in March 1955, specified that this system would include only the data-processing centers, the coding devices at the radar sites, and the communication lines from radar sites to data-processing centers and from thence to the weapon systems. In terms of the Valley Committee's simile, SAGE was not a complete air defense organism, but only its analyzer, judgment, director, and communications components. Sensors (radars) as well as effectors (weapon systems) were treated as related but separate systems, so that the SAGE part of the air defense job would begin at the radar sites with the conversion of data from non-SAGE radars into a form suitable for telephone-line transmission to the SAGE centers, and end with the transmission of precise instructions to the operators of interceptor aircraft or missiles. <sup>2</sup>

Until the appearance of the SAGE Operational Plan early in 1955, Lincoln was primarily engaged, in conjunction with the Air Defense Command and the principal private contractors involved, in working out the detailed design of this system and establishing the configuration that that plan described, and its principal tool for the purpose was the test bed which it called the "Cape Cod System." The test bed, of course, had to be modified from time to time as the conception of the projected air defense ground environment changed. Since the original conception had called for a large number of closely spaced radars, the Cape Cod System that Lincoln began to build in 1952 was to have embraced twelve radar stations more or less evenly distributed throughout an approximate equilateral triangle extending from Hampton Beach, New Hampshire, to Nantucket and from there to East Killingly, Connecticut; but the decision to defer radar development until the data-processing part of the problem was mastered meant that, for the time being, only one radar station was really necessary. When the first version of the Cape Cod System was first operated successfully as a whole on September 30, 1953, it was based mainly on a large radar at South Truro on Cape Cod (an "AN/FPS-3," in Air Force terminology) with a useful range of about two hundred miles. All but one of the other radar sites were functioning by that time, but their radars were of a less powerful type and were used to simulate the gap-filler role.<sup>1</sup> Test results were monitored in the Barta Building, the Whirlwind computer serving as the data-processing element in the system. A Cape Cod test might be limited to the transmission of radar data, might be a means of checking out a computer program or of experimenting with display techniques, or might extend to the full simulation of an air battle. By prearrangement the Strategic Air Command would have one or more of its bombers fly within range of the South Truro radar, and the ultimate test was not only to track such a bomber accurately and in real time but also

to assign it as a "target" to one of two Air Defense Command squadrons (one at Hanscom Field, one at Otis Air Force Base) and vector the interceptor aircraft to the "kill." By 1954 Lincoln was ready to tackle the problem of programming Whirlwind so that, when the same "hostile" aircraft was being tracked through two widely separated radars, the resulting tracks on the display screen would coincide. For this purpose another radar, like the one at South Truro, was added at Montauk Point on Long Island, and the first successful operation of this enlarged version of the Cape Cod System occurred on November 15, 1954.<sup>1</sup>

It was in 1953 and 1954 that various private contractors began to figure significantly in the story. The International Business Machines Corporation, which had been helping Division 6 design an air defense center computer since 1952, received an Air Force contract in 1953 to manufacture and install the future SAGE computers. By July 1953 there was so much going and coming between Cambridge and the IBM plant in Poughkeepsie, New York, that there was talk of establishing regular chartered flights between the two points,<sup>2</sup> and IBM soon afterward opened an entirely new plant in Kingston, New York, for the actual production of these computers. Manufacture and installation of the critically important radar-data coding device, which had been designed by J. V. Harrington, one of the Division 2 group leaders, became the responsibility of the Burroughs Corporation.<sup>3</sup> High-level officials in the American Telephone and Telegraph Company and in its subsidiary, the Bell Telephone Laboratories, had had an interest in what Lincoln was doing from the beginning, and in 1954 the Air Force asked the Western Electric Company to design and construct the SAGE centers and provide certain services connected with the installation and checking out of SAGE equipment, whereupon the Air Force and Western Electric jointly,

with the participation of the Bell Telephone Laboratories, created the Air Defense Engineering Services (ADES) Project, with offices at 220 Church Street, New York.<sup>1</sup> Lincoln thus found itself in a web of sometimes delicate relationships. On the whole, these relationships were fairly harmonious, but those with the two telephone company subsidiaries, Western Electric and BTL, were characterized by what might best be called polite friction. In December 1953 BTL had urged the Air Force to redirect Lincoln's efforts toward a less highly centralized air defense system in which the tracking function would be performed at radar sites instead of in air defense centers, and, although its advice had been ignored, its skepticism remained. Partly for this reason, no doubt, Western Electric as early as June 1954, when ADES had been barely established, sought to delay the computer production schedule in order to allow time for field testing.<sup>2</sup> It was overruled, but it apparently remained on the lookout for opportunities to slow things down. In 1956, when the center-by-center computer delivery schedule had to be changed to provide time for retrofitting the SAGE computers with the enlarged memory that Division 6 had by that time perfected, it again urged a delay that Lincoln regarded as quite unnecessary.<sup>3</sup>

Toward the end of 1954, around the time when the second version of the Cape Cod System was completed and in use, the work on SAGE had progressed to the point that Lincoln had a fairly clear idea of the kind of air defense ground environment that could be created within the next few years, of the capabilities and limitations of this ground environment, and of what the work yet to be done would probably cost. The Air Defense Command, meanwhile, had weighed the various features that might be incorporated in SAGE both against air defense needs and against estimated costs, had recognized that the introduction of SAGE would have a certain impact on its

own organizational structure, and had decided upon such compromises as it deemed necessary or advisable. It was therefore possible to give SAGE its first definite configuration. Lincoln and ADC representatives drew up a detailed statement of this configuration, with the assistance of Western Electric, BTL, and IBM; and ADC headquarters issued it as the SAGE Operational Plan (sometimes referred to informally as the "Red Book") under the date of March 7, 1955.<sup>1</sup> Although this plan would be modified in several respects before the first SAGE center went into operation, and still further modified before the entire SAGE system was completed, it was one of the important landmarks in the story of the system's evolution.

First of all, the United States was divided for air defense purposes into eight sectors and thirty-four subsectors. It was the subsector rather than the sector which approximately corresponded in area to the "typical air defense sector" of Technical Memorandum 20. Sector and subsector headquarters were called, respectively, combat control centers and combat direction centers -- or, for brevity, "combat centers" and "direction centers." In Air Defense Command organizational terminology, the former were division headquarters and the latter wing headquarters. All of the combat centers and all but two of the direction centers (those in the Colorado and Wyoming subsectors) were to be automated. Instead of providing three geographically separated direction centers per subsector, as TM 20 had suggested, the plan specified that the thirty-two automated subsectors should each have one center with a duplex computer -- usually known by its Air Force designation, AN/FSQ-7. The two identical machines comprising an AN/FSQ-7 would be housed in the same building, and either of them alone could handle an air battle. Only one of them would be "active" at any given time; but the standby or "passive" machine, which would be receiving updated information from

the active machine at intervals, and would normally be engaged in such ancillary functions as checking out programs and generating reports, could quickly "dump" whatever it was doing and assume the active role in case of malfunction of the first machine. The problem of an air battle moving from one subsector to another was solved by placing radars so that each direction center could "see" a considerable way into adjacent subsectors, and also by having the direction center computers in adjacent subsectors "cross tell" parts of their data automatically. The role of the combat center was to monitor the activities of its subordinate direction centers (there were to be at least three, and in some cases as many as five, subsectors in a sector), and each combat center was also to have a duplex computer, the AN/FSQ-8, which would differ from the AN/FSQ-7 chiefly in its more modest terminal and display equipment, and which would be kept up-to-date by "forward telling" from the AN/FSQ-7s in the direction centers. The full and unimpeded functioning of this entire structure in a combat situation was what was called "Mode I" operation. If one direction center were destroyed or seriously crippled, the defense of the subsector would be assumed by the adjacent direction centers ("Mode II"), and, if those direction centers were also destroyed, the task would revert to the radar sites ("Mode III").<sup>1</sup>

With the basic SAGE configuration thus established, there was no longer a need for a make-shift test bed like the Cape Cod System, but there was a need for a prototype SAGE subsector, using SAGE equipment and techniques throughout, for "shake-down" testing. The Red Book therefore specified the creation of what it called the Experimental SAGE Subsector (later, Experimental SAGE Sector<sup>2</sup>), centering, not in the original Whirlwind computer in Cambridge, but in the simplex version of the AN/FSQ-7 (commonly called the XD-1) which International Business Machines installed

in the Lincoln Laboratory's Building F during the early months of 1955. Since the Red Book also specified that no new model of radar would be developed for SAGE but that the long-range and gap-filler radars already in Air Force inventory would continue to be used, the existing AN/FSP-3 radars at South Truro and Montauk Point could be incorporated in the Experimental SAGE Sector. As originally conceived, the sector was also supposed to include three other long-range radar sites -- one near Bath, Maine, one in New Jersey, and one in upstate New York<sup>1</sup> -- but the last two of these were never built. The Bath radar began to be erected in the winter of 1954-55, but it was more than a year before the Burroughs Corporation was able to install and check out the SAGE coordinate data transmitters (AN/FST-2) at Bath and South Truro. With only the Bath and South Truro radars in operation, the sector began to be used for shake-down testing on December 3, 1956, the Montauk radar being added toward the end of 1957.<sup>2</sup>

It was not just equipment that needed to be tested. The Air Defense Command would have to operate the combat and direction centers, and, in order to do so, would need to decide how its complement of personnel in the centers should be organized, what their exact functions and responsibilities should be in an air attack, what weapon systems would be available (how many, and at what precise locations), and how it might best adapt its own organizational structure and procedures in order to use SAGE effectively. Until these points were resolved, it would not be possible to program the computer, and the computer program was one of the things that needed to be checked out in the Experimental SAGE Sector. Lincoln's Division 6 would write a master program for SAGE computers, and add the coordinate data (exact location of radars and interceptor bases) pertinent to this sector; but a meticulous operations analysis is necessary before any computer program



can be written, and ADC would obviously have to participate significantly in the analysis of its own direction-center and combat-center operations. In order to gain the necessary working experience in the operation of such centers, none of which as yet existed, ADC established at Lincoln, about the time of the publication of the Red Book, the 4620th Air Defense Wing (Experimental SAGE), with a total staff of about fifty persons, mostly military. The wing incidentally served a liaison function with ADC headquarters (its commander reported directly to the ADC vice-commander), but its primary purpose was to engage with Lincoln in the part of the development process, especially operations analysis, which still remained after the Red Book was issued. It was therefore organized as a prototype SAGE wing, and one of its main contributions was to work out in detail the operational procedures and techniques that would later be adopted in the eventual SAGE wings.<sup>1</sup>

Because each subsector would have its own unique geographical distribution of radar sites, interceptor aircraft bases, and launching sites for the planned interceptor missiles, there would have to be a unique computer program for each direction and combat center. Programming all of the SAGE computers promised to be a major undertaking in itself, especially in the nineteen-fifties when there were still only a limited number of people versed in the arts of operations analysis and computer programming. The Air Defense Command, moreover, would have to find someone besides Lincoln to assume the bulk of this task because Lincoln was contractually responsible only to help bring the first SAGE module (the direction centers at McGuire and Stewart Air Force Bases and the Syracuse combat center) into successful operation, and was not interested in going beyond that. In 1955, therefore, it contracted with the RAND Corporation for all programming beyond the

first module, and RAND assigned the task to its System Development Division. In order to gain the necessary experience, the System Development Division undertook to help Lincoln prepare the first module programs, establishing for this purpose an office at Hanscom Field<sup>1</sup> -- housed, incidentally, in a compound of newly erected Butler-style buildings which, in 1958, would become the executive offices of the MITRE Corporation.<sup>2</sup> But RAND was no more interested in becoming permanently involved in this kind of activity than Lincoln was, and therefore arranged to have the System Development Division detached from itself and reconstituted as a new non-profit corporation. The System Development Corporation, with main offices in Santa Monica, California, and a branch office at Hanscom, was accordingly incorporated in California, in November 1956;<sup>3</sup> and, although it hoped eventually to establish itself in the whole field of system development, its principal initial task was to continue the writing and checking out of the SAGE computer programs. As it happened, SDC was even able to relieve Lincoln of some of the first-module responsibility. On October 1, 1957, when the complete initial version of the direction center active program (i. e., the program for the part of the AN/FSQ computer that would be directly engaged in combat operations) at McGuire had been installed, but when there was still work to be done on the Stewart and Syracuse programs, SDC assumed full responsibility for installing and checking out all remaining direction center programs.<sup>4</sup>

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On July 1, 1958, about a month before MITRE was incorporated, the first SAGE direction center, at McGuire Air Force Base in New Jersey, was ready for use with limited capability and was turned over to the Air Defense Command.<sup>5</sup> A great distance had been traversed in the eight

years since Professor Valley had assembled his committee, and the end was at last in sight. A boldly imaginative approach to air defense had been conceived, refined, adapted to various awkward circumstances, and brought to the verge of completion -- an approach which sought to weave several strands of electronic technology into an ordered fabric that would, in the Valley Committee's simile, function as a single organism. There was, to be sure, a difference between the system envisioned by Valley and his colleagues in 1950 and the system defined in the Red Book of 1955 and installed at twenty-odd locations throughout the United States from 1958 to 1961. Notably, the "telephone-pole radar" idea had been abandoned in 1952, and the long-range and gap-filler radars actually used were not designed by the Lincoln Laboratory but were "off the shelf" items obtained through normal Air Force procurement channels. In effect, SAGE, despite its name, was not even a complete ground environment, but only the data-processing part of that environment. It was, however, the most novel, and therefore the most critical, part of the air defense system for which the Air Force had been waiting, and it may seem in retrospect that eight years was an inordinately long time to make the Air Force wait, especially in view of the presumed urgency of the need. Other ground electronic systems, in some respects even more grandiose, were subsequently completed in much less time. Yet it was only because of Lincoln's pioneering work on SAGE that the development time for other systems, conceptually kindred to SAGE, could be compressed. In the nineteen-fifties, moreover, critics of SAGE were inclined to complain that Lincoln was proceeding with reckless haste. This was especially true of those corporate siblings, the Western Electric Company and the Bell Telephone Laboratories -- BTL having questioned as early as December 1953 whether such massive quantities of undigested data as would be generated in an entire sector could be satisfactorily

processed in a single center, and Western Electric having sought in 1954 and again in 1956 to slow down the SAGE implementation time table in order to permit more thorough testing.

But, although SAGE vindicated itself as a data-processing system, it continued to be criticized. Some of the criticism was preposterous and probably insincere -- for example, the complaint, often heard at Hanscom Field and probably on other Air Force installations during the four or five years after the Russian sputnik launchings in 1957, that SAGE offered no defense against ballistic missiles. People who talked that way (rarely or never did they make their case in writing) were usually hinting that someone behind the scenes had been deliberately swindling the taxpayer. Their reasoning (if "reasoning" is the word) was apparently that, because after 1957 it was suddenly recognized that the missile threat was quite real, therefore in 1953 the Lincoln Laboratory should have known enough to propose an anti-ballistic-missile system and not bother with an anti-manned-bomber system. The same people were inclined to point to the development of SAGE as a story of scandalous waste that could perfectly well have been avoided by sound system management -- meaning, apparently, that throughout the nineteen-fifties the Air Force had unaccountably neglected to apply the procedures which General Anderson's Weapon Systems Management Study Group (to be discussed later) proposed in 1960.<sup>1</sup>

This "boondoggle" theory does not deserve refutation, but it illustrates the tenor and quality of thinking (or non-thinking) in some parts of the Air Force after SAGE had become an accomplished fact and the Air Force's anxiety about the manned-bomber threat had diminished. It also goes to show how completely the essential SAGE concept had implanted itself in the minds of Air Force officers and civilian employees, men absorbed in

day-to-day administrative chores and not much inclined to ponder the long-term implications of programs in which they are involved. When such a person finally grasps a new idea, he is likely to forget how he acquired it and speak as though it were a self-evident truth that he and everyone else always knew. If he is then confronted with some fragment of the long and involved history of the evolution of the idea, he is likely to react with impatience and disgust. He does not see and does not care to be told that it is only through sustained struggle, punctuated with inevitable blunders, that any idea, even a seemingly simple idea, is ever conceived, refined, tested, refined again, and at last vindicated. He is sure he could have done it himself if only he could have found a spare half hour for the purpose, and prefers to think that all the toil and trouble and the retrospectively obvious false moves were the result of stupidity or deviousness or both. Thus, it is really a tribute to the success of SAGE that in some circles it came to be regarded as a "boondoggle."

Not all of the criticism of SAGE was as incompetent as this, however. More cogent was the contention that the system described in the 1955 Red Book and, with minor modifications, actually installed was much too vulnerable. The original idea had been that all SAGE centers should be situated in localities not likely to appeal to an enemy as prime targets and placed underground so that he would have to target them in order to remove them, but that would have involved considerable land acquisition and construction costs. Partly to save money, and partly because there seemed to be no point in "hardening" the centers unless the entire associated communications network were also hardened (astronomically expensive, since it would have precluded the leasing of lines from the telephone company and required the construction of an entirely new communications system extending to all parts of the country),

the Air Force opted instead for sturdily constructed above-ground buildings of standard design -- a four-story building for each direction center and a three-story building for each combat center<sup>1</sup> -- and decided to locate these buildings on land already owned by the government, preferably on existing Air Defense Command bases. When these bases later became Strategic Air Command dispersal bases, and thus prime targets, the effect was to place most of SAGE in double jeopardy: it was already a "soft" system, and now its destruction would be a bonus that would automatically accrue to a successful nuclear attack on the nation's second-strike capability.<sup>2</sup>

Those who argued this way were saying, in effect, not that SAGE had cost too much, but that it (or the air defense system of which it was a part) should have cost a great deal more than it did. Of course, if the Air Force in the nineteen-fifties had asked for the appropriations for a truly hardened SAGE, in addition to the gargantuan sums it was seeking and getting for other purposes, it might well have provoked a Congressional revolt that would have forced it to accept a drastic retrenchment -- in which case it might have ended with no SAGE at all. But, even though hardening may have been out of reach for budgetary reasons, it may nevertheless have been needed for military reasons. If the country had been attacked in such a way that it actually had to use its SAGE-centered air defense system, what could have happened? Would the soft system have enabled the Air Defense Command to destroy the enemy bombers before they reached their targets, thus demonstrating that hardening was unnecessary? Or would it have been quickly overborn and reduced to Mode III operation? For that matter, would a hardened system have done any better?

There never was a SAGE war, and for that reason a conclusive judgment of SAGE's value as a military system will be forever impossible.

Perhaps it should have been hardened. Perhaps, on the other hand, it should never have been attempted and something like the completely decentralized Willow Run system adopted instead. There were always those who held that the Air Force had made a mistake in 1953 when it rejected the Willow Run system in favor of the Lincoln system. A middle view was also possible, and this was advanced by the Bell Telephone Laboratories. Its report of December 17, 1953, mentioned above, raised a number of technical questions concerning the Lincoln Transition System, which Lincoln was able to resolve, but its most important criticism was that the direction centers, even if they could be made to function as desired, would still be vulnerable to direct attack or to sabotage. It did not discuss the possibility of hardening (which, anyway, would not have helped in the case of sabotage), but concluded that the Lincoln system was dangerously over-centralized, and therefore recommended that some important functions that Lincoln purposed to place in the direction centers be removed to the radar sites. Unlike the Valley Committee report of October 1950, it did not explicitly liken an air defense sector to an organism, but it might appropriately have done so. However, whereas the Valley Committee had envisioned a man-like organism with a single large brain in direct control of all functions, and with mere ganglia incapable of independent volition at the radar sites, and whereas the Willow Run system would have resembled a very primitive form of life with no central brain, the BTL organism would have been roughly comparable to the brontosaur, with a small brain in the head and another, semiautonomous brain in the spinal column. For the BTL idea contemplated that the radar sites would have computers of their own, so that they would not only process and screen data prior to transmission to the direction center but also exercise a limited discretionary function. The direction center would therefore enjoy only indirect contact with its own eyes and ears.<sup>1</sup>

Moreover, there was at least something to be said for the brontosaurus, and, indeed, for yet more primitive kinds of organisms. Military experience in the past, while clearly indicating the need for a command center or headquarters in general control of a wide area, also pointed to the importance of local field commanders who could exercise intelligent initiative and not be entirely helpless if cut off from headquarters. It is significant that the Air Defense Command, although placing considerable faith in the highly centralized SAGE, did not neglect to provide for the possibility that the direction centers might be destroyed and the people at the radar sites might have to take charge of the air battle (Mode III) -- a situation in some respects comparable to what the Willow Run system would have treated as the normal situation. The question, of course, was whether modern military technology had not so shrunk the sensor-to-intercept time span as to make the conventional military wisdom obsolete. It may well be that the kind of air defense system that BTL favored would have proved too brontosaurian to cope with a real emergency in the nineteen-fifties and -sixties, even if the emergency had involved manned bombers only and not missiles, and it may also be that under the same circumstances SAGE would have done very well; but, since there never was an emergency of this description, it is perhaps best to suspend judgment.

Whatever one may think of SAGE as a military system, its completion was an historic achievement. At the very least, it demonstrated something that had not been demonstrated before -- that a computerized command center could intelligently and almost instantaneously control complex operations throughout a wide area. Even before the time of the Valley Committee, the Project Whirlwind team had dreamed of a real-time general-purpose computer as the central and coordinating element in the conduct of various kinds of large and involved operations demanding both promptness and



precision; SAGE was the vindication of that dream. Nor was the SAGE principle applicable only to military problems. SAGE itself, to be sure, was a military system; moreover, it was the indispensable precursor of that whole family of other military systems ("command and control" systems, as they were called), the development of which the Air Force rather frantically instigated in the immediate post-sputnik era. But its very existence pointed to the possibility of applying its principle to any number of other tasks, non-military as well as military. Air traffic control is the example that comes immediately to mind, and it is true (as we shall see in a later chapter) that the federal government eventually rejected a proposal to make SAGE an air traffic control as well as an air defense system. What that decision reflected, however, was not a belief that it was impossible thus to combine the air defense and air traffic control functions, but a belief that in the long run, and for non-technical reasons, it might be unwise to do so. Still other possibilities suggest themselves. Cost aside, why might there not be a SAGE-like system for expediting ground traffic in a metropolitan area, or for handling mail or moving freight? The point is that, before SAGE had reached the shake-down stage, there was room for reasonable doubt whether complex and demanding tasks like air defense could be managed in a centralized way, whereas afterwards there was not. Afterwards, one might argue that a SAGE-like approach to such a problem was too expensive or that it was undesirable for some other reason, but one could scarcely say that it was beyond technological reach.

## CHAPTER III

### THE QUEST FOR A SYSTEM ENGINEERING CONTRACTOR

Nevertheless, SAGE was at the center of a serious problem in 1957 -- a problem that had arisen partly because the 1955 SAGE Operational Plan had defined SAGE, not as a complete air defense system, but as only the data-processing part of that system, and partly because the communications on which SAGE would rely were a Western Electric, not a Lincoln responsibility. It is easy to say now that there should have been some central technical authority -- a continuing Valley Committee, perhaps -- over the evolution of the entire system in all of its parts from the beginning, but that is hindsight. These arrangements, involving a division of authority, no doubt seemed natural and reasonable to many people when they were made. The total system, after all, was so large and complex that it had to be developed in segments, and, for development purposes, the data-processing equipment and procedures seemed a natural and manageable segment. In the end, however, the whole air defense train from radars to weapons would either become an integrated whole (the functioning organism of which the Valley Committee had spoken) or it would be nothing, and the SAGE engineers in Lincoln wanted to complete what they had begun. Although its contractual responsibility was limited to the development of a sound data-processing system, therefore, Lincoln began to be concerned, by the summer of 1955 at the latest, about the reliability of such peripheral systems as radars and communications links, and would soon demonstrate similar concern about the interface between SAGE and the various weapon systems that would have to execute SAGE-generated instructions. Around the middle of September Dr. Marshall G. Holloway, Director of the Lincoln Laboratory, received a

letter from a General Boyd of the Air Research and Development Command (a letter which Lincoln had solicited) asking Lincoln to "study model improvements in the SAGE System."<sup>1</sup> A month later, Admiral Cochrane, the MIT Vice-President in charge of relations with government agencies, Dr. Valley, then Associate Director of the Laboratory, and two Lincoln engineers concerned with SAGE communications met in Washington with Mr. Trevor Gardner, Assistant Secretary of the Air Force for Research and Development, at which time Gardner asked Lincoln to "set up a sort of Lamp Light [an earlier major study effort by Lincoln] to study SAGE, including deployment [of radar sites] and boundaries [of sectors and subsectors] and proposed telephone communication techniques."<sup>2</sup> What emerged was something less ambitious than another Project Lamp Light, but Gardner did ask Lincoln, with the assistance of the Air Defense and Air Research and Development Commands and the Western Electric Company, to look into various areas, especially communications, where SAGE might be improved;<sup>3</sup> and early in November Lincoln created for this purpose a "SAGE Improvement Committee" comprising W. B. Davenport (chairman), R. R. Everett, J. V. Harrington, and F. A. Rodgers.<sup>4</sup> The committee appears to have construed its mission broadly, addressing itself not so much to SAGE proper as to the need for a "new and realistic air defense system," and in February obtained the permission of the Steering Committee to establish a working group for an intensive study of this larger problem.<sup>5</sup>

Meanwhile, about December 1955 or January 1956 the SAGE people in Lincoln were beginning to be concerned not only about SAGE radars and SAGE communications but also about whether the various models of interceptor aircraft or missiles then in existence or under development would be satisfactorily responsive to SAGE-generated instructions. When the Valley Committee was at work in 1950, and for some time afterward, there had not

seemed to be any special difficulty about this. The original idea had been that the pilot would simply receive computer-generated instructions by radio and execute them, and, as long as the aircraft in question were of Second World War vintage, that was an entirely reasonable assumption. But, with the advent of newer and faster models of aircraft, it seemed less and less practical to try to "talk" the pilot to the vicinity of his target and much better to extend the automation sequence into the aircraft itself, so that, at least until just before the "moment of truth," the aircraft would be flown from the ground and the pilot would be just sitting there. The new fighter aircraft models that appeared in the 'fifties tended to automate more and more of the critical parts of the pilot's mission. Better yet, why not dispense with the pilot altogether, and also with the parsimonious idea that the interceptor vehicle is valuable and should return to its base to be used again? Why not let the interceptor vehicle be an unmanned and expendable guided missile and incorporate it wholly into an automation sequence that would begin with the radar signals and end with the "kill," interrupted solely by the human judgment of the man at the display console in the direction center? Even as Lincoln was preparing its Transition System proposal, the Boeing Company was at work on the Bomarc, an anti-aircraft missile originally intended for use in conjunction with the surveillance and control system being developed at Willow Run, and still other anti-aircraft missiles were in the offing around this time -- notably, the Army's Nike. Except for Nike, all of these new weapon systems were Air Force systems, and, once the Air Force decided in May 1953 to adopt the Lincoln Transition System rather than the Willow Run system, it was understood that all of them would have to be somehow integrated with and controlled through the Lincoln system -- or SAGE, as it was called after 1954.<sup>1</sup> But the integration problem did not become acute until it was time to write the SAGE computer master

program, for only then did it become immediately necessary to define the characteristics and intended use of a particular weapon with sufficient precision to write these data into the program, and that stage was not reached until near the end of 1955.

Since writing the master program was a Division 6 responsibility, it was Division 6 which first saw the need for a clear definition of the steps of the integration process, and Division 6 concluded that the difficult and time-consuming part of the process was not the actual writing of the program but the determination of the precise data concerning each weapon that would have to be incorporated in the program, and reasoned that only the weapon contractor was in a good position to provide those data. Close liaison between weapon contractors and Lincoln would, of course, be necessary, but Division 6 did not see how it could spare more than about ten of its own people for the purpose. On January 30, 1956, therefore, it outlined a general procedure which it hoped the weapon contractors would follow, arguing that

. . . weapons integration will progress most successfully if the planning, scheduling, and testing connected with the integration is established as a function to be carried out by the weapons system contractor. Planning the integration should begin early in the weapons development program to insure the earliest integration and the best possible exploitation of the combined characteristics of the new weapon and the SAGE System.<sup>1</sup>

Holloway promptly forwarded this Division 6 memorandum to the Air Force as a statement of Lincoln policy,<sup>2</sup> but, unfortunately, there were factors that militated against full cooperation. Nike, an Army rather than an Air Force weapon, was the most awkward case. Since part of the Army's motive in pursuing its Nike program was to resist what it regarded as Air Force encroachment on its anti-aircraft mission, it hardly cared to see Nike

subordinated to an Air Force-controlled ground environment and taking orders formulated in an Air Force computer. But Air Force weapon systems also presented problems. By the mid-nineteen-fifties it had become normal Air Force policy to manage the development and production of a major new weapon system through a "weapon system project office" representing the Air Research and Development Command, the Air Materiel Command, and sometimes the command that would use the system when completed.<sup>1</sup> At first glance it might seem that these project offices, which obviated some of the cumbersome inter-command coordination problems and which exercised considerable authority over both prime contractors and subcontractors, would have facilitated the obviously necessary business of integrating their respective weapons with SAGE, but they do not seem to have used their authority in this way. Even to study a specific integration problem cost time and money, and there were work schedules to be kept and budgetary limitations to be observed; and to act on the results of such a study might easily mean backtracking and undoing a great deal of work already accomplished. Besides, one needs to remember that SAGE had not yet proved itself in 1956 or even 1957, and was still the subject of a great deal of honest skepticism. If weapon-system people were loath to invest more than a polite modicum of sweat and tears in the integration effort, part of the reason may well have been that they simply did not believe that their respective weapons could ever be effectively controlled through SAGE.

Thus, it was not that any weapon system contractor or project office overtly opposed integration with SAGE, but rather that many of them behaved as though SAGE were a trying nuisance that had to be endured. Through the spring and summer of 1956, Lincoln sought to facilitate the process by offering SAGE orientation courses to weapon contractor personnel -- notably, to those working on the F-89H, F-89J, F-101B, F-102A, and F-104A aircraft

and on the Bomarc, Talos, and Nike missiles. Group 61 (System Design) of Division 6, in conjunction with contractor representatives, made preliminary studies of the integration problem in respect to a few of these weapons, and the Air Defense Command held a series of meetings to instruct all concerned as to the manner in which it purposed to employ specific weapons.<sup>1</sup> The results, however, were disappointing, as the following excerpt from an internal Lincoln assessment of the situation in September 1956 will attest:

Boeing has sent a group of 10 persons to Lincoln to become SAGE experts and programmers. The Air Force has subcontracted part of the BOMARC integration test to IBM to assist Boeing. Convair has one man in residence at Lincoln and has received contractual coverage from ARDC to send 8 or 10 more to work on the F-102A integration. Similar programs will be followed with respect to other weapons.

The approach which Boeing and Convair have taken to manning their integration efforts has been to select a few engineers who have some experience with the weapon system to back up the effort and to hire a group of new engineers to make up the bulk of the staff. The training with respect to SAGE has consisted to date of attendance at the IBM programmer training courses. Similar courses on the basic principles of aerodynamics, propulsion, guidance, and fire control will have to be set up by the weapon contractors. More detailed courses on specific weapon systems and SAGE may be required.

IBM have repeatedly said that they are interested in following and even contributing to this integration effort, especially as it reflects on the AN/FSQ-7 equipment requirements. RAND have said that they are anxious to make a major contribution to the computer programming for new weapons. However, neither of these organizations has made a significant contribution to date compared to the Lincoln eight-man effort in this area.<sup>2</sup>

Difficulties of this kind continued through 1957 and were not entirely overcome even by the end of the decade. They caused the Air Force to establish its Air Defense Systems Management Office during the summer of 1957 and,

less than a year later, to convert that organization into the Air Defense Systems Integration Division. They also constituted the heart of the problem without which it is unlikely that anything like the MITRE Corporation would ever have been created.

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Lincoln and the weapon contractors could study the integration problem, exchange information, conduct familiarization courses, and make recommendations, but only the Air Force (only the Office of the Secretary of Defense, in the case of Nike) could act on such recommendations. However, the Air Force, although firmly committed to the SAGE principle, could scarcely afford to make irrevocable decisions concerning the technical questions that the integration problem tended to pose without competent technical advice. Even then, it needed to feel a fairly unreserved confidence that its advisors had insight into the operational as well the purely technical implications of their advice. Where might such advice be found? It probably would not have been difficult to draw together a group of first-rate engineers representing all of the various engineering specialties involved, but such a group, if drawn from random sources and created artificially, would have been quite as helpless as any group of laymen in the face of a problem like this. What was truly needed was a team of engineers who were already thoroughly familiar with the problem -- and, hardly less important, thoroughly familiar with each other and used to working as a team. Obviously, the only team in existence that even began to meet these qualifications was that part of the Lincoln staff which had been actively engaged in developing SAGE. The SAGE engineers in Lincoln had no extensive knowledge of any of the weapon systems in question, but at least they knew SAGE, which was the common factor in all air defense system integration problems,



and, having wrestled not only with technical details but also with the concept of operations in the direction and combat centers, could readily perceive the impact that a weapon integration decision might have on those operations. Moreover, they were the only group of engineers anywhere who were not inhibited by doubts about SAGE, and who might therefore be expected to apply themselves to the integration task not only dutifully but with conviction.

But, although several people, both in the Air Force and in the Lincoln Laboratory, had come around to this conclusion by the spring or summer of 1957, Lincoln's original position was that of the Division 6 memorandum of January 30, 1956 -- that each weapon contractor should assume primary responsibility for integrating his weapon with SAGE and that Lincoln itself should offer only limited assistance. Indeed, not everyone in Lincoln even cared to see the Laboratory become more deeply involved in any part of SAGE, and it may be that Cochrane and Valley were reflecting this reluctance when, in October 1955, in response to Trevor Gardner's request for a SAGE study on the scale of Project Lamp Light, they "took the position that many of these matters are ADC or Telephone Company business and questioned the value of SAGE study by Lincoln."<sup>1</sup> The Steering Committee was already looking forward to the end of the SAGE involvement, and at its October 31 meeting, after it had discussed Gardner's letter and agreed to establish a SAGE Improvement Committee, Forrester, still head of Division 6, advised that "Lincoln should withdraw from its present position of systems responsibility after the first few installations" [i. e., after it had met its contractual responsibility to see the first module of the system, comprising the McGuire and Stewart direction centers and the Syracuse combat center, into satisfactory operation].<sup>2</sup> He forecast that "the SAGE effort should reduce to about 20% of the laboratory in about 2 years," and noted

that "a serious problem arises in determining new programs for personnel freed from the SAGE effort."<sup>1</sup> His colleagues tended to agree with him, taking the view that in the future Lincoln ought to avoid system engineering insofar as possible and concentrate on research and development. Their real reason, however, was probably not so much a snobbish belief that research and development is somehow more virtuous than system engineering as an awareness that SAGE stood in the way of some other projects that they hoped to be able to undertake -- notably, an Air Force-sponsored anti-intercontinental-ballistic-missile program. Since either the Steering Committee or the MIT administration or both had decided that the Laboratory should not become any larger than it already was, the Laboratory would not be free to accept an AICBM assignment unless it could arrange to reduce its SAGE involvement drastically and fairly rapidly.<sup>2</sup>

By January 1956, at any rate, it seems to have been fairly well understood all around that Lincoln would divest itself of most of its SAGE responsibilities as soon as decently possible. The revised Lincoln charter of January 11 did not quite forbid system engineering, but clearly contemplated that Lincoln would engage primarily in research and development, and further provided that, if any of the three sponsoring armed services should ask it "to assume a formal status with regard to any specific equipment or system under development, design or production," it retained the right to decline to do so.<sup>3</sup> The Joint Services Advisory Committee, which represented the armed services in respect to Lincoln, agreed at its January meeting that

. . . Lincoln should plan on phasing out of this program [SAGE] as soon as the commitments undertaken by Lincoln are satisfied and as soon as the Air Force establishes a capability to take over these programs. It was further agreed that the Air Materiel Command and the Air Research and Development Command should get together with Lincoln to draw up a plan for the

phase-out of Lincoln and also the training of adequate Air Force personnel to take over these functions.<sup>1</sup>

In the ensuing correspondence Dr. Valley, Lincoln's associate director, suggested to Colonel Albert R. Shiely, Jr., then in charge of the ARDC contingent in the Air Defense Engineering Services Office in New York, that the Air Force should, among other things, "designate an agency to manage [emphasis in original] the integration of SAGE with the present defense system," reiterated Lincoln's policy regarding future work on SAGE, and added the interesting observation that

What worries us is that we foresee new problems arising in the SAGE System which are not R&D, but which only Lincoln at present is capable of tackling by virtue of knowledge and background; and which in actuality even Lincoln cannot do because of limitations of manpower, supervisory staff, and material resources.<sup>2</sup>

This last may be read in two ways. On the surface, it seems to mean that Lincoln not only foresaw new problems "which are not R&D" but feared lest someone get the crazy idea that Lincoln was the logical organization to tackle them, and therefore wanted the Air Force to designate some agency other than itself to undertake this work. The observation that Lincoln lacked the "manpower, supervisory staff, and material resources" for the purpose would thus be a way of saying that, despite its admitted "knowledge and background," it was quite unsuited to the task. Yet, if one wished to plant an idea in certain Air Force minds, and to do so in such a way as to make it appear that the idea had originated in the Air Force, could there be a better way of going about it? And was there not a motive for making it so appear? As long as there were in the offing some tempting research-and-development projects that could be managed under the established staffing and budgetary ceilings only if the SAGE effort were considerably

reduced, and as long as those ceilings were accepted by the Air Force, by MIT, and by Lincoln itself as virtually fixed, the Steering Committee could hardly help favoring a policy of disengaging from SAGE, and the natural and obvious rationale for such a policy was to assert that Lincoln ought to remain (or become) primarily a research and development rather than a system engineering organization. But suppose that the Air Force were not only to ask Lincoln to engineer the needed improvements in SAGE and, indeed, plan a comprehensive air defense system, but also to assure Lincoln that the funds necessary for this purpose would be in addition to the funds necessary for the other projects in which Lincoln had become interested. Suppose, in short, that the question were converted from an "either . . . or . . ." to a "both . . . and . . ." question. Might that not cause the Steering Committee to reconsider?

This is speculation, of course, but it is not entirely idle because just such a proposal did come from the Air Force. About a month after Valley's letter to Shiely, Colonel Forrest G. Allen of the Air Research and Development Command's then new systems management organization at Wright-Patterson Air Force Base informally offered precisely this task to Lincoln,<sup>1</sup> and, after some exchanges of views, made his offer in a more formal way in August.<sup>2</sup> Lincoln, for its part, responded warily but with an open-mindedness that contrasts oddly with its apparent mood of the preceding winter. Perhaps the change is to be explained in part by the fact that Forrester resigned from the Laboratory in June in order to accept a professorship at MIT's Alfred P. Sloan School of Management. Everett succeeded him as head of Division 6, and there is some reason to think that about this time the Lincoln people who had been most closely connected with SAGE, whether in Division 6 or in Division 2, and who had an obvious interest protracting the

Laboratory's SAGE involvement,<sup>1</sup> began to constitute a distinct faction under Everett's leadership. At any rate, when the Steering Committee debated the ARDC proposal inconclusively at various times in the summer of 1956, the critical question was apparently not whether Lincoln ought to adhere to a path of research-and-development virtue, but whether, if it were to accept, the Air Force would be prepared to give it the considerable financial support and the overriding authority over other contractors, including weapon contractors, that it would have to have in order to do the job.<sup>2</sup> At its meeting on September 4 the Steering Committee voted on the hypothetical question: "If MIT were given all the support it required of the Air Force in the way of money, manpower priority, authority, etc., would the Lincoln Steering Committee feel that MIT should accept such a responsibility?" The negative side prevailed, but only by a margin of seven to five.<sup>3</sup> Because the question was hypothetical, moreover, it is impossible to say with confidence what the majority of the committee thought in respect to the real question. Ostensibly, the vote meant that most of the committee did not wish to see Lincoln extend its involvement in system management on any terms, but this would be true only if the members were paying attention to the exact terms of the question. It is conceivable that at least some of the negative voters were really registering, not a principled objection to system management, but simply an opinion that the question was too unrealistic to be seriously considered.

On September 24 Dr. Holloway formally declined Colonel Allen's offer and advised him to look elsewhere for a solution;<sup>4</sup> but the Air Force, now thoroughly alarmed on account of the problem of integrating weapon systems and SAGE and convinced that no solution was possible without the SAGE team in Lincoln, was not disposed to take "no" for an answer. Its next move was made well above the colonel level. Early in October Lieutenant

General Donald L. Putt (Deputy Chief of Staff, Development, Air Force headquarters), Lieutenant General Thomas S. Power (Commander, Air Research and Development Command), and General Earle E. Partridge (Commander, Air Defense Command) called at MIT to discuss the matter with President Killian, Admiral Cochrane (MIT Vice-President for Industrial and Governmental Relations), and Drs. Holloway and Valley (Director and Associate Director of the Lincoln Laboratory).<sup>1</sup> As reported by Dr. Valley to the Lincoln Steering Committee on October 8, the Air Force was then thinking of setting up

a Joint Project Office which would have responsibility for the weapons integration. Lincoln would hold a relation to this office similar to that which Ramo-Wooldridge holds with respect to General Schriver's [sic] office [i. e., to the Western Development Division, later renamed the Air Force Ballistic Missile Division, in Inglewood, California].<sup>2</sup>

Whether the Steering Committee would have favored such an arrangement can never be known because no such proposal materialized. The trail at this point becomes somewhat obscure, but apparently the MIT administration, which had had its misgivings about Lincoln all along, had no stomach for seeing an organization for which it was responsible become a kind of East-coast Ramo-Wooldridge, and sent Admiral Cochrane and Mr. James McCormack, Jr. (a retired Air Force major general who had recently joined the MIT staff and would soon succeed Admiral Cochrane as Vice-President) to Washington to tell Air Force Secretary Donald A. Quarles informally that it wished to be relieved entirely of its responsibility for the management of the Lincoln Laboratory.<sup>3</sup> For the next few months, there was no more talk of using Lincoln to solve the integration problem.

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The issue was not immediately pressing in the fall of 1956 because it was still not clear that the Air Force would or could arrange its affairs so as to give Lincoln (or any other contractor) the necessary support and authority,<sup>1</sup> but during the next few months the Air Force went a considerable way toward doing exactly that, so that the following August saw Lincoln actually proposing to do the job. First of all, the three commands concerned (the Air Research and Development, Air Materiel, and Air Defense Commands) and Air Force headquarters began in October to face the fact that there needed to be a master plan for an entire air defense system, one that would embrace SAGE, its associated radars and communications, and all existing and projected air defense weapon systems, and thus authoritatively establish the operational requirements by reference to which the various integration problems might be resolved.<sup>2</sup> In February the Air Force Chief of Staff asked Brigadier General D. R. Hutchinson, a member of the Defense Department's Weapons Systems Evaluation Group, to look into the matter, and Hutchinson's April report confirmed the main recommendations at which the three commands had already tentatively arrived.<sup>3</sup> In consequence, the tri-command Air Defense Systems Management Office was established at Hanscom Field in July 1957, although it was not given the sweeping authority and the right of direct access to Air Force headquarters that had originally been intended. It had an executive officer rather than a commander, and that officer was a colonel rather than a general; it was never allowed to be more than a coordinating agency among the three commands which jointly staffed it; and it never obtained a clear statement of mission.<sup>4</sup> It was, of course, supposed to be assisted by a system engineering contractor, but the contractor had yet to be chosen. Nor was it, this time, a foregone conclusion that the

MIT Lincoln Laboratory would be that contractor; indeed, an inter-command conference at Air Materiel Command headquarters in December had listed the Bell Telephone Laboratories, the RAND Corporation, and MIT as possible contractors, in that order of preference.<sup>1</sup> By May 1957, however, BTL (probably at its own request) was no longer being considered, and the choice had apparently narrowed down to Lincoln or the System Development Corporation (the RAND offshoot incorporated in November 1956) or to some joint arrangement between the two. On the 9th of that month Brigadier General I. L. Farman and Colonel Gordon T. Gould of the ARDC system management office at Wright-Patterson visited Lincoln to explain the about-to-be-created ADSMO and to give Lincoln a chance to reconsider the negative position it had taken a year earlier.<sup>2</sup> On June 7 ARDC representatives discussed the same prospect with SDC.<sup>3</sup>

It is not entirely clear how SDC came to be involved. So far, its only business was its contract with the Air Defense Command to make precise analyses of the operations of ADC tactical units and, on that basis, to write the programs for the SAGE computers; but that was a rather limited assignment, and the very choice of the name "System Development Corporation" suggests that from the beginning this new organization aspired to something more ambitious. But what needs explanation is not SDC's willingness to play a leading part in the development of a comprehensive air defense system, but ARDC's motive for encouraging SDC's hopes. The best guess is that ARDC was looking for an opportunity to ease Lincoln out of the picture. It was supposed to be ARDC's mission prerogative to select the military systems to be developed and to control and monitor their development, and in 1953, if left to its own devices, the command would probably have chosen the Willow Run rather than the Lincoln system for air defense. Someone at a rather high level, perhaps in the National Security Council,



had intervened in favor of the Lincoln system, and the effect had been to make Lincoln a privileged contractor -- assured of all the support it needed through ARDC channels because ARDC had been instructed by higher headquarters to provide this support, yet able to disregard ARDC's efforts to interfere and control because, if necessary, it could always appeal through the MIT administration to the Secretary of the Air Force. Now that SAGE itself was nearing completion and the great question was how to plan and engineer a comprehensive air defense system built around SAGE, ARDC could hardly have wished to see the Lincoln Laboratory once again assume the position of a contractor who must be supported without being controlled. It did, to be sure, send Farman and Gould to Lexington with a proposal that seemingly would have given Lincoln exactly that position; but the catch was that, as the ADSMO contractor, Lincoln could not have enjoyed any more discretionary latitude than ADSMO itself enjoyed, and we have already noted that, original intentions to the contrary notwithstanding, ADSMO was not destined to enjoy any discretionary latitude. Meanwhile, in case Lincoln should once again decline the proffered role of technical director of a comprehensive air defense system, there seemed to be a good chance that Air Force headquarters would be willing to let ARDC offer the ADSMO support contract to SDC; and it is even possible that ARDC was hoping all along that its offer to Lincoln in May would be rejected. No doubt, in order to make SDC acceptable to Air Force headquarters, it might be necessary to arrange for the transfer of some of the SAGE people in Lincoln to SDC, but, as of May or June 1957, that did not seem to be an insuperable obstacle. At any rate, it apparently seemed worthwhile from ARDC's point of view to explore any possibility or seeming possibility of giving ADSMO a more pliant contractor than Lincoln was likely to be, and SDC seemed a fairly attractive candidate.<sup>1</sup>

Nevertheless, the initial offer was made to Lincoln, and this time the forces within Lincoln favoring acceptance prevailed. On June 3 Robert Everett addressed what was evidently a carefully considered memorandum to Drs. Carl F. J. Overhage and William H. Radford (who were by that time Director and Associate Director of the Laboratory) summarizing the history of the debate within the Laboratory concerning the system engineering question, exploring some of the implications, and advocating that Lincoln accept the job.<sup>1</sup> The gist of his argument was as follows:

Considerable thought has been given to the proposition that the Laboratory should turn primarily to unfettered research and development.

There is concern that such a role would not only reduce the Laboratory to a supporting position but would reduce to a minimum the influence which the Laboratory could exert on air defense.

Furthermore there is serious doubt that the present budget and physical plant could be supported in this role. There is a strong feeling that the research and development effort cannot vigorously influence systems decisions if separated from the systems work. Equally, systems work becomes stagnant without close support of a vigorous research and development effort.

The stimulating effect of these complementary efforts has been demonstrated within the narrowly defined SAGE concept: it is felt that the same will be true in the broader area of overall electronic ground environment.

Therefore, while the Laboratory is now confronted with an Air Force proposal not substantially different from that made to it last year, the Air Force has now revised its internal organization for systems management [this was written before it had become clear how weak an agency ADSMO would be] and the sentiment within Lincoln is now toward taking on the job.<sup>2</sup>

This was a fairly cogent assessment of the interests of Lincoln as distinct from those of MIT, even though Everett may have somewhat underestimated the amount of financial support Lincoln would be able to command if it eschewed system engineering and, as it eventually did, turned exclusively to research and development. His whole experience, back to the days of Project Whirlwind, lay behind his contention that system engineering and research and development, far from being antithetical, are naturally complementary, either being impoverished by the absence of the other. No doubt, he was also right in suggesting that Lincoln, if it withdrew entirely from systems work, would lose its power to "influence systems decisions," and, no doubt, he was not the only member of the SAGE team in Lincoln who wished to do precisely that -- as "vigorously" as possible. The desire to do this was natural and laudable, and in principle was not different from the desire of an artist to complete his creation. Surely, it would be unreasonable to expect a group of engineers not to care what happened to a system in which they had invested so much of themselves for so many years. The trouble was that "vigorously influenc[ing] systems decisions" meant telling private contractors what to do -- including some very powerful private contractors who were not used to taking dictation. To be sure, the Air Force would do the dictating, but would do so with the Lincoln Laboratory sitting at its right hand; and, since Lincoln was a responsibility of MIT, it would be MIT that would bear the brunt of the inevitable resentment. Lincoln's part in the development of SAGE had already placed a certain strain on good relations between MIT and the American Telephone and Telegraph Company. If Lincoln accepted the ADSMO contract, it would find itself advising ADSMO concerning the proposals and the performance of a far larger number of private contractors than had been involved in SAGE; and, if MIT were still responsible for Lincoln, it could expect much worse cases of friction than

it had experienced with the telephone company, and, indeed, expect to arouse the animosity of most of the major potential employers of its graduates.

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It was in July that matters came to a head. The nature of the ADSMO task and of MIT's misgivings were explained to the Joint Services Advisory Committee on the 9th, with Lieutenant General Donald L. Putt presiding. Someone, perhaps General Putt, asked MIT to reconsider its position; and on the 17th Dr. Overhage discussed the question with President James R. Killian, Provost Julius A. Stratton, Mr. Joseph J. Snyder, the MIT Treasurer, and Mr. James McCormack, the MIT Vice President for Industrial and Governmental Relations, at which time it was concluded that "Lincoln should begin negotiations with the Air Force." Later in the day Dr. Overhage telephoned this news to General Putt; but MIT's misgivings had not been allayed, for at the same meeting "it became clear, during the discussion, that the further expansion of Lincoln [which the Air Force proposal would necessarily involve] would raise questions with respect to the continuing MIT sponsorship of Lincoln.<sup>1</sup>

But, while the way was being paved for a Lincoln bid for the ADSMO task, the System Development Corporation had also, not surprisingly, indicated an interest. Lincoln and SDC had probably known all along that the other was being approached (although available records do not positively indicate this), and it is possible that each from the beginning had recognized the advantages of collaborating. The System Development Corporation, despite its name, was competent only in the narrow fields of operations analysis and computer programming, and would therefore need to draw on system engineering talent which it did not possess but which Lincoln might supply. At the same time, some members of the Lincoln management and the MIT

administration may actually have been hoping that SDC could assume the primary role in advising ADSMO, with Lincoln confining itself to "laboratory support." This may perhaps have seemed to some Lincoln people (although probably not to Everett and his closest associates) to offer a way for Lincoln to "have its cake and eat it too" -- to continue to "influence systems decisions" with something like the desired vigor without assuming the direct responsibility that would almost certainly cause MIT to cast it adrift. At any rate, such a compromise was discussed by Dr. Overhage of Lincoln, Mr. M. O. Kappler of SDC, Colonel Gould of Air Research and Development Command headquarters, and Colonel C. A. Thorpe of ADSMO, at a meeting at Lincoln on July 26. Colonel Gould "indicated that primary responsibility might be given to RAND-SDC," but "requested that Lincoln submit a formal proposal."<sup>1</sup>

Any illusions that the Lincoln people may have entertained did not survive the July 26 meeting. For one thing, Colonel Gould apparently went out of his way to indicate that the ADSMO contractor, whether Lincoln or SDC, would have to accept a kind of petty supervision to which Lincoln was quite unused. He confided to his own memorandum of the meeting that it was "clearly understood that Lincoln is working for the Air Force in this effort, and that the nature of the effort requires that Lincoln be subject to day-to-day direction by ADSMO,"<sup>2</sup> although it is doubtful that Lincoln understood any such thing. During the course of the meeting, moreover, it became clear that Lincoln and SDC had entirely different ideas as to what the air defense system engineering task involved and what it would probably cost. Kappler apparently saw the job as hardly more than operations analysis and computer programming, which could be accomplished at a fairly modest cost, whereas Lincoln saw it as an extensive and quite costly system engineering effort of indefinite duration.<sup>3</sup> The effect was to convince Everett and his

colleagues that SDC simply did not understand the problem and to make them question whether they would be wise to accept SDC leadership. The Steering Committee laid the matter before President Killian at a special meeting on July 29, whereupon Killian "suggested that Lincoln should not accept the ADSMO support responsibility unless it were given a primary role." As a way out of the dilemma that such a primary role would pose for MIT, he also "indicated that MIT might seek a broader sponsorship for Lincoln than it now has"<sup>1</sup> -- meaning, presumably, that MIT might ask a few other universities to join it in a consortium which would collectively sponsor Lincoln, just as a year earlier it had arranged for a consortium of universities to sponsor the Institute for Defense Analyses. Everett and the associate head of Division 6, John F. Jacobs, another former member of the Whirlwind team, then drafted a proposal outlining the full scope of the job as they saw it and contemplating that Lincoln alone would act as technical director, under ADSMO, of the future evolution of the entire air defense system. They recognized that SDC's contribution in operations analysis and computer programming would be quite as necessary as Lincoln's in system engineering, but implied that ADSMO might as well contract separately for SDC's services. Their observations on the relationship that should exist between Lincoln and ADSMO implied that they expected Lincoln to enjoy about the same degree of discretionary latitude that it had always enjoyed as it went about its work. On August 9 Overhage formally advised the Air Research and Development Command that Lincoln would be willing to accept the task as defined in the Everett-Jacobs memorandum, and suggested that the Laboratory should be explicitly designated as the principal technical advisor to the Air Defense Systems Management Office.<sup>2</sup>

There was a fine take-it-or-leave-it air about this Lincoln proposal, probably intentional, and both ARDC and SDC seem to have resented it. Since ARDC had no intention of letting Lincoln sit in the driver's seat, so to speak, the effect was to set the whole quest for an ADSMO contractor back to the starting point. The System Development Corporation, to be sure, submitted its own more modest proposal a week later,<sup>1</sup> and Kappler wrote to Gould on August 20 to explain his objections to the Lincoln proposal -- the main one being "that Lincoln proposes to assume a decision-making role which I believe rightly belongs to the military chief of the ADSMO rather than to any supporting contractor or contractors."<sup>2</sup> But this initial SDC proposal was largely meaningless because, in keeping with the July 26 understandings, it was designed merely to complement the already virtually rejected Lincoln proposal. When Gould got in touch with Lincoln toward the end of the month, he was told that Lincoln had no objection to SDC's submitting an "uninhibited proposal," and was left with the impression that Lincoln "didn't really want the job but had agreed because of patriotism and duty considerations."<sup>3</sup> The System Development Corporation did submit another formal proposal on October 10, whereby it would have assumed sole responsibility for the technical support of ADSMO,<sup>4</sup> but ARDC had meanwhile decided to explore the possibility of finding a private industrial contractor. Gould so notified Overhage by telephone on September 3, explaining that ARDC "had long been aware of our [Lincoln's] reluctance to take on this commitment and did not wish to 'force us into this thing,'" whereupon Overhage "recommended BTL-Western Electric, but was told they were unwilling to accept."<sup>5</sup> Some thirteen possible private contractors were represented at a conference at ARDC headquarters on October 23 and invited to submit proposals, and in November the source selection board recommended the choice of the Radio Corporation of America.<sup>6</sup>

The reason for this latest shift on the part of ARDC is not entirely clear. Perhaps some agents of private industrial concerns had exerted pressure behind the scenes, but ARDC headquarters probably shared anyway the widespread and largely unexamined assumption that system engineering properly belongs to private industry. The prevailing sense of propriety was not necessarily offended if a university laboratory, or a laboratory sponsored by a university, did a certain amount of the engineering pertaining to a system that it had invented, but that was understood to be an exceptional and temporary circumstance that should lead eventually to a private industry contract. Then, too, ARDC may have instinctively felt that it could more easily control a contractor whose motive was profit than a university contractor who would not hesitate to appeal over its head and who took the attitude that he had only accepted the contract in the first place in order to do the Air Force a favor. One needs to bear in mind that for four years ARDC had been compelled to handle the funds for the development of SAGE and yet had not been allowed to control, regulate, and establish management procedures for Lincoln as it went about this work. An RCA could not so easily go over ARDC's head and, as long as the prospects for profit were not affected, would probably not wish to do so. To be sure, an RCA contract would probably have meant the break-up of the SAGE team. RCA might or might not have asked the Lincoln engineers who had been working on SAGE to join it and continue their labors under its auspices, and, had it done so, at least some of them would probably have preferred to accept employment elsewhere. There was really no more reason to think that any private industrial contractor could have won the confidence of Everett and his colleagues than there was to think that SDC could do so. But the need to win their confidence and thus keep them together as a team, although recognized by those in the Air Force (mostly in the Pentagon and in the Air Defense Command) who had



been following the development of SAGE long enough to know what it involved, was apparently scarcely perceived in ARDC headquarters. It is well to remember, moreover, that, if ARDC had had its way, no one would have been able subsequently to convict it of sabotaging air defense; for, while there is every reason to think that the breaking up of the SAGE team would have resulted eventually in a less satisfactory air defense system than the one actually achieved, this is not the kind of thing that can be positively proved.<sup>1</sup>

In any event, ARDC did not have its way. For whatever reason, the idea of giving the ADSMO job to RCA met resistance as soon as it was referred to the Pentagon for final approval. There may have been people in the Pentagon (General Putt, perhaps) who were better attuned to the nuances of the situation in Lexington than anyone in ARDC, and it is possibly significant that both Dr. Killian and Dr. Valley went to Washington in the fall of 1957 -- Killian having taken a leave of absence as President of MIT to become President Eisenhower's Scientific Advisor, and Valley having resigned as Associate Director of the Lincoln Laboratory to become Chief Scientist to the Air Force Chief of Staff. Anyway, the source selection board's choice of RCA as the ADSMO contractor had to be referred to Secretary of the Air Force James H. Douglas, who is said to have rejected it out of hand and to have made yet another appeal to the American Telephone and Telegraph Company.<sup>2</sup> There is no doubt that the telephone company and its subsidiaries had a better reputation in government circles for managerial competence and integrity than most other private concerns, and that reputation may have been merited, but the explanation ordinarily given -- that the telephone company was a government-regulated monopoly -- does not explain. When a government contractor fails to perform or is suspected of some malpractice, the government's only legal recourse is to sue, and it is difficult to

see why it should be either more or less difficult for the government to sue a regulated monopoly than to sue any other private concern. A more likely explanation would seem to be that the telephone company over the years had so ably managed its relations with the federal government that government officials had come to take its integrity and general competence for granted, and therefore instinctively felt more secure in dealing with it than in dealing with almost any other major business organization.

But the telephone company adhered to what had evidently been its policy since the adoption of the Lincoln Transition System in 1953: it would be glad to help but not to assume the primary responsibility.<sup>1</sup> The quandary was complete. The SDC bid for the job and that of RCA had been rejected for various reasons; the telephone company would not accept it; the Lincoln Laboratory would accept it, but MIT would then insist on the Air Force's finding another sponsor for Lincoln. On December 5, however, at a meeting of the Air Force Scientific Advisory Board in Arizona, General Putt informally advised Overhage and Radford of these latest developments, whereupon Overhage and Radford "expressed confidence that a satisfactory method could be worked out between AT&T and MIT for collaboration in this task."<sup>2</sup> Other conversations ensued, and at one point Secretary Douglas spoke to Dr. Killian concerning the problem. Killian was unwilling to pursue the subject because of a possible conflict of interest, but advised Douglas to take it up with his successor at MIT, Acting President Julius A. Stratton.<sup>3</sup> Thus it came about that the Secretary of the Air Force went to Cambridge and conferred with the President of MIT on Saturday, January 18, 1958. Douglas was accompanied by Richard L. Horner, Assistant Secretary of the Air Force for Research and Development; Lieutenant General Donald L. Putt, Air Force Deputy Chief of Staff, Development; Major General Howell M. Estes, Jr.,

Special Assistant to the Air Force Chief of Staff for Air Defense; and George E. Valley, Chief Scientist to the Air Force Chief of Staff -- Valley having arranged the meeting at Douglas's request. The meeting occurred in the home of James McCormack on Brattle Street, McCormack being the MIT vice president in whose purview the problem fell. Stratton was there, and MIT was also represented by its treasurer, Joseph J. Snyder, and by Professor Carl F. Floe.<sup>1</sup>

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Secretary Douglas began by stating the urgency of the Air Force's problem, noting that

. . . the engineering group organized in direct support of the SAGE effort at Lincoln is unique both in being the only such group actually organized and in existence, and also in the sense that the individuals in the group have [the] most complete available background knowledge of the development of the SAGE system.<sup>2</sup>

The important thing was to keep "this group of scientists and engineers" together so that they would be available to ADSMO as a team -- a point which was apparently fully appreciated at the Pentagon level even though it may have eluded the Air Research and Development Command. It was for this reason that Douglas wanted MIT, through the Lincoln Laboratory, to "assume the principal administrative responsibility, under contract, for the necessary technical advisory group to the military director of ADSMO."<sup>3</sup> Evidently in the hope of making this prospect more appealing, he added:

This group would be in a position roughly analogous to that of Ramo-Wooldridge Space Technology Labs vis-a-vis the ARDC Ballistic Missile Division. Weapons contractors, Western Electric, and certain other major contractors having prime contracts with the Air Force, would continue

to hold such contracts. However, in addition, MIT-Lincoln would have freedom to enter into contractual relationship with these and other contractors as may prove desirable.<sup>1</sup>

It was also part of the idea that ADSMO would be reorganized and strengthened and that it would be commanded by a general officer.<sup>2</sup>

In reply, Stratton recognized that MIT had a responsibility to assist "in all appropriate ways" the attainment of the practical results of its research and development programs, but felt that "there are limits beyond which a research and development organization should not intrude in the industrial field."<sup>3</sup> MIT's sensitivity on this point was understandable enough: for reasons already touched upon, it did not wish to alienate private industry, and it had cause to think that the danger was not entirely imaginary.<sup>4</sup> But Stratton then added an interesting further observation:

Moreover, MIT has permanent public responsibilities as an educational institution which the Institute considers to be of paramount importance, subject only to occasional demands of genuine urgency in the national interest which may require temporarily subordinating, in some specific area, MIT's primary role. MIT is not a private contractor in the usual sense, but is a public trust; its management feels its responsibility not to a particular group of "stockholders" but to the broad future of the nation's position in science and technology.<sup>5</sup>

He also called attention to the fact that, a year or so earlier (presumably at or just after the time when it informally raised the possibility of divorcing itself from Lincoln altogether), MIT had asked the Air Force to create "a new management mechanism for that part of the Lincoln endeavor which had the appearance mainly of an industrial enterprise."<sup>6</sup> As for Lincoln's offer in August to accept an ADSMO contract, he pointed out that it had been made "with some misgivings, and after lengthy consideration,"<sup>7</sup> adding that

If MIT-Lincoln assumes the position of principal technical advisor to ADSMO, there can be no escaping the fact that ADSMO will in general have no real alternative to approving the recommendations of the advisory group, and that industry will consequently look upon the explicit advisory role as encompassing a large measure of implicit authority in the decision-making process. This cannot be a comfortable position for an educational institution.<sup>1</sup>

At first glance this all seems reasonable enough, but how had MIT come to be in such a dilemma in the first place? If it had never agreed to establish and be responsible for the Lincoln Laboratory, it would not have had a problem. When it established Lincoln in 1951, and the Instrumentation Laboratory at about the same time, to be sure, it was responding to the urgent request of the Air Force Chief of Staff, but that is not to say that it was bludgeoned into doing something against its will. After all, it received those requests because members of its own faculty (e. g., the Valley Committee) had laid the foundations of research and development programs of such obvious pertinence to national defense that the Air Force was bound to take an interest in them. Moreover, MIT had been encouraging its faculty to do this sort of thing since the beginning of the Second World War when, at government expense, it organized and managed the wartime Radiation Laboratory. Being an institute of technology rather than a university in the ordinary sense, it could scarcely have afforded to do otherwise. Any university that wishes to avoid sterility in its teaching must see that many of its faculty are continually engaged in some pioneering venture in their respective fields of interest, but research in technology (usually called "research and development") is usually more expensive than mere scientific research, and far more expensive than scholarly research in, say, history or literature. The armed services were the only conceivable sources of funds in the amounts needed for MIT's kind of research. Without such funds during the war, MIT

could never have established its preeminence in the field of radar, and, if, after the war, it had not continued to court the armed services, it would simply have denied itself the best opportunities it was likely to get to do what it was primarily supposed to do.<sup>1</sup>

Yet Croesus's patronage has its dangers. Croesus is likely to insist on having a strong and sometimes clumsy hand in the management of a laboratory which he knows full well would not exist but for him. In the case of the Radiation Laboratory during the war, he insisted on hiring so many non-MIT people that some MIT professors grumbled that their campus was overrun with "foreigners." No doubt it was for this reason that the Lincoln Laboratory was moved out of Cambridge as soon as possible, and the interests and sensibilities of the MIT faculty were further protected by the fact that the Lincoln staff, although enjoying the prestige of being associated with MIT, were not given academic rank or tenure. What is more, Croesus is likely to think that he is buying something the nature of which he has a right to specify; and what he wants to buy is never that general enlargement of knowledge to which the academician is dedicated, but a product that will help him meet specific needs of his own. The initial contract under which he agrees to fund the academician's project is invariably based on the tacit assumption that his objective and the academician's objective, although different, are in harmony -- that the attainment of the one will automatically assure the attainment of the other. But, if the project proves to be more costly and of longer duration than was originally anticipated, and especially if it is found to have crossed that rather obscure line that is supposed to separate research and development from system engineering, this illusive harmony is likely to disappear. The university laboratory conducting the project is likely to think that, with still more time and money, it could

make an even greater contribution to knowledge than was originally contemplated, and may therefore be tempted to stray from the straightest and shortest path to the contractually specified product. The history of Project Whirlwind illustrates the kind of misunderstandings that can thus arise, and also shows how the university administration tends to become involved. For a university administration the problem is an awkward one. On the one hand, it cannot afford to give the impression that it is letting its own people down; on the other hand, it cannot gracefully assume a position of partisan advocacy of a system its people are developing because that would be to abandon the disinterested spirit which is one of the essential marks of an academic institution.<sup>1</sup>

MIT understood the danger, and had no intention of letting itself drift into the ways of academic unrighteousness, but it had to be careful. Thus, when Killian came to the timely rescue of the Lincoln Transition System in 1953, he did so with a probably studied air of detachment, deftly avoiding an overt partisan advocacy of that system -- even though he was probably not as disinterested as his letter to Secretary Finletter might seem to imply.<sup>2</sup> Three years later, when part of the Lincoln Laboratory began to agitate in favor of accepting the task of designing and engineering a comprehensive SAGE-centered air defense system, at least some members of the MIT administration and faculty apparently decided that Lincoln was already taking more time and attention than could be justified in terms of the Institute's primary educational purpose, and that a still larger Lincoln would be intolerable. Those "new problems arising in the SAGE System which are not R&D," to which Valley alluded, would certainly mean continued wrangling with Western Electric and the Bell Telephone Laboratories about such matters as the SAGE implementation timetable, with weapons contractors about the integration

problem, and very likely with other contractors and with the various Air Force commands involved. Since Lincoln, to its credit, had strong views on these questions, it would inevitably wish to impress those views as forcefully as possible on the appropriate Air Force authorities, and, as long as it were a part of MIT, it would be obliged to ask the MIT administration to intercede in its behalf from time to time. The kind of intercession required, moreover, would not be the detached scholarly presentation of an idea that is becoming to a professor, but the exertion of direct pressure on government officials.

Although the Lincoln Steering Committee sometimes talked as though MIT might be induced to play such a role,<sup>1</sup> it is probably safe to say that this was the last thing to which the MIT administration would have consented. The obvious way out of the dilemma was for MIT to insist that the Air Force find another sponsor for Lincoln -- or, failing that, to induce a few other universities to join it in a consortium for the joint management of Lincoln. Such a step might conceivably have deprived the Institute of some interesting opportunities for federally financed research, but might nevertheless have been the wiser course. Toward the end of 1956, at any rate, Cochrane and McCormack were sent to Washington to advise Secretary Quarles informally that MIT wanted somehow to rid itself of its responsibility for Lincoln.<sup>2</sup> When Killian was obliged to look into the matter of the ADSMO contract in the summer of 1957, he, too, took this line. He did nothing to discourage Lincoln from submitting its August proposal, and even gave the Steering Committee some fatherly advice concerning the terms on which it should insist, but at the same time he made it clear that, if Lincoln chose to go that way, its connection with MIT would have to be severed. But then Killian went to Washington on a leave of absence, Stratton became Acting President,



and no one at MIT was talking any more about getting rid of Lincoln. Some members of the MIT community evidently decided, or had thought all along, that Lincoln was far too valuable an asset to be given up, and that the thing to do was not to get rid of it because its SAGE involvement had become embarrassing, but to make it get rid of its SAGE involvement so that MIT could retain it without embarrassment.

It was, then, a rather delicate maneuver that MIT diplomacy was attempting to execute at the Stratton-Douglas meeting in January 1958. Stratton was undoubtedly sincere in arguing that MIT could not allow itself to become more deeply involved in SAGE than it already was, but his purpose in making that point to Douglas could not have been simply to complain about it. His probable intention was to present the problem in such a way that Douglas would be prompted to propose the solution that he desired -- namely, the creation of a "new management mechanism" for all SAGE-related matters so that they could be detached from Lincoln and Lincoln could thenceforth be the kind of research and development laboratory, eschewing system engineering, that MIT then wanted it to be. It helped that the Air Force, for its part, was interested not only in resolving the ADSMO problem but also in having Lincoln, preferably under MIT auspices, continue to pursue several research programs not related to SAGE, and therefore had its own reason for not wishing to see MIT cast Lincoln adrift.<sup>1</sup> Anyway, Douglas and his colleagues came up with the only possible solution under the circumstances, and the one for which Stratton had apparently been waiting:

The Air Force therefore suggests that if this administrative responsibility is thought to be unsuitable as a permanent responsibility, perhaps a phased program might be worked out through which MIT might still accept the responsibility initially, in order to save valuable time. The new, powerful ADSMO must move quickly into effective operational status.

Afterwards, with the assistance of the Air Force and the cooperation of the principal industrial contractors, a successor management organization can be created.<sup>1</sup>

Stratton was happy to entertain this idea, and promised to take it up at the next meeting of the MIT board of trustees. The burden would be on MIT, of course, to see to the forming of the new organization, arrange for its sponsorship, and disentangle its affairs from those of the Lincoln Laboratory, but that, in Stratton's judgment, would be a price worth paying for the twin objectives he had in mind -- an end of the SAGE involvement and a reorienting of what would be left of Lincoln toward research. These chores, as the Air Force people observed, "might be regarded by MIT not as the creation of a new problem but as a means toward solving its existing problem of phasing out the SAGE enterprise."<sup>2</sup> Moreover, there was every reason to think that

. . . the Department of Defense generally, and certainly the Air Force in particular, would wish to give permanent support to a substantial research and development effort at Lincoln under close MIT sponsorship as a defense research laboratory.<sup>3</sup>

MIT would then be able to realign the Lincoln program so that it would be

. . . in clear relevance to the fields of MIT's special competence and to the proper course of growth of the Institute so that the Lincoln activity may be more closely meshed with 'on-campus' research than has been the case in the immediate past.<sup>4</sup>

Of course, MIT would not be able to do this unless the Air Force kept its part of the bargain, especially as regards the strengthening of ADSMO. Perhaps this was what Stratton had in mind when he pointedly observed that "a specific, generally time-phased plan known to all at the outset" would be needed to convince not only the MIT board but also "the technical staff

members now in Lincoln who would transfer to the new organization."<sup>1</sup>  
Failure to persuade the latter to join the new organization could wreck the whole plan. The meeting ended, however, on a note of mutual satisfaction. It was thus that MIT and the Air Force reached the critically important agreement which led in due course to the creation of the MITRE Corporation.

## CHAPTER IV

### ESTABLISHING THE CORPORATION

It would be another six months before the MITRE Corporation would be incorporated and a year and a half before it would be fully "on its own," but the meeting in Cambridge in January 1958 marked the decisive turn. For two years before that time, everyone concerned had known that it would take a great deal of system engineering and system management before an air defense system centering around SAGE could become an operational reality, but it had seemed well nigh impossible to arrive at mutually acceptable terms under which this indispensable effort could be organized. Much remained to be done, but now at least the two principal parties, MIT and the Air Force, had agreed as to the general form of what was probably the only possible solution, and would thenceforth move with all deliberate speed toward the realization of that solution. What President Stratton and Secretary Douglas agreed to try to do on January 18, it is important to emphasize, was not to create an air defense system engineering team, since the team already existed in the form of the engineers in Lincoln who had developed SAGE, had wrestled with the integration problem for the past two years, and were continuing their labors without interruption even as negotiations proceeded; but rather to devise "a new management mechanism" for that team -- one that would enable MIT to divorce itself from a system engineering and management responsibility which it regarded as inappropriate for an educational institution, and at the same time assure the Air Force that the desired air defense system would be satisfactorily completed. Stratton's part was first to obtain the approval of the MIT board of trustees and then to devise

and institute the "new management mechanism"; Douglas's was to see that the Air Force created within itself a strengthened Air Defense System Management Office with the authority to carry out the system engineering advice it would receive, and to make sure that the necessary Air Force contracts would be forthcoming. A cardinal point in all of this was that the "new management mechanism" and the terms under which it would function had to be acceptable to the SAGE engineers, for their participation was essential and they were quite free to refuse to join a new organization that they found unattractive.

Although the exact nature of the proposed new home for the SAGE engineers was apparently not discussed on January 18, there seems to have been a tacit understanding that it would be some kind of non-profit corporation. Some time in the preceding autumn Assistant Secretary Horner had asked McCormack whether MIT would be willing to help organize such a corporation<sup>1</sup>, and by December the Lincoln Laboratory had begun to speak informally of a "Cape Cod Corporation"<sup>2</sup> -- a name of unknown coinage but one which no doubt seemed apt because the Cape Cod System (later transformed into the Experimental SAGE Subsector) had become an historic symbol of the kind of thing the SAGE team did. In view of some things that were happening around this time, it is not difficult to understand why the non-profit idea seemed to be the obviously desirable solution. There were rumors that some of the Radio Corporation of America's competitors had complained against the proposal to make RCA the prime contractor for the technical support of ADSMO and had indicated that they would be unwilling to accept subcontracts and share their trade secrets, and also that RCA's own management, on discovering that the contract would include a clause forbidding RCA to supply hardware or other components of the air defense

system, had lost enthusiasm for the contract.<sup>1</sup> Moreover, there were already complaints, whether justified or not, that the Ramo-Wooldridge Corporation, a private and emphatically profit-making concern, was abusing its special relationship with the Air Force Ballistic Missile Division, so that no prudent administrator would care to set up anything that might look like an east-coast Ramo-Wooldridge. But there were several kinds of non-profit (or not-for-profit) corporations -- the non-stock membership corporation, of which RAND was the classic example; the non-profit subsidiary sometimes established as a public service by a large private industrial concern, as in the case of the Western Electric Company's Sandia Corporation; the organization sponsored by a consortium of private institutions, such as the Institute of Defense Analyses which MIT, along with four other universities, had helped to create in 1956; and perhaps some others. In effect, Dr. Stratton's task was to arrange a suitable adaptation of one or another of these models. In Mr. James McCormack, a retired Air Force major general, then MIT's Vice President for Industrial and Governmental Relations, he had the assistance of a man who had recently engineered the formation of the Institute for Defense Analyses and who, as Director of the Atomic Energy Commission's Division of Military Application in 1949, had played a critical part in inducing the Western Electric Company to establish the Sandia Corporation to take over the Los Alamos Laboratory from the University of California.<sup>1</sup>

The Massachusetts Institute of Technology tended to assume at the outset that it would have to be at least one of the sponsors of the new corporation, but, beyond that, there were no preconceptions as to the type of non-profit corporation that would be formed or as to the number or identity of the sponsors it should have. The idea that "MIT and the RAND Corporation might jointly sponsor the establishment of such a non-profit corporation"

(semi-prophetic of the solution eventually adopted, since, although RAND itself had nothing to do with the creation of MITRE, about half of the original MITRE trustees were also trustees of RAND or of the System Development Corporation) was mentioned as early as January 27, but only as one of several possibilities.<sup>1</sup> Around that time McCormack did seek the assistance of Mr. H. Rowan Gaither, then President of the Ford Foundation, but that step did not imply a commitment to the idea that the "Cape Cod Corporation" need be, like RAND, a non-stock membership corporation; for Gaither had been instrumental in the formation not only of RAND but also of IDA, and, according to McCormack, both the RAND and the IDA models were being kept in mind.<sup>2</sup> There was also the thought that, instead of creating a new corporation, MIT might allow the System Development Corporation to establish a new division to accommodate the SAGE team,<sup>3</sup> and Gaither at one point was of the opinion that the new corporation ought to be a temporary expedient pending eventual merger with SDC;<sup>4</sup> but both of these ideas were advanced in ignorance of the sentiments of the SAGE team, and nothing came of them. The Sandia model seems not to have been considered, probably because no one wanted a corporation of the Sandia type unless it were organized and managed by the Western Electric Company, and Western Electric had already told Secretary Douglas that it did not wish to accept primary responsibility in this affair. Moreover, it is unlikely that the SAGE engineers would have been any more willing to work under the aegis of the telephone company than under that of RCA or SDC, although their concern over the telephone company's attitude toward SAGE may not have been widely known outside of the Lincoln Laboratory.<sup>5</sup> Nevertheless, there was apparently some expectation in December and January that Western Electric or the Bell Telephone Laboratories or both would be willing to play a major part -- short of primary responsibility, to be sure, but perhaps extending to joint

sponsorship along with MIT.<sup>1</sup> If key officials in the telephone company ever entertained such a thought, however, they changed their minds. The only concrete cooperation to come from that quarter occurred on February 10 when McCormack and Dr. Carl F. J. Overhage, Director of Lincoln, called on Dr. Mervin Kelly and Dr. James B. Fisk, President and Executive Vice President of BTL, and obtained their permission to offer the presidency of the yet-to-be-formed corporation to Mr. Clair William Halligan, who had been associated with some part of the telephone company organization since 1926 and, since 1951, had been BTL's Director of Military Engineering. Even this was no more than a friendly and non-committal gesture, for, when Mr. Halligan indicated that he would accept, as he did in April, BTL's only commitment was to grant him an indefinite leave of absence for this purpose.<sup>2</sup>

Meanwhile, it was not until March 3 that Secretary Douglas wrote to Dr. Stratton confirming his proposal of January 18.<sup>3</sup> The presumable reason for the delay was that the Air Force wished first to complete a step it had promised to take at the Cambridge meeting -- namely, to overhaul and strengthen ADSMO, that tri-command military agency created the previous summer to receive and implement the desired technical advice. Since December some Pentagon circles had begun to recognize the need to strengthen ADSMO,<sup>4</sup> and the Air Force representatives on January 18 were apparently aware that this was a point of some concern both to the Lincoln Laboratory and to the MIT administration. Hence the explicit Air Force assurances on that occasion that ADSMO would soon be commanded by a general officer and would be given a degree of authority comparable to that of the Ballistic Missile Division. In early February, evidently under some Pentagon pressure, the commanders of the Air Research and Development



and the Air Materiel Commands agreed that ADSMO should become the Air Defense Systems Integration Division under the command of Major General Kenneth P. Bergquist, then a member of the Air Force headquarters staff and previously the Air Defense Command Deputy Chief of Staff, Operations. Bergquist set about his new duties with determination and perhaps a touch of passion, but he had an uphill fight. Dr. Valley warned him that he had "a selling job to do" to convince the SAGE people in Lincoln that he could in truth give the air defense integration program the effective direction it required; and ARDC and AMC, both jealous as ever of their respective mission prerogatives, were loath to see ADSID enjoy the overriding authority it would have to have in order to do the job.<sup>1</sup> On paper, Bergquist gained the authority he needed (except as regards control over weapons development funds) in the form of a special Air Force regulation published on March 31, which formally established ADSID, defined its mission, and authorized its commander to communicate directly with the Air Force Chief of Staff on matters relating to its mission.<sup>2</sup> Although, as later developments would show, there was some difference between what General Bergquist was "legally" empowered to do and what the realities of Air Force politics would permit him to do, Secretary Douglas evidently considered by March 3 that he had initiated movement in the right direction and that it was time to make his proposal to MIT in writing.

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Robert Everett and his colleague, John F. Jacobs, meanwhile, had some definite ideas as to the kind of organization that ought to be created and as to the proper scope of its activities. When Overhage asked him in February to estimate staffing requirements, they responded with what was essentially a reworking of the estimate they had included in Lincoln's

proposal of the preceding August to undertake the technical support of ADSMO, except that this time they wanted a substantial number of people engaged in the development of components and still others who could devote themselves to non-programmatic research, and therefore called for a total of 690 rather than 511 as before:<sup>1</sup>

Establishing the objectives of the air defense system (including preliminary system description)	65
Preparing detailed system specifications (including 100 engaged in system and component development)	145
Conducting studies and tests (including not only those using the Experimental SAGE Subsector but also those who would supervise direction and combat center installation and Bomarc testing)	290
Preparing implementation schedules	25
Non-programmatic ("basic") research	100
Administration and services	65
	<hr/> 690

This tabulation is a fairly good map of the job as they saw it, indicating that they expected to have something to say about the objectives as well as the detailed specifications of the contemplated air defense system, and to supervise the entire sequence from design to implementation. In August, however, they had not thought it necessary to ask for a component development activity or for any non-programmatic research because Lincoln had both; whereas in February, when it was a question of planning an entirely new organization, they considered that this new organization needed its own competence in both areas in order to be able to stand on its own feet. They recognized that Lincoln and the "Cape Cod Corporation" might and probably would cooperate at first to compensate for each other's lacks, but argued that "each will rebuild as rapidly as possible the parts lost in the split and,

as they gain their own competence, they will grow apart," and that the increased manning they were asking for was "part of the cost of splitting the present organization [Lincoln] into two parts."<sup>1</sup>

Anyone disposed to take a narrow view of the ADSID-support job would be likely to regard both the competence in components and the non-programmatic research as "frills," but Everett and Jacobs did not see them in that light. As regards the former, they maintained that

A systems effort cannot survive without authoritative and up-to-date component knowledge that can come only from an active components development activity within the same organization. Even if an isolated systems effort is well-staffed initially with component specialists, this knowledge will rapidly decay leaving the organization helpless in the face of its unruly and now more knowledgeable component suppliers. Conversely the components effort cannot survive without an intimate connection with an effective systems effort to give meaning and direction to the components development. An isolated components activity will drift away from reality into frustration and ineffectiveness.<sup>2</sup>

This, as the reader will recognize, is reminiscent of Everett's earlier argument that system engineering and research and development ought to be combined in the same organization and that either is impoverished in the absence of the other.<sup>3</sup> In respect to the non-programmatic activity, Everett and Jacobs had in mind something that would be

. . . not necessarily immediately related to the system job. It will be more like research, although we do not presently see any activity like the present Div. 3 solid-state research. The work will, however, be basic in character, intended to provide long term improvements. The work will be insulated from the vicissitudes of the direct ADSID<sub>4</sub> support job and may be in areas not directly related to air defense.<sup>4</sup>

Here, too, it was a matter of keeping the system engineering enterprise vigorous and healthy, but there was also another thought:

The non-programmatic work has two basic purposes. First, it is to provide the new ideas and techniques and a source of newly trained manpower for the system work. Second, it is to provide a greater competence for the Corporation to enable it to grow beyond the ADSID work should this be necessary [emphasis supplied].<sup>1</sup>

Already, in February 1958, Everett and Jacobs were contemplating the possibility that the new corporation might some day need to "grow beyond the ADSID work" and perhaps beyond the Air Force. For one thing, although the Air Force was preparing to give ADSID at least some of the authority needed for an effective integration of Air Force air defense systems, there were some important non-Air Force systems, notably the Army's Nike missile system, that also needed to be integrated, and the SAGE engineers who would have to do the integrating did not wish to be balked by inter-service rivalries. For another, it was essential to persuade as many as possible of these SAGE engineers to make the transition into the proposed new organization, and Everett and Jacobs, who knew them well, evidently judged that it would take something besides salary to attract them -- an intellectually stimulating environment, for example, and also a reasonable prospect of permanence. They were already accustomed to a fairly stimulating environment in the Lincoln Laboratory, and some of them looked back nostalgically to Project Whirlwind, which had been, if anything, even more stimulating. Part of the secret in both cases had been the cross-fertilization that can come from a judicious combination of the programmatic and the non-programmatic, and it was only natural that men like Everett and Jacobs should remember this as they began to think about forming still another professional organization. However, the same people who had worked on Whirlwind were now about ten years older. In the 1940's they had been young men who could afford to join what might well have proved, and did prove, to be a temporary branch of a university laboratory for

the sake of gaining a valuable kind of experience; but it would not do to tell them at this point in their lives that the new enterprise they were invited to join would last only until the SAGE-centered air defense system was completed, or only until the manned-bomber threat had passed -- and, be it remembered, the intercontinental ballistic missile was already rearing its sleek and awesome warhead, and, only months before, the Russians had launched their first two sputniks. Therefore, anyone who seriously expected, in 1958, to induce these SAGE engineers not only to leave Lincoln but also to join, virtually en masse, a completely new and untried organization (and, after all, the whole object was to do precisely that) had to offer the prospect of permanence, and, moreover, had to make that prospect convincing. It would not be convincing unless the organization could look forward to an indefinite series of interesting challenges comparable to the SAGE challenge, and one could not prudently rely on the Air Force alone as a source of future challenges. Such, presumably, were the reflections of Everett and Jacobs as they addressed themselves to this thorny issue:

Why, however, should Cape Cod be established as a long-term venture? Will there not be sufficient momentum in the original staff to carry the organization through the period of manned-bomber threat? The answer is no, for two reasons. First, from the point of view of the Air Force, the presently-defined job is fairly long-term, at least five years. In addition, if the combination of ADSID and Cape Cod proves effective, as we expect, it would be of continuing value in the Air Force's systems problems and should not knowingly be allowed to decline in ability. Second, and even more important, the high calibre of staff required for the Cape Cod job can only be recruited into an organization with potential for life and growth. This fact cannot be over-estimated. Cape Cod must be an organization that will outlast the manned bomber threat, that can and will look beyond ADSID and beyond the Air Force for future opportunities and support.<sup>1</sup>

Yet it was not so much Everett and Jacobs and their colleagues as it was the MIT administration, especially Stratton, who cared deeply whether this new organization was ever successfully launched. One imagines that Everett and Jacobs would still have been quite happy to see Lincoln undertake the work in question, but MIT was determined not to let that happen. In order to discharge its moral obligations both to the Air Force and to the SAGE engineers, therefore, MIT had to create a "new management mechanism" under which these engineers, although separated from Lincoln, could be persuaded to stay on the job; and, in order to do that, it had to pay attention to their views and concerns. This being so, it could not regard Douglas's formal proposal of March 3 as more than partially reassuring. By creating ADSID, the Air Force was indeed moving to overcome the inter-command jealousies that tended to retard the work that had to be accomplished, but even ADSID could hardly lead the way to a fully integrated air defense system unless it had authority over the Army and Navy as well as the Air Force parts of that system. Moreover, the SAGE engineers expected to enjoy the same discretionary latitude that they had enjoyed in Lincoln as they went about their work, and there was no sense in building a house for them to move into unless the house afforded a fair prospect that they might do so. Nor could it be safely assumed that the Air Force would take a sufficiently liberal view of the matter to make this possible. On the contrary, Everett and Jacobs were distressed to find, in mid-March, that General Bergquist intended that ADSID, not the new corporation, should control and determine the use of the Experimental SAGE Subsector -- a facility built with Air Force money, to be sure, but one that the SAGE team had conceived and designed and had come to regard as its own peculiar tool. Bergquist, moreover, did not share the Everett philosophy that a system engineering organization without an active research and development program on the side

is likely to become sterile even as a system engineer, and had indicated that he would not be inclined to allow the new corporation to budget for such a program. Thus, the danger that the new corporation might become a kind of thrall to the Air Force was visible four months before it was created.<sup>1</sup>

It was obviously desirable to do whatever could be done to settle the terms of the new corporation's relationship with the Air Force before the corporation was created, and, insofar as possible, to settle them in a way calculated to appeal to the SAGE team. The best safeguard would be to make sure that the new corporation had other customers besides the Air Force, so that neither the Air Force nor any of its other customers would be able to control it completely. It was probably with an eye both to the inter-service character of the air defense task and to the SAGE engineer's need for independence, therefore, that the Institute's Visiting Committee to the Division of Sponsored Research, after looking into the matter, urged Dr. Stratton to "insist that the assignment of responsibility not indefinitely confine the new systems engineering organization to the Air Force role alone," and it was probably for the same reasons that the Executive Committee of the MIT Corporation concurred in this sentiment.<sup>2</sup> In effect, MIT was apparently trying to repeat a maneuver it had successfully executed in 1951 when it saw to it that the Lincoln Laboratory was empowered to accept work from any or all of the three armed services -- although it is pertinent to observe that Lincoln had nevertheless become for all practical purposes an Air Force captive contractor and that the very real autonomy and even power which it had managed to enjoy was probably attributable, not to its tri-service relationship, but to the recognized urgency of its tasks and to the prestige it drew from its MIT connection. At any rate, on a trip to Washington about a week after receipt of the Douglas letter, Dr. Stratton

conveyed these MIT views in separate conversations with Deputy Secretary of Defense Donald A. Quarles and Secretary of Defense Neil McElroy. Both gentlemen recognized the inter-service problem and indicated an intention to do something about it eventually, but Quarles felt that the immediate urgency was to integrate the Air Force parts of the air defense system, and McElroy was reported (by McCormack, who was also present) to have put the matter thus:

I cannot say today [ March 12, 1958] precisely how the system engineering contractor can bring together Army, Navy, and Air Force parts of the air defense system. We are right now working out a reorganization of the Department of Defense to improve coordination in all areas. But I would ask that in organizing the new contractor effort you provide flexibility to take on the Department of Defense requirements as we develop them.<sup>1</sup>

This was hardly a binding commitment, but it was probably the best that Stratton could have achieved under the circumstances. McElroy was alluding, of course, to the Eisenhower Administration's controversial Defense Department reorganization plan, which President Eisenhower presented to the Congress in a special message on April 3 and which led to the Department of Defense Reorganization Act which he signed into law on August 6. This measure enhanced the authority of the Office of the Secretary of Defense and created inter-service operational commands which answered to the Joint Chiefs of Staff, but, unlike the original proposal, did not deprive the service secretaries of their right to appeal directly to the Congress over the head of the Secretary of Defense, and thus left the services with considerable powers of obstruction. Perhaps it was for this reason that the Directorate of Defense Research and Engineering, one of the Act's important innovations, was not able to do much effective integrating until about 1963. Had the Act been passed in its original form, that directorate might have been able to assert itself earlier, in which case it is conceivable that ADSID might before long have been detached from the Air Force and reassigned directly to the Office of the Secretary of De-



fense, and the inter-service difficulty which troubled the MIT administration and the SAGE team (and which, incidentally, contributed to the frustration of General Bergquist) might have disappeared. The future was not destined to unfold in this way, but Stratton had pressed his point as far as circumstances permitted. From this time on there was really nothing to do but to proceed with the launching of the new corporation in the faith that eventually the gentleman's agreement with the Office of the Secretary of Defense would somehow be honored.

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However, the kind of non-profit corporation to establish and the kind of sponsorship to provide for it had still to be determined, and at some time between February and May at least one prominent member of the MIT community, Professor Vannevar Bush, challenged the tacit assumption that MIT would have to be one of the sponsors. It was apparently Bush's view that, since the engineering of a comprehensive air defense system was an inappropriate activity for an educational institution, MIT ought to avoid even the indirect connection that sponsorship would imply, and Stratton was probably of the same mind.<sup>1</sup> An ideal solution would be a consortium of private business concerns which would establish, own, and assume full responsibility for the new corporation, so that MIT would not even have to be represented on the corporation's board of trustees and the divorce would be complete. In order to avoid even a suspicion of conflict of interest, moreover, it would be well if all or most of the members of the consortium were not engaged in the electronics industry and neither had nor expected to have any air defense contract. In pursuit of this idea, McCormack approached a number of major business interests, including American Telephone and Telegraph, Dupont, Standard Oil of New Jersey, Consolidated Edison of New York, and three or four others, and met with their representa-

tives at the University Club in New York City on May 14. Also present were Dr. Bush, who argued in support of the idea, and Mr. William Webster, a long-time friend and colleague of Rowan Gaither and a member of the RAND board of trustees, who, because he lived in the Boston vicinity (he was Chairman of the New England Electric System), had agreed to help render the assistance that McCormack had requested of Gaither.<sup>1</sup>

Unfortunately, the University Club meeting revealed a distinct lack of enthusiasm for the consortium idea, which therefore had to be abandoned,<sup>2</sup> and the Institute was left with its problem. Lincoln was meanwhile continuing with the day-to-day tasks of engineering an integrated air defense system, so that, even without the proposed new corporation, ADSID was already enjoying an informal working relationship with the SAGE team. If the Institute were ever to rid itself of this inappropriate responsibility, it had no choice but to establish and, at least initially, to sponsor the new corporation itself. On June 3, therefore, President Stratton replied formally and affirmatively to Secretary Douglas's letter three months earlier.<sup>3</sup> He proposed that everything being done or about to be done in support of ADSID be covered under a new and temporary contract with the Air Force, in order to facilitate the administrative separation of this work from Lincoln's other projects, and that MIT then, with Air Force assistance, create a new non-profit corporation which would eventually become the ADSID contractor but, for the sake of a smooth and orderly transition, would function at first as an MIT subcontractor. The transitional period was not to exceed two years, and within that time the new corporation would gradually take charge of the various parts of the task, MIT being especially anxious that it should as soon as possible assume direct responsibility for the hiring of the new personnel who would be necessary and for the operation of the Experimental SAGE Subsector.<sup>4</sup> Nor did MIT intend to have anything more than absolutely

necessary to do with the managing of the new corporation. As Dr. Stratton put it,

. . . we conceive that the policies and operating practices of the corporation must generally accord with those of successful industry. We therefore propose that high level business and industrial management experience be brought into the new corporation initially through temporary loan of operating personnel and membership on the board of directors, as a public service, from sources which minimize the possibility of conflict of corporate interests. The building of a more permanent management team can then proceed in an orderly fashion.<sup>1</sup>

In respect to the points that had been of special concern to the SAGE team, this proposal of June 3, 1958 was in the spirit of the Lincoln Laboratory proposal of August 9, 1957. There was the same insistence that the SAGE team, now in the guise of the non-profit corporation about to be created, should be unimpeded in its efforts to plan and supervise the implementation of a comprehensive and integrated air defense system, and that it should enjoy substantial autonomy in determining how to go about this task. Dr. Stratton reminded Secretary Douglas that

. . . we at MIT attach great importance to your statement that the ADSID Commander will have ample authority to make final decisions for the Air Force on the engineering integration of the air defense mission system, and will have effective control of the funds necessary to implement his decisions. In fact, we believe that no contractor could succeed in the advisory role unless such real authority is exercised by the head of the office to which advice is to be supplied.<sup>2</sup>

In order to avoid ambiguity as to the authority that would have to be exercised over other contractors, he remarked that

... we consider it very important that the position of MIT under this contract, and subsequently the position of the successor organization, be unequivocal among other contractors as the central and principal systems advisor to ADSID. To this end, we believe that the Air Force should emphasize the desirability of the systems advisory contractors entering into subcontracts with existing air defense contractors and other contractors as necessary for work in support of the systems advisory function.<sup>3</sup>

Dr. Stratton also took occasion to make it a matter of record that MIT had taken certain other positions since the meeting of January 18. He called attention to the fact that the new corporation would eventually expect to serve, not just the Air Force, but the entire national military establishment:

It is our expectation that . . . strength and flexibility can be built into the new organization to enable it to accept not only the responsibilities now firmly intended for it by the Air Force but additional air defense systems engineering tasks the Department of Defense may contemplate for future assignment to such a centralized operation.<sup>1</sup>

Nor did he fail to allude to the difference of opinion that had arisen during the spring between Lincoln and ADSID concerning "the amount of research and development work the systems engineering organization may undertake,"<sup>2</sup> a point in which Everett and his associates had been interested at least since Everett's memorandum regarding the ADSMO proposal a year earlier. However, instead of arguing, as Everett had argued, that research and development and systems engineering are complementary and that either is impoverished without the other, Stratton stated the case in terms perhaps more likely to be appreciated by the Air Force:

The point is an important one because of its bearing on the technical skills required by the organization, on its attractiveness to scientists and engineers, and on its future relationship to the Lincoln Laboratory. Our conclusion is that although very little of such work will be required of the systems engineering organization at the beginning, the contract should provide for research and development activities that prove necessary to the direct support of the systems engineering function and to the healthy development of the professional staff.<sup>3</sup>

The insistence on the status of "principal systems advisor to ADSID" may be readily explained as an effort to obviate the frustrations that can so easily arise when a task requires more authority than is granted.

Very likely, it would be too much to suggest that it was made with an eye especially to the System Development Corporation, but it did have a bearing on the still undecided role that the latter would play. The System Development Corporation knew, of course, that the Air Force had been negotiating with MIT since January, but until May it had apparently not realized that part of the idea was that the proposed new corporation should have a dominant, if not exclusive, voice in advising ADSID. Writing to Mr. Gaither on May 10, the SDC president, Mr. M. O. Kappler, envisioned that there would be a division of the advisory function wherein it would be SDC's part to "formulate air defense system evaluation studies to determine the worth of new operational proposals or procedures and formulate plans for the integration of new weapons or equipment into the air defense system from the computer program viewpoint."<sup>1</sup> SDC was under contract to the Air Defense Command (one of the three commands represented in ADSID) to develop the SAGE computer programs, but Kappler believed that this extension of SDC activity could be authorized under the existing ADC contract, and referred to an agreement on the point "which has been concurred in by ADC, SDC, ADSID, and Lincoln Labs."<sup>2</sup> It quickly appeared that there had been a misunderstanding. The document in question seems to have been "drawn up by ADC and SDC, and presented to ADSID and Lincoln," and to have been "in effect, a codification of the present pattern of relationships among ADC, ADSID, SDC, and Lincoln." According to McCormack, moreover, Overhage had asked that it be modified to apply "only to the period prior to the formation of the new corporation," and General Bergquist, for reasons of his own, had then redrafted it so as to exclude all reference to Lincoln.<sup>3</sup> The SDC trustees at their meeting on May 28 were reported to have rejected these modifications as "tantamount to nullification because they were unsatisfactory to ADC and SDC and made

without their consent after four-party agreement had been reached," but they decided not to press the issue. As for their sensing "a change from the expected SDC and CCC [Cape Cod Corporation] cooperative atmosphere to one of clear domination by CCC,"<sup>1</sup> McCormack later explained to Stratton that

. . . the Air Force has said that the responsibility and authority for the systems integration of the air defense system are to be centralized in ADSID, and that a central systems engineering contractor is required to work in support of ADSID. It has seemed to us obvious that the show will not go without the cooperation of other Air Force commands and contractors, as Secretary Douglas has assured us will be forthcoming. I think what is wrong is that what has seemed so obvious to us has not so appeared to SDC, that we were slow in realizing this, and therefore only gradually came into the practice of saying firmly things which had not occurred to us initially as needing to be said.<sup>2</sup>

Mr. Kappler and the SDC trustees were understandably disappointed, for the decision meant that SDC had lost what was probably its best hope of outgrowing its original character as an operations analysis and computer programming specialist and becoming, in the full sense of the phrase, a "system development corporation." Their protests to Gaither, however, produced hardly more than a few telephone calls and an apparently amicable meeting between Gaither and Stratton, and Gaither remained quite willing to accept the chairmanship of the new corporation when formed.<sup>3</sup> It is not clear whether Secretary Douglas ever learned of the displeasure of the SDC trustees, but, if he did, he was not dissuaded from the course to which he was committed. On June 25 he formally acknowledged Stratton's letter of June 3 and indicated his full and unqualified acceptance of the MIT proposals and stipulations.<sup>4</sup> Negotiation of the interim contract whereby MIT would initially and temporarily accept the ADSID support responsibility was already under way when Douglas wrote,<sup>5</sup> and the Lincoln Lab-

oratory was already making plans to engage additional technical personnel ("ADSID Reserve," as they were called informally) who would supplement the SAGE team when the time for transfer to the new corporation came.<sup>1</sup> By mid-July MIT had received a signed Air Force letter contract,<sup>2</sup> and everything was in readiness for the actual creation of the separate system engineering organization that had been contemplated since the Douglas-Stratton meeting in January.

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It was left to McCormack and Webster to accomplish the legal steps of incorporation. With the assistance of Mr. John M. Woolsey, Jr., a Boston lawyer whom they engaged for the purpose, they drafted the charter or "certificate of incorporation" of what they decided to call The MITRE Corporation and, as of July 21, incorporated it in Delaware as a membership organization modelled after the RAND Corporation.<sup>3</sup> On August 4 they chose the first five members:<sup>4</sup>

H. Rowan Gaither, Jr. -- Chairman, Board of Trustees, RAND Corporation; and Chairman of the Board, Ford Foundation.

Franklin R. Collbohm -- President, RAND Corporation; and Chairman, Board of Trustees, System Development Corporation.

Julius A. Stratton -- Chancellor and Acting President, Massachusetts Institute of Technology; Trustee, RAND Corporation; member of the board, Ford Foundation.

James McCormack, Jr. -- Vice President in Charge of Sponsored Research, MIT.

William Webster -- Executive Vice President, New England Electric System; Trustee, RAND Corporation; Trustee, MIT.

The first members' meeting occurred the following day in the Lexington offices of the System Development Corporation, adjacent to the Lincoln Laboratory and soon to become the offices of the MITRE Corporation, at which

time five additional members, also present, were added:<sup>1</sup>

Lloyd D. Brace -- Pres., First National Bank of Boston; Trustee, MIT; member, Board of Directors, American Telephone and Telegraph Co.

William T. Golden -- Trustee and member of Executive Committee, SDC.

Edwin E. Huddleson, Jr. -- San Francisco attorney (partner of Gaither); Trustee, RAND Corporation; Trustee and member of Executive Committee, SDC.

Robert C. Sprague -- Chairman and Treas., Sprague Electric Co.; Trustee, MIT.

Clair W. Halligan -- Executive, Bell Telephone Laboratories.

The ten members thereupon elected themselves to the MITRE board of trustees, which thus became a body identical with the membership.<sup>2</sup> In the latter capacity, they named Gaither as board chairman and chose the following corporate officers.<sup>3</sup>

President	Clair W. Halligan.
Treasurer	Joseph J. Snyder, Vice Pres. and Treas., MIT.
Assistant Treasurer	Paul V. Cusick, Comptroller, MIT.
Secretary	Thomas F. O'Donnell, who until this time had administered the SDC Lexington office.

they also established an executive committee of the board of trustees, comprising Gaither, Halligan, McCormack, Stratton, and Webster, with Webster as committee chairman.<sup>4</sup> Three more members and trustees were elected at the next meeting on October 7:<sup>5</sup>

Dr. Luis W. Alvarez, Associate Director, University of California Radiation Laboratory.

Charles A. Coolidge, member of the Boston law firm of Ropes & Gray.



Dr. Lawrence R. Hafstad, Vice President, Research, General Motors Corporation.

In the selection of the first ten of these thirteen members and trustees, there was a deliberate symmetry. Four of them (Stratton, McCormack, Brace, and Sprague) had some kind of an MIT connection; four others (Gaither, Collbohm, Golden, and Huddleson) were associated with RAND or SDC or both; Webster had ties with both RAND and MIT; and only Halligan, included ex officio, had no connection with either.<sup>1</sup> (Stratton, to be sure, was also a member of the RAND board, and, moreover, had known Gaither since the days of the MIT Radiation Laboratory during the Second World War; but, since he was then President of MIT, his MIT connection was no doubt considered primary.) It was part of the intention that the MIT and the RAND-SDC connections should be approximately equal, and this was mutually advantageous because, on the one hand, it assured MIT that someone besides itself would share the responsibility of "sponsoring" MITRE (a responsibility MIT would have preferred to avoid altogether if that had been possible), and, on the other, it gave those who had SDC's interests at heart at least a voice in controlling MITRE. However, it would be a distortion to say, as is sometimes said, that MIT and RAND co-sponsored the MITRE Corporation. RAND in its corporate capacity had played a vital role in the formation of two other non-profit membership corporations -- SDC in November 1956 and Analytic Services, Inc., in July 1958.<sup>2</sup> --but as a corporation it had no part in the creation of MITRE, and neither had SDC. Gaither, Collbohm, Golden, Huddleson, and Webster were acting as private individuals. The same might perhaps be said of Brace and Sprague, but not of Stratton and McCormack; for the creation of MITRE was the fulfillment of one of MIT's urgent policy objectives, so that assisting that creation in every possible way, including acceptance of mem-

bership in the Corporation and on its board, were duties that devolved upon Stratton and McCormack by virtue of their respective positions as officers of the Institute. Indeed, the MIT imprint on MITRE was far deeper than that of any other organization with the possible exception of the Air Force, consisting, as it did, not only in the persons of Stratton and McCormack on the board but also in the greater part of the SAGE team, which, a few months later, became the nucleus of MITRE's technical staff. "Sponsorship," in this context, is admittedly a vague term, but the Air Force has a better claim to be considered a co-sponsor of MITRE than RAND has. MITRE, after all, was the result of some two and a half years of negotiation (not to say "backing and filling") between MIT-Lincoln and the Air Force, and SDC did not become involved in the story until the summer of 1957, and Gaither and Webster even later. Besides, it was only because the Air Force stood ready to fund a MITRE contract that the creation of the Corporation was feasible.

The question of the reality of sponsorship was one thing; the desirability of being a sponsor, or of being known as a sponsor, was another. Nothing so well illuminates the true situation as the curious story of the name "MITRE" -- a name which all but inevitably brings MIT to mind. Especially when the name is spelled in capitals, as it is the Corporation's custom to do, one tends to think to oneself: "'MIT' -- that's obvious; I wonder what the 'R' and the 'E' could mean." The most straightforward rendering that seems to suggest itself is "MIT Research and Engineering," and this explanation has had a certain currency. Those who happened to know that some prominent RAND personalities had had a hand in establishing the Corporation have been inclined to think the name meant "MIT-RAND Engineering," while others, with a snide cast of mind, have favored "MIT Rejected Engineers." Yet the incorporators, who coined the name,

have always repudiated these meanings, maintaining that they chose it after consulting a dictionary and a thesaurus and learning therein of the various meanings of the word "miter" -- a smooth joining of pieces cut, usually in a carpenter's miter box, to fit together exactly in a diagonal seam; a headband worn by women in ancient Greece; a liturgical headdress worn by bishops and abbots; a headdress worn by ancient Jewish high priests and adorned with a gold plate with the inscription "Holy to the Lord"; and a protective shield.<sup>1</sup> Of course, they discovered this word by turning to the part of the dictionary containing words beginning with the letters "mit," but it has been suggested that they did not mean to imply a definite MIT connection and did not at the time think of the significance that others might attach to those three letters. At least one of the incorporators disliked long and clumsy titles and wanted something simple and with pleasant connotations. At any rate, after considering whether to spell the name the English way, ending in "er," or the French way, ending in "re," and deciding that the latter would be more suitable, the incorporators proceeded to incorporate The MITRE Corporation.<sup>2</sup>

Everyone was apparently satisfied with the choice except Dr. Stratton, who would have much preferred a name that did not suggest the Massachusetts Institute of Technology but who, it seems, had not made his wishes on this point clear beforehand.<sup>3</sup> For him and probably for some of his MIT colleagues, the object was not only to rid the Institute of all actual responsibility for managing the technical evolution of a major military system, but also, insofar as possible, to obviate any public tendency to associate the Institute even loosely with such an activity. It would be a few years yet before it would begin to be a public relations liability for an academic institution to be associated or suspected of being associated with the "military-industrial complex," but Stratton was already alive to the

danger. Moreover, if the MITRE Corporation were commonly believed, even if erroneously, to be some kind of MIT agency, MIT would still suffer the opprobrium of those business executives who had all along resented the fact that the Lincoln Laboratory had been designing and developing SAGE, on the ground that the job properly belonged to private industry, and who would thenceforth take the same view of MITRE; and there would continue to be a certain vague suspicion that MIT was not quite the disinterested pursuer of knowledge that it ought to be.<sup>1</sup> It was because of Stratton's protest that the MITRE board devoted time in October to the possibility of changing the name. The alternative that seemed least unattractive was "The SHIELD Corporation -- again, for some reason, spelled as an acronym, but nevertheless an indication that the protective-shield conception seemed particularly appropriate to several members of the board. The prevailing sentiment on the board, however, was against making a change; and Stratton acquiesced, partly because he recognized the legal difficulties that a change would involve and partly, no doubt, because he saw that any change would necessitate some public explanation of the reason for being dissatisfied with the original name, thus calling attention to the very thing from which he hoped to detract attention."<sup>2</sup>

As it was, the fuss did attract attention in Lincoln, coming, as it did, at a time when several members of the Lincoln staff were considering whether or not to throw in their lot with the new Corporation and become part of its initial technical staff. Denials that "MITRE" meant "MIT Research and Engineering" and assertions that it really meant a bishop's hat or a protective shield tended to be received with skepticism and to evoke some unsolicited alternative renderings, ranging from the spiteful "Must

I Trust Robert Everett?" to the whimsical "Many Italians Trying to Run Everything."<sup>1</sup> The Corporation itself probably contributed to this state of affairs by persistently spelling its name as an acronym, even while disavowing any conceivable acronymic meaning. If it had wished its name to be associated with one of the dictionary meanings of the word "miter," it should logically have adopted the spelling appropriate for an ordinary proper noun: "Miter" or, perhaps, "Mitre." Most of the dictionary meanings, to be sure, were hardly pertinent, but there could hardly be a meaning more pertinent to the kind of organization MITRE was than the one drawn from carpentry. What, after all, had the SAGE engineers been doing for the past several years if not to trim, adjust, and modify -- in short, to "miter" -- various electronic and weapon systems to form a coherent and integrated air defense system? What else is implied in the phrase "systems engineering," and what else was MITRE's original raison d'etre? Yet the acronymic spelling remained, and there must be a reason why it did. The example of the RAND Corporation was probably an influence, even though the cases were not parallel because "RAND" was a genuine acronym meaning "research and development," whereas no one would admit that "MITRE" was an acronym for anything. But this does not preclude the possibility that someone connected with the Corporation may have had a motive in preferring the acronymic spelling -- a motive that would be the mirror opposite of Dr. Stratton's motive. For MITRE, far from being embarrassed to have it known that some kind of a connection existed between it and MIT, would derive a needed prestige from such a connection. As later developments would show, it was often at a disadvantage in dealing with the Air Force because it had to do so entirely on its own, and it might have been better able to conduct its affairs according to its own independent professional judgment if, like the Lin-

coln Laboratory, it had had the MIT administration standing right behind it. Thus, it seems not entirely unreasonable to wonder whether the first three letters of the name "MITRE" were not, so to speak, a swatch surreptitiously snipped from MIT's mantle -- not a large enough swatch to do much good, as it happened, but the largest that circumstances would allow.

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More important in the long run than the question of the name was the fact that the Corporation was deliberately modeled after the RAND Corporation. It was thus not only a quasi-public non-profit corporation with close ties to the military establishment, but a member of a novel and interesting sub-group of such corporations. It was the third of its kind to be created, the RAND Corporation dating from May 1948 and the System Development Corporation from November 1956; and on July 28, 1958, a week after its own incorporation, it was joined by a fourth member of the tribe, Analytic Services, Inc. Two more would emerge within the next three years -- the Aerospace Corporation in June 1960, and the Research Analysis Corporation in June 1961. Of these, the last named was primarily associated with the Army, and the rest with the Air Force. Each of the six was a membership organization with no capital stock and no initial capital except as provided through loans; each was governed by a board of trustees (unsalaried except for the chairman and the executive committee) which was legally responsible only to the members; each was allowed by its initial charter, or certificate of incorporation, to work only for the federal government, although this limitation would later be relaxed; and each in practice worked exclusively or primarily for the Air Force (or the Army in the case of the Research Analysis Corporation),

normally under a cost-plus-fixed-fee contract.<sup>1</sup> The purpose of the fees was to give the corporations stability and some discretionary latitude in the management of their affairs -- to let them accumulate funds to tide themselves over periods of uncertainty while government appropriations were pending, acquire physical plant and equipment over and above what the government was willing to provide, and initiate non-reimbursable research programs in order to attract and hold staff members of the desired calibre.<sup>2</sup> Now, a part of these fee receipts went into the purchase of durable property, chiefly land and buildings, title to which was vested in the corporations, and which had potential sale value. Although this property was not "profit" in the sense of being convertible into dividends, it was "profit" in the sense of being net gain to the corporations; and, since such net gains were not occasional windfalls but as essential and intended feature of normal operations, it is questionable whether the term "non-profit corporation" is appropriate. There has been some disposition, mostly in the corporations themselves, to substitute the term "not-for-profit corporation" -- a way of admitting that the corporations did experience something partially resembling a profit while at the same time insisting that profit-making was not their raison d'etre. But this legal distinction is a very fine one, and has failed to impress the world at large. The press has almost invariably continued to call these anomalous organizations by the briefer and simpler term, and so has the Air Force, even in its official papers.

The legal architect of the curious and perhaps seminal institutional innovation was H. Rowan Gaither, a San Francisco lawyer, who invented it when Franklin R. Collbohm, then Director of Project RAND, sought his help in detaching the Project from the Douglas Aircraft Company. In 1946 the Air Force had prevailed on Douglas to sponsor that unique enterprise,

but by late 1947 all concerned wished to end this arrangement and yet not kill the enterprise, and the only feasible solution seemed to be to reconstitute it as the RAND Corporation.<sup>1</sup> A broadly similar situation gave rise to each of RAND's imitators. MITRE was created because MIT would not hear of letting the Lincoln Laboratory engineer the evolution of a complete SAGE-centered air defense system. The System Development Corporation was established in 1956 to continue the work of programming the SAGE computers, a task that RAND had assumed the year before but regarded as an unwelcome distraction from its proper field of interest.<sup>2</sup> Analytic Services, Inc., was a continuation of the Scientific Analysis Office which Melpar, Inc., a supplier of test equipment and other hardware to the armed services, had created in 1957 to meet the special and confidential needs of the Air Staff Director of Development Planning; and that office, in turn, derived from a study group established a few years earlier by the Corvey Engineering Company, a small Washington consulting firm that Melpar had subsequently acquired. Until Melpar entered the picture, other private industrial concerns had been willing to lend this group the proprietary technical information it needed in order to do its work, but it was soon apparent that the group would not be able to function unless it were separated from Melpar. RAND was asked to take charge of it, but chose instead to sponsor Analytic Services -- which, incidentally, not only began life with RAND trustees and officers on its board, as in the case of MITRE, but, unlike MITRE, received major financial, administrative, and managerial assistance from RAND as a corporation.<sup>3</sup> The creation of the Aerospace Corporation in 1960 marked an epoch in the history of the same missile engineering enterprise that the Ramo-Wooldridge Corporation had undertaken in 1954, in support of the Air Force's Western Development Division (later, the Ballistic Missile Division), and



in 1958 had transferred to a profit-making subsidiary, Space Technology Laboratories, Inc. It occurred because of a growing opinion in the Congress that no private profit-making concern ought to enjoy such a privileged relationship with the Air Force as the work necessarily involved.<sup>1</sup> The Army's Research Analysis Corporation succeeded the Operations Research Office, which the Johns Hopkins University had administered for the Army under contract since 1948, and was created in 1961 because both the University and the Army wished to end the contract.<sup>2</sup> In every case there was an already established activity which was considered essential to national defense, and an already established team of experts who were thoroughly conversant with the technical problems involved; and in every case it was a question of keeping these experts on the job even though the organizational superstructure under which they worked had to be changed. In no case did the creation of a Gaither-style corporation mark the beginning of anything. Always, it happened because existing contractual arrangements had broken down and because there was no other feasible solution in sight.

Even so, not everyone welcomed what Gaither and his imitators had wrought. There was always a tendency among some business executives to feel that these not-for-profit corporations were usurping a function that properly belonged to private industry, and there was a corresponding tendency among some civil servants and some military officers to feel that they were usurping an inherent function of government. Neither objection was well taken, and it will be convenient to discuss both at a later point in the story; but it is instructive to consider the misgivings of Deputy Secretary of Defense Donald A. Quarles when he learned that MITRE had been established on the RAND model. He had known at least as early as his conversation with Stratton in March that MIT was going

to divest itself somehow of its SAGE and SAGE-related responsibilities, probably through the formation of some kind of non-profit corporation; but he had not been told, because it had not then been decided, that the RAND model would be the one adopted. It is unlikely that he objected to any and all kinds of non-profit corporations, since, after all, he was a former president of the Sandia Corporation and in 1956 had come to the conclusion that the only way to give the Weapon Systems Evaluation Group the kind of support it needed was to create yet another non-profit organization, the Institute for Defense Analyses. He did not need to be told that some problems could not be met with either military or civil-service personnel and yet were inappropriate for private industry, and he understood that the problem that had given rise to MITRE was in that category; but he nevertheless regretted the choice of the RAND model, fearing that that kind of solution to admitted problems might lead to criticism.<sup>1</sup>

It is not clear what kind of criticism he feared, or from what quarter. As a former telephone company executive, he was undoubtedly aware of the general prejudice of the business community against this sort of thing, but it is unlikely that he uncritically shared that prejudice. McCormack, after talking with him in August, thought that perhaps he meant that any organization of the RAND type was "unanchored except in a board of trustees." His view of RAND apparently was that it "seemed to grow forever in cost and range of interests, and the Air Force is not wise enough to control it."<sup>2</sup> At a meeting in his office on September 3, he aired his misgivings with Douglas, Stratton, and Halligan, suggesting that perhaps the thing to do was to let MITRE be absorbed by the Institute for Defense Analyses; but his visitors pointed out that the IDA and MITRE missions were less similar than he apparently thought, and Stratton, who had not wanted MIT in its corporate capacity to be even a member of the

IDA consortium, said that "the IDA setup was giving some concern to some of those who have sponsored it." It would obviously not have suited Stratton's purpose to let IDA absorb MITRE because MIT, a member of the IDA consortium, would thus have retained a share of those very SAGE-related responsibilities of which he wanted MIT to be rid. Nor surprisingly, he offered the counter-suggestion that MITRE should be allowed to absorb IDA, a much more attractive idea from his standpoint since it would have put an end to the IDA consortium, about which he had always had misgivings, still further reducing MIT's managerial responsibilities to the military establishment.<sup>1</sup> Probably the only solution that would have pleased Quarles and Stratton alike was the industrial consortium that Vannevar Bush had advocated, since that would have "anchored" the new corporation without making MIT one of the anchors; but that prospect had been explored in May and, as we have seen, had to be abandoned because none of the industrial concerns approached cared to cooperate.

Quarles evidently decided to accept the fait accompli, and there was no further talk of any kind of merger; but his anxiety is none the less interesting. As he had apparently seen all along, any RAND-like organization was a curious legal anomaly in that no one, not even its members, could be said to "own" it. The members, to be sure, were the body to whom the board of trustees was responsible, and were thus the ultimate legal authority in the determination of corporate policy; and the right to exercise that kind of authority is one, but only one, of the essential marks of ownership as that concept is usually understood. But ownership is also understood to be based on inheritance or purchase and to confer both a right to appropriate any profit and a liability for any loss, and the members clearly did not qualify as owners under any of these tests. If investment of funds were the sole test of ownership, then the federal government would

have to be regarded as the owner of all six corporations, since they all began with no assets and (except for RAND, which had a small bequest from the Ford Foundation) managed to acquire assets only as they collected their fees, all of which came from the government. But this will not hold either. For one thing, the government could not appoint or remove members or trustees, and thus could not directly determine corporate policy -- although, admittedly, it could exert powerful indirect influence through the awarding and managing of contracts. For another, there was initially no stipulation that the government might recover fees or property purchased with fees, even if the corporation were to be dissolved. The clause covering dissolution in the MITRE charter said that in such an event the members would transfer any net assets to a "successor charitable or nonprofit corporation, contributions to which are deductible for Federal income tax purposes," or, if there were no such successor, to any other "charitable or nonprofit corporation" that they might name.<sup>1</sup> The RAND, SDC, and Analytic Services charters had broadly similar provisions,<sup>2</sup> but, interestingly, the Aerospace charter (June 1960) marked a change, providing that any remaining assets should be turned over "to the United States of America as the Secretary of the Air Force may direct."<sup>3</sup> Similarly, the Research Analysis Corporation charter empowered the Secretary of the Army to dispose of assets.<sup>4</sup> Not until 1962 was the MITRE charter amended to the effect that the President of the United States had to be given sixty days' advance notice of an impending dissolution, during which time he might ask in writing that the assets be transferred to the government.<sup>5</sup> No doubt, these changes protected the public interest, but they did not fully establish government ownership because they did not affect the independence of the members and trustees in determining corporate policy.

It does not follow that anything fraudulent was afoot. If any of these corporations had happened to be dissolved while the unmodified language of its original charter was still in effect, for example, it is difficult to believe that its members would have resisted or wished to resist any equitable claim by the government. Nor, as yet, was this question of ownership that had apparently troubled Quarles a matter of more than theoretical interest, since the indirect control that the Air Force (or the Army) could and did exercise through the contract mechanism was sufficient for all practical purposes. But, if one of these corporations should some day obtain, not just a few minor contracts with agencies other than its principal client, but several substantial contracts with a variety of clients, the Air Force (or the Army) would no longer be able to use its own contract with that corporation as an instrument of virtually coercive pressure. The "unanchored" corporation would then be genuinely independent and autonomous, and, if it failed to behave responsibly, would be beyond the reach of any known control short of legislative fiat.<sup>1</sup>

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In any case, the business of preparing the new corporation to assume its functions proceeded fairly rapidly, even in spite of some wrangling with minor Air Force officials concerning the fee question and other matters of contract administration. Indeed, Secretary Douglas was mildly surprised at the speed of developments when Dr. Stratton and Mr. Halligan called at his office on September 3 to explain what had been accomplished up to that time.<sup>2</sup> By the end of August MITRE, although still without technical personnel, had twenty-two persons on its payroll, comprising the Corporation officers and a few secretaries and other minor employees,<sup>3</sup> and had established its executive offices in the cluster of interconnected "Butler" buildings at Hanscom Field next to the Lincoln

Laboratory buildings. Commonly known at the time as the "RAND Buildings," these temporary structures had been erected about two years before to accommodate that part of RAND's System Development Division (soon to become the System Development Corporation) assigned to work with Lincoln on SAGE computer programming. When MITRE was created, however, SDC decided to close its Hanscom Field office at the end of August, and on September 1 MITRE assumed the security and custodial responsibility for the buildings and also acquired about forty former SDC non-technical employees.<sup>1</sup> The Air Defense Systems Integration Division, comprising nearly two hundred military and civilian personnel, was already occupying a part of the space in these buildings, and continued to do so, so that MITRE began life in the closest physical proximity to both Lincoln and ADSID, the two organizations with which it was then intimately associated and needed to be in daily contact.

The technical support of ADSID that MITRE had been created to provide was, of course, already being provided by the Lincoln Laboratory under the letter contract (not yet "finalized" or "definitized") to which MIT and the Air Force had agreed in July. The plan was for MIT to issue a subcontract to MITRE as a vehicle for the gradual transfer of the work in question, and MIT did so as of September 1;<sup>2</sup> but, before MITRE could assume actual responsibilities, it had to have substantial funds at its disposal, partly to meet certain special expenses involved in setting itself up in business, and partly to assure itself of the stability and semi-independence that not-for-profit corporations were supposed to enjoy. MIT managed to obtain a sufficient advance payment on its contract to meet the immediate need,<sup>3</sup> but provision for the new corporation's independence and long-run stability proved more difficult. The RAND Corporation had been able to meet this problem at the very beginning in 1948 by arranging

for a large loan (later converted to an outright grant) from the Ford Foundation, and had therefore found an annual fee of six percent of reimbursable costs generally satisfactory.<sup>1</sup> By 1958 the six-percent fee had become a kind of precedent as regards not-for-profit corporations, although not necessarily as regards profit corporations,<sup>2</sup> and the creation of the System Development Corporation in 1956 and of Analytic Services in 1958 did nothing to modify the precedent because RAND, which sponsored both of them, was able in one way or another to see that their initial needs were met.<sup>3</sup>

But MIT, knowing that there was no one to play Ford Foundation to MITRE and yet wishing to put MITRE on as independent a footing as possible, had proposed a fourteen-percent fee when it was negotiating the initial letter contract in June and July, apparently on the basis that the Air Force had allowed such a fee to the Ramo-Wooldridge Corporation. Mr. W. P. Kelly of the Air Materiel Command, who represented the Air Force in those negotiations, thought that fourteen percent was too much but at length agreed that ten percent would be reasonable.<sup>4</sup> However, the money for the ADSID-support contract, including any fees, would come, not through AMC (which was involved only because the Air Force had made the negotiation of contracts an AMC mission), but through the Air Research and Development Command and its local agency, the Air Force Cambridge Research Center. Indeed, it would devolve upon CRC to administer this contract, once negotiated, just as it had all along been administering the Lincoln contract. Perhaps because Lincoln's experience with CRC had been on the whole quite satisfactory, MIT was somewhat surprised to learn in mid-September that the CRC administrative contracting officer, Frederick F. Martin, doubted that existing directives would permit a fee in excess of six percent.<sup>5</sup> He was apparently not personally opposed to

the larger fee (incidentally, he resigned his post at the end of October to become MITRE's Contract Manager<sup>1</sup>), but his successor, Donald E. Barton, on the strength of an opinion by the ARDC Director of Procurement, Robert E. Miedel, served notice on November 7 that ten percent was not acceptable and that six percent would be "an equitable allowance, all things considered" -- observing that the government had already authorized an advance payment and was furnishing much of the needed facilities, and arguing that "some of the costs which Mitre expects the fee to embrace are in fact allowable and recoverable through overhead or as direct charges." As regards "specific costs which are of an unusual nature," the same letter volunteered the suggestion that

. . . appropriate Government representatives are available for a conference, with the expectation that The Mitre Corporation can be given definite subcontractual coverage for reimbursement of such costs as are reasonably incident to performance of the ADSID work. If it evolves that some costs are unallowable and that a significant amount is involved, the entire matter will be resubmitted to Headquarters ARDC for reconsideration.<sup>2</sup>

Ostensibly, the dispute was about money, but McCormack was probably right when he wrote to Stratton on November 20 that what was really at stake was control. He noted that in the November 7 letter "all of the money we were asking for is offered through direct reimbursement and overhead -- there is even an offer to talk about otherwise unallowable items of cost."<sup>3</sup> The point was that monies paid to MITRE as reimbursable costs or overhead, or through specific provision for special or unusual costs, would be subject to ARDC's periodic review, and would thus put ARDC in the position of approving or disapproving MITRE's every move; whereas fee monies could be spent at the Corporation's discretion and without the necessity of tedious reams of justification papers. At issue was the Corporation's freedom to act on its own instincts and to en-



joy the autonomy that an organization must have if it is to maintain a truly professional character. "The result of accepting the ARDC decision," prophesied McCormack, "would inevitably be a captive organization, unduly responsive to individual staff opinions throughout the Air Force."<sup>1</sup> Indeed, whether it knew it or not, the fledgling MITRE was already in the thick of the second major power struggle in its history -- the first having occurred during its gestation period the preceding spring. It was during the spring before MITRE was created that ADSID had tried to deny the proposed corporation the working control of the Experimental SAGE Subsector, the principal tool that MITRE would have to use for the next few years; and it was then that MIT had extracted from the Air Force a vague moral commitment to allow the new corporation to conduct its own independent research program, and from the Secretary of Defense a vague assent to the proposition that the new corporation would not be tied to the Air Force indefinitely.<sup>2</sup> This second struggle would also end in a compromise in which MITRE would gain a minor concession, but at the cost of a fundamental weakening of its strategic position.

Concerning ARDC's proposal to meet MITRE's financial needs in almost any conceivable way except through a ten-percent fee, McCormack remarked that "neither MIT nor the Mitre Trustees can accept such an arrangement";<sup>3</sup> but, as he immediately went on to observe, the process of transferring the ADSID-support responsibility from Lincoln to MITRE was then in mid-passage, so that neither MIT nor MITRE was in a good position to face a prolonged impasse. Lincoln had already hired several new people for MITRE and was continuing to hire more, and was carrying them temporarily on its own payroll, as "ADSID Reserve." Substantial sums had been committed to the purchase of equipment and supplies.<sup>4</sup> Early in September Robert R. Everett and John F. Jacobs, Head and

Associate Head of Lincoln's Division 6, had agreed to accept the positions of Technical Director and Associate Technical Director of the MITRE Corporation,<sup>1</sup> and had set about to plan and recruit for MITRE's all-important technical staff. They were themselves transferred to MITRE's payroll on October 1, along with John C. Proctor, who had been in charge of the support services unit (Group 60) that Division 6 had inherited from Project Whirlwind, and who now became Director of MITRE's Technical Services Department (Dept. C-30); and they were followed a month later by eleven other Division 6 people, most of whom had also come to Lincoln from Project Whirlwind.<sup>2</sup> Six of them had joined the Whirlwind staff in 1949 or earlier:

Kenneth E. McVicar (Leader, Lincoln Group 61, System Design), to become Head, MITRE Dept. D-11, Design.

John A. O'Brien (Ldr, Gp. 62, Exper. SAGE Subsec. Installation), to become Head, Dept. D-12, Sub-System Development.

Edwin S. Rich (Ldr, Gp. 64, ESS Shakedown Testing), first to become Head, Dept. D-14, Test and Evaluation, and a few months later, after O'Brien's departure, Head, D-12.

Lawrence L. Holmes (staff member, Gp. 64), to become Assoc. Head, Dept. D-14.

David R. Israel (Ldr, Gp. 66, Special Studies), to become Head, Dept. D-16, Special Studies.

David R. Brown (Ldr, Gp. 68, System Office), first to become Head, Dept. D-18, System, and later, when D-18 was abolished, Head, Dept. D-13, Component Development.

Charles A. Zraket and Walter S. Attridge, Jr., who had been on the Whirlwind staff less than a year before it became Division 6 of the Lincoln Laboratory in January 1952, and who had since become Leader and Associate Leader of Lincoln's Group 67, Advance SAGE Program Development, now became Head and Associate Head, respectively, of MITRE's Department D-17, Advanced Design. The remaining three had come to Lincoln in 1952

or 1953: William J. Canty and Richard S. Fallows, both Associate Leaders in Lincoln's Group 62, accepted comparable positions in MITRE's Department D-12; and Charles C. Grandy, Associate Leader in Group 64, joined Department D-14 in a similar capacity and, when Rich was moved to Department D-12, became Head of D-14.

Before MITRE could prudently receive the rest of the SAGE people and the "ADSID Reserve" people, it needed a finally negotiated subcontract with MIT, not a mere letter contract, but that had to wait until the negotiation of the prime contract with the Air Force was completed, and that, in turn, depended on an agreement concerning the fee. MITRE had reason to fear delay because with every passing week there was increasing danger that many of the SAGE engineers might decide not to move into the new home that had been prepared for them after all; indeed, this was presumably the time when some of them were tempted to read "MITRE" as meaning "Must I Trust Robert Everett?" As McCormack told Stratton in the already cited memorandum of November 20:

Recruiting from within Lincoln presents new uncertainties daily. Key division and group leaders have transferred, but we are in no position to transfer the bulk of the people who should go with Mitre, for lack of a Mitre of some substance, at least having a subcontract from MIT. And there is increasing prejudice to the possibility of transferring the group initially intended for Mitre. Quite simply, with time passing they wonder more and more whether Mitre is other than a shadow. It is important not only to Mitre but to the future Lincoln that we get this first big painful move behind us.<sup>1</sup>

Nor was MIT's own position any more comfortable. If its plans for riding Lincoln of system engineering responsibilities through the creation of MITRE had proved abortive, it could either have admitted defeat and accepted the ADSID-support task permanently (most unlikely as long as Stratton was President), or it could have terminated the ADSID-support

contract and, at a heavy cost in severance pay, discharged the Laboratory's entire SAGE contingent:

The potentialities of the labor situation are awesome. For example, there is at least a quarter of a million dollars one way or another involved in how we handle the matter of severance for Lincoln employees going with Mitre. Union leadership is of course advising against accepting a transfer, and for severance pay. A month ago this could have been managed; today we must admit that there is some question as to our ability to manage it; in another month or two, it is obvious that the situation will not be manageable. If we grant severance pay to union members, then what about clerical and professional employees? In this connection, our clerical workers are becoming more vulnerable to union organization as a result of these delays.<sup>1</sup>

For a change, it was the Air Force that could afford to sit back and wait. Its only real concern was that ADSID should get the needed technical support, and Lincoln had been furnishing that all along anyway. Unless MIT took the truly desperate step of moving to end Lincoln's ADSID-support activities as soon as possible regardless of consequences, letting the Air Force, MITRE, and Lincoln's SAGE personnel all fend for themselves, the Air Force had no need to be anxious; and the people in ARDC headquarters who had made an issue of the matter of the fee undoubtedly realized that there was very little chance of that happening.<sup>2</sup>

At any rate, even though Paul V. Cusick, the MIT Comptroller and MITRE's Assistant Treasurer, chose not to respond to the Cambridge Research Center's proposal of November 7, the fee question was not allowed to rest. It was thoroughly discussed with the Air Force Chief Counsel, Max Golden, on November 24, at a meeting attended by representatives of all of the Air Force agencies involved and by Mr. Cusick. The upshot was a compromise whereby MIT (ultimately, MITRE) would receive a fee amounting to ten percent of the first \$5,000,000 to be appropriated under

the ADSID-support contract plus a lower percentage, to be determined later, of the balance. Interestingly, it was the ARDC Director of Procurement, Robert Miedel, who proposed this compromise; and, since Miedel had vigorously supported (if he had not actually instigated) the Cambridge Research Center's opposition to the ten-percent fee as originally proposed, and since he came to the meeting with this formula already in mind, one is tempted to think that the formula or something like it may have been his objective from the first. If so, he served the Air Force well. At one stroke, he obviated whatever chance there may have been that MIT or the MITRE trustees might have broken off negotiations and thus precipitated an unpleasant situation, assured MITRE of sufficient funds to get itself started, and yet preserved the Air Force's future ability to keep MITRE on a fairly short tether.<sup>1</sup> Moreover, although he insisted that he did not mean to establish a precedent, that is apparently what he did do; for the essential principle of his compromise was that fees should be given to not-for-profit corporations according to what they could show to be their actual need, not according to some arbitrary percentage of the total value of their contracts. It would not be many years before the Air Force would entirely abandon the percentage approach to the fee question and force the corporations to negotiate for their fees annually and in absolute amounts.<sup>2</sup>

For the same reason that the compromise was to the long-run advantage of the Air Force, it was to the long-run disadvantage of MITRE, although there is no evidence that anyone in MITRE perceived this at the time. In any case, MITRE could not then have withstood the short-run consequences of refusing, and MIT, with its whole plan for ending its SAGE involvement hanging in the balance, would probably not have appreciated any balking by MITRE even if MITRE had been inclined to balk. The

compromise, with its face-saving but ultimately meaningless provision that the fee for the first \$5,000,000 would be ten percent, was accordingly accepted, and on that basis MIT agreed, on December 31, to a definitive Air Force contract in the estimated total amount of \$12,980,000<sup>1</sup>, having already, about a week earlier, given MITRE a definitive subcontract.<sup>2</sup> With the way thus cleared, Lincoln proceeded to transfer to MITRE as of January 1, 1959, all of the SAGE personnel who were then willing to throw in their lot with the new enterprise, and all of the "ADSID Reserve" people who had been hired at various times during the preceding six months to fill anticipated posts for which no suitable Lincoln candidates were available. Altogether, MITRE acquired 485 former Lincoln employees at this time, including 193 professional staff members, so that its total payroll rose from a mere handful to something more than five hundred, including a professional staff of a little more than two hundred.<sup>3</sup> These figures, although better than it had been feared they might be at the height of the fee crisis, were less than original expectations. They did include several former members of Division 2, Aircraft Control and Warning, which had been almost as completely absorbed in SAGE as Division 6; but the effort to give MITRE competence in the fields of communications and radar components by attracting certain people from Divisions 3 and 4 was, for the time being, unsuccessful, and two whole groups in Division 6 (William N. Papian's Group 63, Digital Computer Development, and Patrick Youtz's Group 65, Vacuum Tubes -- of which the latter was then quite small) chose to remain with Lincoln.<sup>4</sup>

Nevertheless, this action of January 1 was the crucial step, for MITRE could not thereafter be described as a mere shadow. It would remain under MIT's tutelage another seven months, until its first direct contract with the Air Force took effect on August 1, but Stratton, ever

anxious to minimize the connection with MIT, had already withdrawn from the executive committee of the MITRE board, his place being taken by Brace.<sup>1</sup> In his capacity as President of the Institute, which was still contractually responsible, Stratton did write to Secretary Douglas on January 7 to report formally on the actions completed on the 1st,<sup>2</sup> and again on May 25 to indicate that everything was in readiness for MITRE to assume a direct contract so that the MIT contract could end.<sup>3</sup> Even after August 1 MITRE still had to depend on the Lincoln Laboratory for a while for administrative support, since it was not able to begin to move its newly acquired technical staff out of the Lincoln buildings into a building of its own until September, but, once it had its technical staff, it was able to function as an autonomous organization. During the course of 1959 it more than doubled its total personnel strength, and several of the additional people recruited, especially during the first six months of the year, were Lincoln people who had hesitated to make the break in January. (The fact that MITRE people were for a while continuing to work side by side, so to speak, with their former Lincoln colleagues, may have helped to win the confidence of the latter.) With these developments, the search that had begun in 1956 for an organization other than Lincoln to deal with the Air Force's air defense system engineering problems was at last successful, and MIT was able to wash its hands of the whole complicated business nearly a year sooner than Stratton had anticipated when he wrote to Secretary Douglas in June 1958.

## CHAPTER FIVE

### NEW WORLDS TO CONQUER

Had it not been for the need to evolve an integrated air defense system centering in the Semi-automatic Ground Environment, the whole series of developments leading to the creation of the MITRE Corporation would never have occurred; yet at no time did MITRE consider itself as existing solely for this purpose. The purpose was undeniably important: before the Air Force could enjoy the advantage of the air defense system for which it had been struggling, paying, and waiting since the time of the Valley Committee, the problem of making the various manned and unmanned interceptors work in harness with the direction centers had to be solved, a program for each direction-center and combat-center computer had to be written, a substantial number of operating personnel had to be trained, the centers themselves had to be built, their equipment had to be installed, and the whole operation of each sector and subsector had to be checked out. But the New York Subsector, with direction center at McGuire Air Force Base, went into limited operation on July 1, 1958; work on the other subsectors and sectors was proceeding on schedule; and there was every reason to think that in five years or so all problems would be met and SAGE would be successfully introduced in all scheduled sectors and subsectors<sup>1</sup> -- so that, well before that time, MITRE would need an entirely new challenge in order to keep itself going. The quest for a new challenge (or challenges) was a major topic in the deliberations of the trustees throughout 1959,<sup>2</sup> but it began in the spring of 1958, before the Corporation was created, when Dr. Stratton went out of his way to obtain what assurances he could that there would be other tasks to look forward to, even if that meant working for agencies other than the Air Force.



To anyone who had had no part in the launching of MITRE, this search for work beyond the completion of SAGE must have seemed unreasonable and even perverse: in order to provide for the solution of one genuine but temporary problem, a permanent organization was created with a continuing appetite for any number of new problems. Some such reflection may have been one of Quarles's reasons for doubting the wisdom of creating MITRE, and even McCormack had doubts.<sup>1</sup> Indeed, someone must have raised this question soon after the Douglas-Stratton meeting in January, for, as we have seen, Everett and Jacobs dealt with it explicitly in their February memorandum to Overhage concerning what was then informally called the "Cape Cod Corporation." Yet the case for building into the new organization an expectation of permanence was a strong one. Everett and Jacobs put their finger on it when they said that "the high calibre of staff required for the Cape Cod job can only be recruited into an organization with potential for life and growth."<sup>2</sup> The SAGE engineers in Lincoln, who would have to be the heart of this staff, were at least as dedicated to their work as most engineers, but they surely knew that that work would not last forever. To have told them frankly that the new organization they were asked to join would last only a few years, with the implication that they would then have to shift for themselves, could only have caused them to shift for themselves immediately; and that would have defeated the primary objective of the whole maneuver, which was to keep them together long enough to do the things that had to be done before SAGE could be a useful system. Thus, if there had not been the prospect of interesting work other than the fulfillment of existing commitments in respect to SAGE, MITRE, as a "new management mechanism" to meet those commitments, probably could not have been created at all, and one is hard pressed to imagine how they could ever have been met.

As it happened, there was prospect of interesting work beyond SAGE -- work generated by the intense anxiety arising from the implications of the Russian sputnik launchings on October 4 and November 3, 1957. It would be too much to say that these dramatic and unexpected demonstrations of Russian prowess introduced the "space age," but they did have a sharp impact on the American public consciousness -- an even sharper impact than the news in the summer of 1949 that the Russians had detonated an atomic device had had. The popular alarm expressed itself in several ways, notably in the widespread belief that the United States had somehow fallen behind the Soviet Union in producing young scientists and engineers and in the consequent tightening up of American education at all levels from primary school to college, with principal emphasis on studies leading to a scientific or engineering career.<sup>1</sup> The creation of the National Aeronautics and Space Administration in 1958 to coordinate and direct an intensive and expensive United States space exploration program was a quite popular step at the time, and about the same time there was an upsurge of all kinds of military programs that had some bearing on the real or imagined threat from outer space, although only a short while before it would probably have been impossible to persuade the Congress to fund any of these efforts. Little in Air Force history is as striking as the way things suddenly began to move in late 1957 and early 1958. Secretary of Defense Charles E. Wilson's plans for drastic defense economies, which had caused such agonizing budgetary reappraisals in the months just before the sputnik launchings, were unceremoniously assassinated; a flurry of "get moving!" orders emanated almost immediately from Air Force headquarters; and in less than six months a helter-skelter scramble to develop and acquire a variety of ambitious and expensive new Air Force systems was under way.

It was in this time that most of the new crop of Air Force electronic systems destined to come into use in the early or middle 'sixties either originated or began to be pursued in earnest -- the most extreme example of headlong haste being the Ballistic Missile Early Warning System (BMEWS). The Air Force had recognized a need for such a system in June 1955, but for two years nothing was done except to study the problem. Then, suddenly, it was decided that within three years there had to be three widely separated stations of powerful scanning and tracking radars (in Greenland, Alaska, and Great Britain) to keep watch in the Arctic heavens; in December an Air Force source selection board chose the Radio Corporation of America and the Western Electric Company as prime and associate prime contractors (to design and install the radars and the rearward communications, respectively); actual contracts were awarded in January and February; on February 12 the Air Force Vice Chief of Staff determined that the "executive management" of the acquisition process would devolve upon the Air Materiel Command rather than the Air Research and Development Command, a clear sign that the system would be procured and installed as soon as possible and with a minimum of research and development; and two days later AMC established the BMEWS project office at 220 Church Street, New York, collocated with Western Electric's Air Defense Engineering Services Project Office.<sup>1</sup> The Geophysics Research Directorate of the Air Force Cambridge Research Center organized Project Harvest Moon on November 30 (soon renamed Project Space Track) to collect and analyze observational data on man-made satellites, and in February, at the instigation of the Defense Department's new Advanced Research Projects Agency, Space Track undertook to plot the paths of all such satellites so that their precise positions at any future date and hour could be predicted.<sup>2</sup> In January ARDC established a project office at Wright-Patterson Air Force Base to speed the acquisition of the

STRATCOM or Strategic Communications System (later renamed AIRCOM and, still later, AEROSPACECOM), really a congeries of interconnected communication systems that was supposed to extend eventually to nearly all parts of the world;<sup>1</sup> and in April it created another such office, also at Wright-Patterson, to develop and acquire the Strategic Air Command Control System to automate communications between SAC headquarters and the widely deployed SAC forces.<sup>2</sup> It was during 1958 that the idea of putting the SAGE combat centers underground began to be seriously considered, and also the idea of burying the more critical parts of the then new North American Air Defense Command (a joint American and Canadian command) in the rocky interior of a Colorado mountain. Of these last, the first took the form of the abortive SAGE-super-combat-center proposal, and the second was the germ of what later became the NORAD Combat Operations Center in Cheyenne Mountain.

In military and government circles, to be sure, there had been for some time a growing apprehension of danger of a thermonuclear attack from or through outer space, probably by intercontinental ballistic missiles. After all, the Air Force began to develop the Atlas, its first intercontinental ballistic missile, in 1954, and there was every reason to think that what the United States could do the Soviet Union could and probably would do sooner or later. By 1955 the Air Force had authorized a number of studies looking toward an eventual ballistic missile defense system,<sup>3</sup> and at least as early as 1956 the Civil Defense Administration was agitating for an expensive program for building radioactive fallout shelters practically everywhere.<sup>4</sup> It was in 1956 that General Earle E. Partridge first raised the question whether the Air Defense Command headquarters should not go underground;<sup>5</sup> the Strategic Air Command had wanted its control system since 1954;<sup>6</sup> and there had been voices calling for an integrated Air Force communication

network even earlier.<sup>1</sup> As for SAGE, there had always been those who had favored underground centers in out-of-the-way places, connected with the rest of the world by communication lines fairly well protected against bomb damage, and who had never ceased to regret that the SAGE Operational Plan of March 1955 had called for a "soft" system.<sup>2</sup> The Eisenhower Administration had commissioned several studies of the nation's defense posture and prospects, one of them being the study organized in May 1957 by H. Rowan Gaither. The Gaither Committee did not submit its report to the National Security Council until November, a month or more after the first sputnik, but had probably arrived at its main conclusions before that. Its most famous (not necessarily its most important) recommendation was its call for a \$22,000,000,000 bomb shelter program, which was immediately brushed aside as too impractical to be considered.<sup>3</sup> Even the sputnik scare was not enough to convince politicians that it would be politically prudent to tell the American home owner that he should forthwith dig up his front lawn to install an underground shelter equipped with all of the facilities necessary for him and his family to live sealed off from all physical contact with the outside world for as long as thirty days; but the late 'fifties were nevertheless a time when the savants of the RAND Corporation were engrossed in thermonuclear war games on paper, in which whole major metropolitan areas in the United States and the Soviet Union were assumed to be annihilated like pawns on a chess board, and when office boys paused on the way to the drinking fountain to read the poster showing the route to the nearest shelter. The apprehension of danger existed before sputnik, especially in the higher levels of government and in the armed services and even, to an extent, in the mind of the "man on the street"; but it was sputnik that so galvanized public opinion as to make it, for a year or two, politically mandatory to spend vast sums in a headlong rush to acquire ambitious, even fantastic,

military systems relating in some way to the real or alleged "space age" threat. Such was the climate in which the MITRE Corporation was born.

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Through 1959 and 1960 MITRE's main activities had to do with the completion of existing plans relating to SAGE, and thus fell under the heading of "old business." Unlike Lincoln, which had been contractually responsible only for the completion and successful operation of the first SAGE module (the direction centers at McGuire and Stewart Air Force Bases and the Syracuse combat center), MITRE had this responsibility for all SAGE centers. It therefore had to work closely with Western Electric's Air Defense Systems Engineering Project Office and with the Air Force's SAGE project office (the latter designated 416L in November 1959), both at 220 Church Street in New York, and to have representatives on hand as each center was checked out. For liaison purposes it maintained a small office at 220 Church Street under J. P. May until the 416L office moved to Hanscom Field in March 1960.<sup>1</sup> The principal missile weapon to be used in conjunction with SAGE was the Bomarc, and, on Western Electric's recommendation, the Air Force decided that SAGE-Bomarc integration testing would be conducted, not in the Experimental SAGE Subsector, but in the Montgomery Air Defense Sector, since the latter included Eglin Air Force Base and permitted Bomarc flights over the Gulf of Mexico. MITRE therefore had a small number of people on temporary duty at Eglin and at the Montgomery center at Gunter Air Force Base until it was found, during tests in the summer and early autumn of 1960, that the Bomarc "A", using an F-101B platform, chronically malfunctioned. On October 14 the Air Force concluded that further Bomarc "A" testing would be uneconomical, and later abandoned Bomarc "B" also, so that the only missile weapons destined to be actually used in conjunction with SAGE were the Army's ground based Nikes, which remained under the

Army's operational control.<sup>1</sup> Meanwhile, another important SAGE adjunct which MITRE had inherited from the Lincoln Laboratory was the Airborne Long Range Input (ALRI) program. It had been recognized for some time that an effective air defense, even against manned bombers, needed as much early warning as possible. The Distant Early Warning System in the Arctic, already complete except for its eastward extension to Iceland,<sup>2</sup> met part of the need, but the country was still exposed on its ocean flanks. Five "Texas towers," placed at intervals near the edge of the North Atlantic continental shelf, provided stationary radar platforms from which the New York and Boston direction centers could "see" considerably farther out into the Atlantic than would have been otherwise possible, but this coverage was never extended to the rest of the Atlantic or to any part of the Pacific coast. For several reasons it seemed a better idea to rely on airborne platforms even though that meant a constantly moving platform and therefore posed difficult technical problems which it had not previously been necessary to face. ALRI would not be fully operational until September 1963, but it was one of MITRE's continuing concerns from the beginning.<sup>3</sup>

A yet more exciting idea, and one which seemed to promise to keep MITRE busy for many years to come, involved a new kind of computer and called for a radical overhauling of SAGE itself. The AN/FSQ-7 had marked an important stride in computer technology when first conceived and designed in 1952, but it was a vacuum-tube machine and solid-state devices had since been perfected to the point that another generation of computers was in the offing, much faster than the AN/FSQ-7 and with much greater program and memory storage capacity, yet much more compact. This, together with renewed anxiety about the survivability of SAGE in case of thermonuclear attack, led to an idea for the radical improvement of SAGE --

or, perhaps one should say, for an entirely new system that would gradually take the place of SAGE. Not only were the combat centers, which existed primarily to monitor and assist the direction centers, to be moved to underground "hardened" facilities where they would be impervious to almost anything except a direct hit; they were also to be equipped with new solid-state AN/FSQ-7A computers of greatly enlarged capacity, so that they could assume several new functions besides their primary function. The AN/FSQ-7A existed in concept only in August 1958 when Charles Zraket's Group 67 of Lincoln's Division 6 explored the "super-combat center" idea with the Air Defense Command, but survivability was not the only advantage anticipated. The proposed computer would be better able than the existing SAGE computers to track targets, control high-speed missile weapons such as Bomarc, process early warning information, and handle communications with both NORAD and Strategic Air Command headquarters. It would enable the super-combat center to take direct charge of an air battle in a subsector where the direction center had been destroyed. Moreover, it would still have unused capacity even after these extra functions had been programmed. Why not, then, let the super-combat centers also serve as centers for the control of normal air traffic -- or, at any rate, of en route traffic at altitudes high enough (preferably above 24,000 feet) to be continuously within range of the SAGE radars? This thought, too, was discussed in August 1958.<sup>1</sup>

The idea was undeniably attractive. To the SAGE engineers who would soon join MITRE, it was a stimulating challenge -- a venture into territory that was new enough to be interesting and yet not completely unfamiliar because the problems to be resolved would be analogous to problems already faced and overcome in the development of SAGE. In some



respects it must have seemed like the fabled fountain of youth, for the prospect it suggested was essentially one of going back, so to speak, to the days when the Lincoln Transition System had been first conceived and once again planning and designing an intricate and ingenious system centering in a computer, again fighting the kinds of running battles that had been fought with outside agencies through the mid-fifties, winning again on the strength of sheer technical competence, and, of course, doing it all much better the second time. To the Air Defense Command, to ADSID, and to some persons in Air Force headquarters, the appeal appears to have been of a different but no less potent kind. There had always been those in the Air Force who had regretted that, for reasons which they regarded as false economy, the Air Force had chosen to make SAGE a "soft" and all too easily vulnerable system, but now there was a chance of having a thoroughly "hardened" system instead. True, the underground super-combat centers would require some very costly excavations, and, on top of that, there would have to be large new outlays of funds to cover the inevitable development and engineering work -- all this for a system that would still provide defense only against air breathing craft and not against ballistic missiles. But perhaps the extra expense would be justified after all, for the mere advent of a ballistic missile threat by no means negated the still quite real possibility of attack by manned bombers. Besides, if the super-combat centers were to assume an air traffic control as well as an air defense function, there seemed to be a good chance that the operating and maintenance costs, if not the initial construction and engineering costs, could be shared with the Civil Aeronautics Administration or with the about-to-be-created Federal Aviation Agency.

It says something about the importance attached to the super-combat center idea that the Air Defense Command reduced it to an operational em-

ployment plan in November, only three months after the August meeting when Zraket had broached and explained it, and that Air Force headquarters approved this plan with some modifications on February 5, 1959. The exact location and the degree of hardening of the super-combat centers were still not determined, but all concerned were assured that, as soon as they were, the Air Force would take action to fund the necessary underground excavation and construction in the military construction programs for fiscal years 1960 and 1961. There were to be ten of these underground centers altogether. One would be in Canada, somewhere in the Ottawa Air Defense Sector, and would thus be a responsibility of the Royal Canadian Air Force. Of the nine to be built in the United States, four would be deployed so as to cover the Canadian frontier, situated in the Syracuse, Chicago, Minot, and Spokane sectors, and the remaining five would be in the Raleigh, St. Louis, San Antonio, Phoenix, and Portland sectors. Two of the old-style above-ground combat centers with AN/FSQ-8 computers (Syracuse and Chicago) already existed, and the Seattle combat center would be completed according to schedule, but those intended for Fort Knox, Kansas City, Minot, and Phoenix were deleted from the program. Six direction centers were also deleted, so that there would be only twenty-three direction centers altogether (and, of these, two more were destined to be deleted in 1960). There was still no decision as to whether the underground centers would assume an air traffic control function, for that would depend on an agreement between the Air Force and the recently created Federal Aviation Agency, and the FAA at that point had gone no farther than to agree to experiment with a joint system in the Albuquerque sector. It was for this reason, however, that the Albuquerque direction center, although above ground, was to be equipped with the new FSQ-7A computer rather than with the FSQ-7 which was still normal equipment for a direction center.<sup>1</sup>

A green light had been obtained in record time, and for a while things seemed to be going forward at a brisk pace. The conception of the FSQ-7A computer had already been refined to the point that it was possible to ask an industrial contractor to design and manufacture it, and once again it was the International Business Machines Corporation which was chosen for the purpose, presumably because of its accumulated experience with the earlier SAGE computers.<sup>1</sup> Meanwhile, for the same reason that Lincoln had needed the Experimental SAGE Subsector as a test and check-out facility, MITRE would need a super-combat center facility. It would not be necessary to harden this facility, and the ESS radar network could be adapted, but the central element would have to be, not the XD-1 (the simpler version of the FSQ-7, installed in Lincoln's Building F in 1955), but a prototype of the FSQ-7A, which would be called the XD-1A. It became the task of Edward D. Reardon of MITRE's Department 12 to supervise the planning and construction of a new four-story building, to be physically attached to the existing Lincoln buildings and called Building L, to house the XD-1A, a command post, and related equipment. At this point, however, signs of trouble began to appear. In April the cost of the Building L facility was estimated at \$3,250,000, but during the next three months the figure crept up until it was somewhat in excess of \$4,000,000, partly as a result of some initial uncertainties concerning specific requirements and partly because of modifications demanded by the Army Corps of Engineers, which in July was asked to approve the plans and let the necessary contracts. Also, it occurred to someone that the building intended for the FSQ-8 combat center at Minot Air Force Base, North Dakota, was already built and would not be needed for its original purpose. Would it not be a kindness to the taxpayer to scrap the Building L plans and use the Minot building instead? In July MITRE had to estimate the cost of adapting the Minot structure in order to

demonstrate that this procedure would cost nearly twice as much as Building L. There were continuing delays. It was important to begin construction by October 1, 1959, in order to be ready for the XD-1A which IBM was due to deliver the following May, but October passed into November and November into December with the sod on the Building L site still undisturbed.<sup>1</sup>

Now four million dollars more or less could hardly have a lethal effect on something as big as the super-combat center program, which promised to end with an aggregate cost in the billions, but this Minot proposal and other snipings at Building L were probably symptomatic of an underlying anxiety about that total cost. It was, or course, the hardened features of the super-combat centers that made them so expensive. Major excavations, especially if they have to be deep excavations, are always costly, and there were to be nine of them in the United States. Moreover, there would be no point in excavating at all unless the centers were provided with air and water purification devices and other provisions against radioactive fallout, and unless all communication lines in and out of them were also hardened. The latter would mean nothing less than an entirely new and very expensive nation-wide communications network. Perhaps the Air Force had been too glib with its assurances in February that it would include all this in the military construction program. Anyway, the moment of truth came in December when it decided not to do this. The super-combat center idea was dead from then on, although Air Force headquarters did not formally withdraw its approval of the super-combat center operational employment plan until the following March 30, 1960.<sup>2</sup> The result was a reversion to the original SAGE program, except that now there would be only three combat (FSQ-8) centers and they would monitor only the direction centers (FSQ-7) in the Northeast, the upper Middle West, and the Pacific

Northwest. Most of the other direction centers would be either in the upper Plains area or in the Southwest, including California, and only one (Montgomery) would cover almost the entire Southeast. Since the Albuquerque and Kansas City direction centers were also deleted, there would be only twenty-one automated direction centers altogether, so deployed as to cover everything within several hundred miles of the Canadian border and the Atlantic and Pacific coasts. All of Texas and most of the Plains and Rocky Mountain regions would be covered only by the old manual system.<sup>1</sup> As for the two FSQ-7A computers that IBM was in the process of manufacturing at its plant in Kingston, New York (one for Building L and one for Albuquerque), one was eventually delivered to the International Electric Corporation (subsidiary of the International Telephone and Telegraph Corporation) at Paramus, New Jersey, to be used as a test facility for the development of the Strategic Air Command Control System (465L), and the other was cannibalized.<sup>2</sup>

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The demise of the super-combat center plan meant that the air defense against manned bombers would not make the ambitious stride that had been hoped for, but the long run implications for air traffic control were perhaps even more grave. The super-combat centers, to be sure, would have been pertinent only to the high altitude en route part of the air traffic control problem and would not have solved the problem of congestion in terminal areas, but for a long time there would be people, especially in MITRE, who would contend that the prospect for an adequate en route system had been set back by at least a decade.<sup>3</sup> MITRE continued to think that air defense and air traffic control ought to be combined in a single system. Indeed, the notion was one which the engineers who had developed SAGE had had in the backs of their minds for some time. It was an outgrowth of an earlier Lincoln idea that even the system defined in the 1955 SAGE operational plan might be made to

incorporate an air traffic control function; and that, in turn, was an outgrowth of a still earlier idea that goes back to Project Whirlwind. In September 1948, almost a decade before the super-combat centers were first mentioned, Jay W. Forrester listed air traffic control as one of the many and varied problems to which Whirlwind might be applied,<sup>1</sup> and David R. Israel, who joined the Whirlwind staff in 1949, wrote a thesis on "The Application of a High Speed Digital Computer to the Present Day Air Traffic Control System" for the master's degree he received from the Massachusetts Institute of Technology in 1951. Nor were the Whirlwind people the only ones to see possibilities in this field. Other teams of electronic engineers were also pioneering in computer technology around the same time, and were therefore on the lookout for promising computer applications. Any problem that was essentially a problem of processing data from a number of different sources, such as geographically dispersed radars, seemed to lend itself to solution by computer, and air traffic control was obviously one of these. Since radars that could scan the skies and track aircraft already existed, and since the MIT Radiation Laboratory had successfully developed the radar-based Ground Controlled Approach system for traffic near military airfields in England during the war, the further idea of harnessing radar and computer to control air traffic was probably inevitable.<sup>2</sup> The point here is simply that the Whirlwind staff shared this idea, which thus became part of the Whirlwind legacy to Lincoln and later to MITRE.

The Whirlwind people, of course, were soon to join the Lincoln Laboratory where, for the next several years, they were almost exclusively preoccupied with air defense; but they never entirely forgot their interest in air traffic control, and some things began to happen about 1955 that prompted some of them to turn their attention to it once again. It was around that time that commercial airlines began to put jet aircraft into regular service, and

therefore to fly at high altitudes hitherto frequented almost solely by military aircraft, so that the danger of mid-air collisions was no longer limited to the lower altitudes and the congested areas around airports. The Air Navigation Development Board, which represented the three armed services and the Civil Aeronautics Administration, had seen as early as June of that year that SAGE had implications for the development of a common system for the regulation of all air traffic, whether military or civilian.<sup>1</sup> The work of programming the SAGE computers had barely started at that time, but for a while it seemed that the air defense function would not exhaust their capacity and that, at least in peace time, they could also serve an air traffic control function; and air traffic control, although involving many things not related to air defense, would also rely, in part, on radar data, and would have to process and display data in much the same way.<sup>2</sup> In May 1955 the Director of the Bureau of the Budget asked William B. Harding to form a special group to study the "long-range needs for aviation facilities and aids," and the Harding group's report on December 31 called, among other things, for the integration of air defense and air traffic control "on a priority basis." Inasmuch as the Lincoln Steering Committee was then looking forward to the end of the SAGE commitment, this Harding recommendation must have seemed especially timely, for it seemed to point to another job for the SAGE engineers. Lincoln, however, had no authority to intrude into the air traffic control field, and Dr. Valley, who brought the matter before the Steering Committee on February 6, 1956, did not think the time was ripe to seek that authority -- partly, one gathers, because he knew that the subject was politically touchy even then and because he considered it wiser to wait for a more opportune moment. He did, however, think that the Laboratory ought to keep abreast of developments, and it was arranged that David Israel of Division 6 and H. Sherman

of Division 2 should do this.<sup>1</sup>

On the following June 30 a United Airlines plane and a Trans-World Airlines plane collided and crashed in the vicinity of the Grand Canyon, killing all on board both planes (more than a hundred people). Both planes were proceeding eastward from Los Angeles through what was then called an "uncontrolled airway" -- i. e. , an airway unserved by the ground based navigational aids which the Civil Aeronautics Administration had by that time managed to provide in more congested areas.<sup>2</sup> There was an immediate public clamor, and the need for adequate measures for the safety of air traffic at last began to command attention in high places. Moreover, this Grand Canyon disaster was an en route, not a terminal area, mishap, and was therefore the kind of thing to which SAGE, with its far reaching radars and its capability of displaying a moving situation throughout an area the size of several States on a cathode ray tube, seemed especially pertinent. Edward P. Curtis, who, as Special Assistant to the President for Aviation Facilities Planning, was then beginning to organize another study, a kind of sequel to the Harding study, asked the Lincoln Laboratory for its views on the subject, and Lincoln now had some views to impart. What it proposed on September 17, 1956, in Technical Memorandum 64, "A Proposal for an Evolving Air Traffic Control System," was a system using much the same kind of equipment and techniques as SAGE used, and it estimated that the country might be able to enjoy such a system by 1963 if work started immediately and all went well.<sup>3</sup> The memorandum was itself a bone of contention for the next several months, but by July 1957 Elwood P. Quesada (who had succeeded Curtis around the time of the submission of the Curtis Report in May, would become the first and only Chairman of the Airways Modernization Board, created by the Congress in August as a direct result of the Curtis Report, and, more than a year later, would become the first Admin-



istrator of the Federal Aviation Agency) was sufficiently interested to talk seriously with Sherman about the possibility of using the old Cape Cod System, centering in the original Whirlwind in the Barta Building, for experimental work, and even wished to borrow Sherman for sixty days "to assist in preliminary organization and planning."<sup>1</sup>

The Lincoln Steering Committee was still not sure it wanted to see the Laboratory embark on this venture, which was system engineering quite as much as SAGE was. It was even then in the throes of screwing up its courage to make its reluctant proposal to act as technical advisor to the Air Defense Systems Management Office, and this air traffic control business, if pursued, might eventually dwarf even the ADSMO task. By November it had thought the matter out to the point of deciding that it was interested

. . . in a broad, long-term study of ATC problems, and a study of the possible applications of SAGE to ATC, as opposed to quick-fix solutions such as are now being implemented by equipment manufacturers,

and wished to know whether Quesada seriously intended to use the Cape Cod System, which it would otherwise probably terminate.<sup>2</sup> All this was discussed when Quesada visited Lincoln on December 13 in the company of Malcolm A. MacIntyre, Under Secretary of the Air Force, and Major General Howell M. Estes, Jr., Assistant Chief of Staff for Air Defense Systems.<sup>3</sup> After sputnik, the Air Force was at least as interested as the Airways Modernization Board in somehow combining SAGE with an air traffic control system, for SAGE not only had proved expensive to develop and install (it was already being called a three-billion-dollar system) but, mainly because of the number of trained personnel required to operate a direction or combat center, promised to be continuously expensive to use. The prospective ballistic missile danger by no means removed the possibility of a

manned bomber attack that SAGE alone could meet, and, as we have seen, the Air Force was then seeking a way to keep the SAGE team together long enough to finish its work; but, if the expense of operating SAGE could be shared with another agency, the net increase in appropriations the Air Force would have to seek from the Congress in order to meet the new emergency would be so much the less. But, when C. R. Wieser, Head of Division 2, saw Quesada in Washington on December 23, the latter explained that AMB planned to establish its experimental facility at the former Naval Air Station near Atlantic City rather than in the more congested area of the Cape Cod System, and would probably contract with the General Precision Laboratories for the "quick fix" of the existing air traffic control system so urgently needed not only for the sake of air traffic safety but also to enable AMB to show a possibly skeptical Congress that it was "really doing something." Yet at the same time Quesada indicated his own belief that "the Air Defense and Air Traffic Control systems should be integrated for both economic and operating reasons," and that "Lincoln must be relied on heavily to assist in such integration."<sup>1</sup> Then, on January 2, 1958, Civil Aeronautics Administrator James T. Pyle (the Civil Aeronautics Administration, like the Airways Modernization Board, was destined to be supplanted by the Federal Aviation Agency a year later, but at this time was still operating the only actual air traffic control system the country had, and was still a Department of Commerce agency, quite separate from Quesada's AMB), on a visit to Lincoln, "expressed interest in integration of SAGE and Air Traffic Control, if this can be accomplished without sacrificing Air Traffic Control capability even during a threat";<sup>2</sup> and a week later, on January 9, Secretary of Commerce Sinclair Weeks and Deputy Secretary of Defense Donald A. Quarles signed an "Agreement Relating to Joint Use of Certain Facilities by the Department of Commerce and the Department

of Defense" (sometimes called the "White House Agreement"), whereby they pledged their respective departments to cooperate in the development of "an air traffic control system functionally compatible with the nation's defense capabilities in peace and war" and designated the AMB as the agency to determine the best means of doing so.<sup>1</sup> This was not a commitment to integrate air traffic control with SAGE, but it definitely opened the door to a serious proposal for such integration.

Soon afterward, David Israel's Group 66, Special Studies, began to plan a series of experiments involving the Boston Air Route Traffic Control Center at Logan Airport, the Experimental SAGE Subsector radars at South Truro and Bath, and the old Whirlwind computer in Cambridge -- the latter being chosen in order not to interfere with SAGE test operations involving the XD-1 computer in Lexington. The object was to demonstrate certain phases of "possible SAGE-air traffic control integration and co-operation." As Israel explained on March 28:

Flight plans, position reports, and other air movements information available at the High-Altitude sector at the ARTCC (at Logan Airport) will be transmitted from the ARTCC via on-line manually-operated teletype directly into the Whirlwind Computer. A number of error prevention, error detection error correction features will be provided in an attempt to yield a flexible but relatively error-free input to the computer. . . . The computer will process, decode, extrapolate and store up to 24 incoming flight plans. Periodically, the present position of the flight plans will be displayed to a Track Monitor along with all radar (search and Mark X) data received within the past minute. Four Track Monitor positions will be provided. The monitors will be permitted to make adjustments in the extrapolated flight plan position so as to correlate the position with the incoming radar data. The correlated and corrected present flight plan positions will be encoded and transmitted back over a 1300 pps circuit to the Boston ARTCC where they will be presented on a remote display console. . . . In addition to the remote display, the computer will prepare and transmit a number of different tele-

type messages to the ARTCC which add to the information on the remote display.<sup>1</sup>

A few months later the Civil Aeronautics Administration agreed to cooperate in this CAA High Altitude Remote Monitor (CHARM) project. Actual CHARM tests began in December 1958, by which time Israel had joined MITRE, and continued under MITRE auspices through May 1959. The idea in the background, of course, was that SAGE itself could be broadened to include an air traffic control as well as an air defense function, but CHARM was a necessary preliminary study. For air traffic control would involve several things that were irrelevant to air defense -- notably, the correlation of actual flight progress with flight plans, the occasional amendment of the latter in the light of the former, the issuing of maneuvering instructions to aircraft in flight and in danger of collision, and perhaps eventually the inclusion of weather information. By the time it was over, CHARM had not only demonstrated that SAGE-like techniques and equipment could be usefully brought to bear on the high-altitude en-route part of the air traffic control problem, but had also taught Israel and his staff a great deal about the problem and given them an appreciation of the kind of adaptations that SAGE would require in order to become a dual-purpose system.<sup>2</sup>

Meanwhile, even as the CHARM tests were getting under way, the Air Force, the Airways Modernization Board, and the Civil Aeronautics Administration began to behave as though it were a foregone conclusion that air defense and the control of at least high-altitude en-route traffic would eventually be integrated. In June 1958 AMB established a liaison office at Hanscom Field, which it called the Air Defense-Air Traffic Control Integration Division (later to become the Air Defense Integration Division, or ADID, of the Federal Aviation Agency), and which it collocated in the "Butler" buildings with the Air Defense Systems Integration Division. A

month later, at Quesada's instigation, Under Secretary of the Air Force Malcolm A. MacIntyre (who was also the Department of Defense representative on AMB) designated ADSID as the "focal point" for the entire Department of Defense in respect to matters relating to this integration.<sup>1</sup> Between July and October a committee representing ADSID, CAA, and the new AMB office at Hanscom hammered out an extensive working paper entitled "A Concept for Integration of Air Traffic Control and Air Defense," which contemplated that the functions of surveying the air space above 24,000 feet and of processing and displaying the resulting data would be accomplished simultaneously for air defense and air traffic control purposes alike, by means of SAGE equipment, but that Air Defense Command and CAA personnel would then separately apply this data in the execution of their respective missions. Traffic at altitudes below 24,000 feet was knowingly left out of account, partly because SAGE had been designed primarily with an eye to the detection and tracking of bombers that would normally travel at the higher altitudes and its radars and radar sites had been chosen on that assumption, and partly because AMB had already contracted with the General Precision Laboratories for the development of a Data Processing Central system for the lower altitudes. In order to achieve this high-altitude integration, however, it would be necessary to collocate SAGE direction centers and air route traffic control centers in the same ground installations and make them responsible for identical geographical areas.<sup>2</sup> On January 20, 1959, as a first step toward this end, the Air Defense Command and the new Federal Aviation Agency (which had absorbed AMB on November 1, 1958, and CAA on January 1, 1959) agreed to make the direction center then planned for Albuquerque, New Mexico, a joint facility accommodating both SAGE direction center personnel and air route traffic controllers.<sup>3</sup>

For a while the need to collocate direction centers and air route traffic control centers and make corresponding area boundary adjustments threatened to be a stumbling block. The SAGE implementation schedule then in force called for twenty-nine direction centers, and there were about the same number of air route traffic control centers, but their respective areas overlapped in almost all cases. The problem had been faced at a meeting of Air Force, CAA and AMB representatives at the AMB offices in Washington on the preceding August 21, when a working group was appointed to devise a mutually acceptable set of coincident area boundaries, but the necessary adjustments would inevitably be expensive and the Federal Aviation Agency might well have found itself in the position of having to bear the greater part of this expense.<sup>1</sup> From FAA's point of view, however, the super-combat center idea, first bruited at about the time of the AMB meeting, offered some important compensating advantages. It would mean that some air route traffic control centers, instead of being relocated, could be eliminated, thus permitting a significant economy, and, even more important, it would mean that in case of war the air traffic control function would be as well protected as the air defense function. The boundary alignment group assumed that the super-combat centers would be approved after the Air Defense Command issued its operational employment plan on November 5, although actual approval did not come until three months later,<sup>2</sup> and was able to propose ten sets of coincident boundaries on April 30, 1959.<sup>3</sup> On May 12 the FAA published another working paper, "The Concept for Enroute Air Traffic Control and Air Defense Super Combat Center Integration," which, like the October concept paper, limited itself to en route traffic, but which went beyond the earlier paper in that it called for "positive separation" not only of all aircraft above 24,000 feet but also of all aircraft flying under instrument flight rules at any altitude.<sup>4</sup> Ten days later, on May 22, Deputy

Secretary of Defense Thomas S. Gates, Air Force Under Secretary Malcolm A. MacIntyre, and Federal Aviation Administrator Elwood R. Quesada signed a formal agreement to proceed on this basis.<sup>1</sup> Now, for the first time, there was a definite understanding that the two functions would be integrated, and the Air Defense Command modified the super-combat center plan accordingly on June 19.<sup>2</sup>

MITRE, meanwhile, had been getting its feet thoroughly wet in the technical details of the integration problem through the CHARM project it had inherited from the Lincoln Laboratory, and published the final CHARM report on June 9.<sup>3</sup> The next step was to apply what had been learned to the super-combat centers with their large-capacity solid-state computers and their very large geographical areas. Israel's Special Studies Department (D-16) was now in a position to formulate a tentative design for an en route system to be operated from the projected underground centers, and FAA, although still not ready to commit itself irrevocably, was sufficiently impressed to wish to work with MITRE in planning such a system for possible later adoption. Both FAA and MITRE had reasons for wishing their relationship to be covered by a special contract rather than through an understanding with MITRE's principal "customer," the Air Defense Systems Integration Division; and ADSID, although it did not wish to see MITRE make a habit of contracting with agencies other than itself, was not inclined to stand in the way in this case. It knew that the integration of air defense and air traffic control was as much in the interest of the Air Force as of anyone else, and it even agreed in advance that, as long as work on SAGE itself was not affected, MITRE might use the Experimental SAGE Sector as a tool in the development of the contemplated air traffic control system. Thus, when MITRE began its SATIN (SAGE Air Traffic Integration) Project under a

direct contract with the Federal Aviation Agency on October 19, 1959, it did so with ADSID's approval and encouragement.<sup>1</sup>

SATIN was originally conceived in the context of the super-combat centers but in December the Air Force decided not to build those centers. Yet hope for a dual purpose system did not die immediately. By mutual agreement SATIN was changed into a project to study the feasibility of giving the FSQ-7 direction centers an air traffic control function, and was pursued on that basis until the expiration of the FAA contract at the end of 1961.<sup>2</sup> Despite its adverse action regarding the super-combat centers, the Air Force at that time was at least as interested in air safety as the FAA. In particular, the Strategic Air Command had been concerned about the danger of collision at high altitudes ever since commercial jet aircraft had begun to frequent those altitudes some five or six years earlier, and on June 11, 1959, General Curtis E. LeMay, then Air Force Vice Chief of Staff, had asked ADSID to devise an interim solution to the danger, using either the existing SAGE system or, where SAGE had not yet been introduced, the old Air Defense Command manual system.<sup>3</sup> As a result, the Air Force asked FAA on December 15 to assign some air traffic controllers to test the feasibility of using direction center equipment to provide a flight following and radar advisory service for high altitude traffic. With MITRE's technical assistance, FAA accordingly conducted Project Trailsmoke in the Chicago Air Defense Sector from April through June 1960, extending the experiment to the Detroit sector during the latter half of June.<sup>4</sup> But, although the eighteen controllers who participated in Trailsmoke reported favorably, FAA's misgivings tended to deepen. Much of the originally intended SATIN capability had had to be sacrificed when the super-combat center idea and the projected FSQ-7A computer were abandoned; in the above-ground direction centers an air traffic control system would be just as vulnerable as the



original SAGE had been and would continue to be; and the necessary cancellation of the coincident boundary agreement of May 22, 1959, left the boundary problem as unresolved as ever.<sup>1</sup> Perhaps the key to FAA's anxiety was contained in the joint FAA and Air Defense Command report on Project Trailsmoke on October 1, 1960, which concluded that it was feasible to use SAGE for a high altitude traffic advisory service "provided the inherent capability in the SAGE system is made available for the service."<sup>2</sup> There was the rub. The Air Force had already cancelled the super-combat centers; who could say how long it might be before it decided to cancel still other parts of SAGE or perhaps even discontinue that system? Besides, there had all along been people in FAA who had questioned the wisdom of automating air traffic control to the extent that would be necessary if it were to be integrated with SAGE.<sup>3</sup> The FAA was still not ready to turn its back on SAGE, but in that same month of October 1960 it conducted an experiment in the Chicago and Indianapolis Air Route Traffic Control Centers known as Operation Pathfinder to determine whether it could not provide area positive control for high altitude traffic, the main service that would accrue from integration with SAGE, with its own existing resources.<sup>4</sup>

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Aside from the prospect of adapting SAGE to the super-combat centers and integrating air defense and air traffic control in those centers, MITRE's chief initial hope of developing a major new field for its talents was the North American Air Defense Command Combat Operations Center, the concept of which was only beginning to emerge toward the end of 1958. The North American Air Defense Command was itself an innovation at that time -- a joint United States and Canadian command, with headquarters at Colorado Springs, created informally in August 1957 under an agreement between the two countries that was ratified on May 12, 1958. Its staff was

partly American and partly Canadian, with an American commander-in-chief and a Canadian vice-commander-in-chief; it was responsible for the air defense of the entire continent north of the Rio Grande; and it had operational control over all of the air defense forces of both nations (including, in the American case, not only the Air Force's Air Defense Command but also all Army and Navy anti-aircraft forces).<sup>1</sup> Even before it was created, there had been concern lest the air defense of the United States be paralyzed through the destruction of the Air Defense Command headquarters -- which, in the immediate post-war years, had been situated at Mitchel Air Force Base on Long Island, twenty miles down wind from mid-town Manhattan. It was precisely to avoid a prime target area like the vicinity of New York City that, on January 1, 1951, the headquarters of the reconstituted Air Defense Command was established at Colorado Springs,<sup>2</sup> and by 1956, as already noted, General Partridge, then Commander of ADC, felt that even this was insufficient protection and began to look to the neighboring mountains for additional security. Once established, it was NORAD rather than ADC that needed this protection, but what NORAD originally envisioned was simply an immense rock-lined cavern into which its entire headquarters could be moved without essential change and from which it would have essentially the same communications with the outside world that it already enjoyed. In 1958 the New York firm of Parsons, Brinkerhoff, Hall & McDonald studied three possible sites in Colorado (Lowry Air Force Base, a location near Boulder, and Cheyenne Mountain), although NORAD had virtually decided upon Cheyenne Mountain, about ten miles south of Colorado Springs, even before the study was completed;<sup>3</sup> and Dunlap & Associates, engaged about the same time to investigate the functional requirements of this underground center, took it for granted that there would be no radical recasting of the existing headquarters organization, and therefore considered

only how existing headquarters functions could be moved underground more or less intact.<sup>1</sup>

In September 1958 John F. Jacobs had occasion to visit Colorado Springs and learn something of the hole-in-the-mountain idea as it was then beginning to take form. Upon his return to Lincoln he asked Walter S. Attridge, Jr., who had accompanied him and who was then Associate Leader of Group 67 (Advanced SAGE Program Development), to look into it. On November 15 Attridge, who had in the meantime joined MITRE, was back in Colorado Springs, along with Eugene D. Lundberg, and there followed a period of a few months when Attridge, Lundberg, and two or three others were virtually commuting between Massachusetts and Colorado.<sup>2</sup> There was still room for innovative thinking because the requirements for the proposed combat operations center had not yet been precisely defined, and the idea they came up with -- predictably, in view of their SAGE background -- was that the center's operations should be not only conducted underground but also largely automated. It was the ballistic missile threat which had given rise to the idea of the underground center, and that, to be sure, was a quite different kind of threat from the one which SAGE had been designed to meet. A NORAD center would need to have "eyes" covering the whole continent, and would also need intelligence data not necessary in the case of SAGE. Moreover, there could be no question of parrying an onslaught of intercontinental ballistic missiles, for such a thing as an anti-ballistic-missile system did not then exist and was not even in prospect. The most that NORAD could hope to do, even with its underground center, would be to notify the Strategic Air Command so that the latter could launch a retaliatory strike in the few minutes before its own bases and missile sites would be destroyed, and then create pandemonium in every major metropolitan area in the country by notifying the Civil Defense Administra-

tion that the time had come to execute its ludicrously inadequate plans.<sup>1</sup> Still, there was a certain conceptual kinship between the automated SAGE direction center and the proposed automated combat operations center in Cheyenne Mountain. In each case, the idea was to receive in a central location data transmitted electronically from several scattered points and, again by electronic means, to extract from those data a readily comprehensible picture of a moving situation -- and to make the whole sequence as automatic as circumstances permitted. In each case, the conception was the conception of men not inhibited by doubts as to what automatic data processing could do.

The MITRE board of trustees was sufficiently impressed with the ideas of Jacobs, Attridge, and their colleagues -- or, at any rate, sufficiently alive to the need for the Corporation to establish itself in some major project other than SAGE -- to make a special effort to win the favorable attention of NORAD headquarters. It chose the Broadmoor Hotel in Colorado Springs for its third meeting, on January 16-17, 1959, and made the technical session of the meeting an occasion for presentations to members of the NORAD staff.<sup>2</sup> The Air Defense Systems Integration Division was, of course, kept informed throughout, and collaborated with MITRE personnel in preparing a formal proposal which was presented to NORAD in mid-February.<sup>3</sup> NORAD had meanwhile secured the approval of the Joint Chiefs of Staff for its combat operations center, and on February 27 Air Force headquarters formally assigned the development responsibility for the project to the Air Research and Development Command.<sup>4</sup> Before the end of March ARDC had established a project office at Wright-Patterson Air Force Base for this purpose.<sup>5</sup> Thanks partly to the sense of urgency surrounding this project, and partly to the fact that by 1959 there was beginning to be a fund of experience in the acquisition of new electronic

military systems, things proceeded for a while at a fairly brisk pace. In the case of SAGE it had taken more than two years to go from the first formal system proposal (January 1953) to the publication of the SAGE Operational Plan (March 1955); in the case of this combat operations center system, NORAD headquarters issued an operational plan on October 16, 1959 -- just eight months after MITRE's formal proposal.<sup>1</sup> By that time the system project office at Wright-Patterson was already soliciting letters of interest from possible industrial contractors; the first press release on the project was issued on November 5; and before the end of November the access road to what would become the main portal to the cavern to be excavated from Cheyenne Mountain was completed.<sup>2</sup>

At this point, however, there came a temporary delay. On November 24 Air Force headquarters instructed ARDC "to defer all action on System 425L [the Air Force's numerical designation of the NORAD Combat Operations Center system] for an indefinite period."<sup>3</sup> The reason was that it was then in the process of reviewing the requirements for all electronic systems and wished to make no new commitment of funds until it could think its way through the tangled web of new systems then in some stage of development and arrive at a comprehensive view of its true needs. William J. Becker of the Air Force headquarters Directorate of Requirements had already organized a Control Systems Integration Working Group drawn from various concerned Air Force agencies, private industries, and non-profit corporations (MITRE was represented in the persons of Walter S. Attridge and William E. Holden), and, at the instigation of Lieutenant General Bernard A. Schriever, then Commander of ARDC, MITRE was on the point of assembling at Hanscom Field another multi-agency group called the Winter Study Group to evaluate "the technical realism of the L systems." Both of these studies (to which it will be necessary to refer later) addressed themselves to far more than

System 425L, but System 425L is a good illustration of the then acute problems which occasioned them. A combat operations center, no matter how secure or how thoroughly automated, would be of no value unless its communications with the outside world were also secure and automated. It was, of course, part of the idea that the Cheyenne Mountain center would promptly receive all items of intelligence relating to its mission, especially intelligence of an impending missile attack, and that it would be able to issue appropriate instructions and warnings with equal promptness. But System 425L itself would not extend outside the hole in the mountain. Its eyes, ears, and voice would all be other systems such as the Ballistic Missile Early Warning System (474L), Space Track (496L), and perhaps a satellite "spy in the sky" system then under consideration<sup>1</sup>; and each of these other systems had its own project office, separate from and in no way subordinate to the System 425L office. On October 16, 1959, to be sure, Air Force headquarters had authorized a BMEWS central computer and display facility at the NORAD Combat Operations Center,<sup>2</sup> but it would take more than that before the BMEWS function was integrated into the proposed automated center. What needed to be thought out in minute detail, and probably automated in considerable part, was not just a few routine processes internal to the NORAD center, but the entire sequence from the first warning blip on a Greenland radar screen to the display panel in the Cheyenne Mountain war room and from there to Air Defense Command forces, to Strategic Air Command headquarters, and to the White House.

Yet the Cheyenne Mountain project fared better than the super-combat centers or the SATIN program, for Air Force headquarters authorized its resumption on March 23, 1960, although it also asked the 425L project office to restudy the whole system and make new recommendations. On August 1 the project office (which by that time had moved to Hanscom Field)

recommended that a temporary above-ground automated combat operations center be established as soon as possible, and that construction of the permanent facility in the mountain be started in time to meet a completion target date in 1964. It also estimated the eventual aggregate cost at \$116 million and urged that the system's priority be raised to assure adequate support. MITRE accepted a formal Air Force task assignment to design the system on November 21; the tunnel and chamber designs were completed in December; the Air Force source selection board, for the selection of a system contractor, was reestablished on January 10, 1961; the 425L office issued the first version of its Proposed System Package Plan on February 15; and in June the Utah Mining and Construction Company, chosen by the Army Corps of Engineers, began actual excavation. On July 21 the source selection board chose the Burroughs Corporation as the system contractor, although the Defense Directorate of Research and Engineering had in the meantime specified that MITRE would remain responsible for the design of the system.<sup>1</sup>

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MITRE had made a brave beginning. Born within a year of the first Russian sputnik launchings, it had responded to the challenge of the times with energy and imagination. In addition to carrying on the still unfinished work relating to the original SAGE system, principally the integration of weapon systems, it had generated the basic conception of three new systems -- an impressive feat even though only one of them, the NORAD Combat Operations Center, was destined to materialize. Also, capping all this, it began almost immediately to explore with NORAD and with the new Directorate of Research and Engineering of the Office of the Secretary of Defense a comprehensive plan for the integration of all facets of continental air defense. By the summer of 1959 it was working informally with a Dr. Skifter in OSD and with NORAD on this master air defense plan,<sup>2</sup> and, with the Air Force's

knowledge and approval, submitted a report to OSD in October.<sup>1</sup> As it went about these exciting new tasks, it anticipated -- indeed, had been encouraged to anticipate -- that they would eventually take it well beyond its initial role as a system engineering organization in support of the Air Force. The invariable references to the "scope of MITRE" or the "expansion of the scope of MITRE" in the successive Reports of Operations which the management issued to the trustees before each board meeting in 1959 unmistakably suggest that both the management and the board considered that MITRE should and probably would become a kind of architect for the whole air defense system of both the United States and Canada,<sup>2</sup> and for a while there was some thought that the part of this work that transcended the Air Force should be covered, not by an informal agreement to fund it through the existing Air Force contract, but by a new and separate contract with OSD.<sup>3</sup>

Through all of this, MITRE was guided by an able and distinguished board of trustees, drawn from a variety of fields and including several individuals who in one way or another had had a hand in national defense affairs for a decade or more. It had inherited from the Lincoln Laboratory a group of engineers who had already worked together on SAGE and whose accumulated SAGE experience constituted an excellent foundation of technical talent. By the middle of 1960 it had managed to double its technical staff and more than doubled its total population, achieving thereby a balanced and flexible organization well suited to the tasks it would have to undertake; and, to accommodate these people, it had acquired a piece of land in Bedford, about four miles from Hanscom Field, and had begun to build its own buildings. Its period of MIT tutelage had ended on August 1, 1959, when it entered upon its first direct contract with the Air Force, and before the year was out it had two additional contracts -- a small one with the Navy and a larger and more significant one with the Federal Aviation Agency. By 1960, how-



ever, it had to make a major readjustment. The Air Force discontinued the Air Defense Systems Integration Division and reoriented the MITRE contract first to the short-lived Air Force Command and Control Development Division and then, on April 1, 1961, to the Electronic Systems Division. One result was that MITRE's "scope" was indeed broadened, but in a way not originally contemplated. Instead of being given charge of the master-planning of the entire air defense system, it was obliged to concern itself with all Air Force ground electronic systems -- "command and control" systems, as they were then usually called. Another was that with minor exceptions there would be no separate contracts with military agencies other than the Air Force, non-Air Force work being provided for in the Air Force contract, so that MITRE had no choice but to accept a status it had been led to believe it would never have to accept -- that of a permanent Air Force captive. The change gradually but inevitably affected its original distinctive character and esprit de corps.

What had given it this unique character in the first place were those former members of the Lincoln staff who would probably have been content to remain in Lincoln indefinitely if MIT had been willing to let Lincoln continue its system engineering activities, but who finally decided to follow the example of Everett and Jacobs and make the transfer. Some of them had been in Lincoln only a year or two, but others had been there long enough to see the ideas of the Valley Committee evolve into the Lincoln Transition System and then into SAGE, and a few of them had been associated with Project Whirlwind before that. Both Whirlwind and SAGE had been severely criticized from time to time, often by people in a position to know what they were talking about; yet in both cases these engineers adhered to their convictions, persisted in doing things in what they regarded as the right way, and eventually had the satisfaction of refuting their critics. This record of repeated

success in the face of difficulty and informed skepticism tended to confirm them in an attitude that seems to have been characteristic of the Whirlwind team from the beginning -- an attitude that said that an engineer ought to do whatever he does, not because it happens to be called for in a contractual statement of work, but because he regards it as intrinsically sound, and, moreover, that he ought to do it the way he thinks it should be done, despite any contrary urgings or, sometimes, even instructions by outside interested parties. To live this way is to lead an interesting life. It means that at times one finds oneself sailing very close to the wind, as Forrester did more than once in his dealings with the Office of Naval Research. The Whirlwind experience and, even more, the SAGE experience -- the latter involving several years of give and take not only with the Lincoln management but also with a variety of industrial contractors and military organizations -- had imbued these men with enough worldly wisdom to keep them from doing anything foolhardy, but, far from depriving them of their saltiness, had left them as independent-minded as ever. Because they occupied the key positions in MITRE's technical staff, they tended to impart something of their flavor to the whole organization.

Yet there were signs, faint at first and perhaps never clear except in retrospect, that in MITRE this healthy magic might not continue to work as well as it had in the past -- that this time the mere dogged adherence to the right way of doing things might not be enough to maintain indefinitely the high morale with which the Corporation began. One of these signs -- there were others, to be discussed later -- was simply that MITRE was supposed to be a permanent organization. To be sure, it could not have been created at all except as a permanent organization, but, still, the fact had implications. It meant that MITRE had from the beginning, and had to have, a kind of organizational self-consciousness from which the old Whirlwind staff and the

SAGE element in Lincoln had been largely free. When MITRE established some new technical department and augmented its staff, it did not do so simply because its single-minded pursuit of some specific technical achievement had suddenly brought it to the point of perceiving that this was a necessary step toward that achievement, but because it wanted to convince the Air Force or some other potential client that it would be able to handle a job it hoped to get. It was concerned about its "scope" and the possibility of expanding the same. The moment one tries to imagine a Forrester sitting down and seriously discussing such a thing as the "scope" of the Whirlwind organization, the contrast becomes clear. Even to raise such a question is to imply that the organization itself is the end and that the work the organization does is important not so much for the work's sake as for the organization's sake. As for Lincoln, it was a permanent organization just as MITRE was, and there is some reason to think that its Steering Committee, like the MITRE board and the chief MITRE officers, tended to concentrate on questions concerning the organization's long-range future. But, when Forrester and his staff joined Lincoln and became Division 6, the circumstances were such that their attention remained fixed on their work; and this seems to have been true not only of the bulk of the staff but also of Forrester and Everett personally, despite the fact that Forrester and Everett were also members of the Steering Committee. To them, Lincoln was no more an end in itself than the old Servomechanisms Laboratory had been. If it had not been necessary to create MITRE, the same group of engineers, then led by Everett, would in all probability have kept on concentrating on the work in hand, taking Lincoln for granted as an organizational home much as one takes a rented building for granted -- as something one must have on order to do one's work, but incidental to the work itself. The creation of MITRE meant that these engineers, for the first time in their collective experience, had no choice but to

address themselves to the problem of building an organization, and therefore of putting the organization first and of treating their work as something to be justified in terms of its impact on the organization's welfare.

There is a crucial difference between wanting to do something and wanting to be something. As long as one is primarily seeking to do something -- something, that is, which is ambitious and yet within one's powers, and in which one is already engaged and has made some progress -- one is in an excellent state of mental health and has about one a kind of power which will usually prevail over those who merely wish to be something. The only hazard is that, if one perseveres, one may succeed. When that happens, one needs to find something else to do, and the "something else" has to be, not just a dream, but an on-going activity in which one is fully absorbed. The transition is difficult and treacherous -- even more so for a group of people than for an individual. A group such as the team of engineers who had worked on SAGE has not only to think of things that need doing and that it knows how to do, but also to immerse itself in its new activity to the point that it can forget itself once more. Yet, before it can do that, it must first persuade someone else to give it the license and the means to go to work, and that is the moment when it is vulnerable. It can scarcely help putting forth arguments that sound like "sales pitches" rather than considerations arising naturally from the work it is doing. It may well be forced to adopt a new organizational structure, thereby disturbing some of the subtle and delicate relationships among its members that had given it its original character, and it is almost sure to be tempted to talk, and therefore to think consciously, about its "role" and its "scope." It is, in short, likely to become aware of something of which it had hitherto been happily unconscious -- that it is an organization which exists and would like to continue to exist. It has eaten the fruit of the tree of self-conscious knowledge, and can never be the same again.<sup>1</sup>



## CHAPTER SIX

### THE MILITARY POWER STRUGGLE, 1958-1959

Much of what happened to MITRE in its early years must be understood in the context of what was happening in the Air Force and in the Department of Defense at the same time, and to explain that it is first necessary to explain why the Air Force never let the Air Defense Systems Integration Division become what it was originally supposed to become -- an agency with authority over air defense systems comparable to the authority that General Schriever's Ballistic Missile Division in Inglewood, California, exercised over missile systems. Secretary Douglas had given quite definite assurances on this point when he visited Cambridge in January 1958, and the clear implication was that ADSID's yet-to-be-formed contractor would play a part comparable to that of the Ramo-Wooldridge Corporation. Both the Air Force and the Massachusetts Institute of Technology representatives at this crucially important meeting agreed that there needed to be a fully integrated air defense system with SAGE as its data-processing center, and that, in order to achieve this, the Air Force would have to create an agency (ADSID) with plenary authority over all parts of this total system and to cooperate with MIT in providing this agency with a system engineering contractor largely composed of persons already familiar with the technical aspects of the problem through their prior work on SAGE. It is true that all of this was a gentlemen's agreement and not a legally enforceable commitment, but there is every reason to think that the Air Force as well as MIT was acting in good faith at the time.<sup>1</sup>

Moreover, General Bergquist viewed the situation in much the same way from the moment he was chosen in early February to command ADSID.

He was already acquainted with the problem, for, although his immediately prior assignment had been in the Air Force headquarters staff, he had come to the Pentagon from the Air Defense Command, where he had been Deputy Chief of Staff, Operations. The story has it that an incident in the early morning hours of April 17, 1952, had made a permanent impression on him. The intelligence officer on duty that night at ADC headquarters had learned that four vapor trails had been observed over Nunivak Island in the Bering Sea, and had then found to his consternation that all lines to Alaska had gone dead. Bergquist was among the officers who had had to hasten from their homes to the headquarters in the middle of the night, and not long after he arrived there was another report -- this time of an unidentified object or objects moving rapidly southwestward over Presque Isle, Maine. Before daybreak the whole of ADC was alerted, the Joint Chiefs of Staff were notified, and even President Truman was awakened. It all proved to be a false alarm, but Bergquist did not thereafter need to be told how extremely important it was that ADC should not only be able to react promptly at the first sign of an impending attack but also be able to determine positively and with equal promptness that its information was valid. The danger of a retaliatory strike being launched on account of a false alarm was hardly less than the danger of an actual attack.<sup>1</sup> Thus it was that Bergquist came to ADSID with the air of a man responding to a high calling, and he knew that ADSID would fail, as had the Air Defense Systems Management Office before it, unless it were given far more authority than a mere system project office. From the first he realized that ADSID would need to "function practically as a directive agency of Headquarters USAF, similar to AFBMD [Air Force Ballistic Missile Division],"<sup>2</sup> and in mid-March 1958 he tried to persuade the Air Force's Air Council to approve such a grant of authority.<sup>3</sup>

He did not succeed. ADSID was formally created by a special Air Force regulation at the end of March, and that regulation equivocated. It made ADSID responsible for planning the integration of air defense systems, authorized it to engage a contractor for technical assistance, said that the ADSID commander should have authority commensurate with his mission, and allowed him to bring his more urgent problems directly to the attention of the Air Force Chief of Staff. But, quite intentionally, it did not say that ADSID might approve or disapprove plans for the development and acquisition of particular air defense systems, insist on design modifications in the interests of compatibility with related systems, control system funds, or otherwise interfere in the doings of the still largely autonomous system project offices. Unlike Schriever, Bergquist had no license to take the bit in his teeth. Like the ADSMO which it replaced, ADSID was merely a joint advisory agency of the Air Defense, Air Materiel, and Air Research and Development Commands. Specifically, it was empowered

to provide the necessary managerial guidance for command action [emphasis supplied] required to insure an effective, properly time-phased, and technically compatible integrated Air Defense Mission System. . . .

and even this, as the regulation nervously added, it was to do "in accordance with approved plans, requirements, and procedures." The prerogatives of the three commands were not compromised, for only they could take action, and, unless Air Force headquarters told them to do so, they did not have to heed ADSID's recommendations. The only important differences between ADSMO and ADSID were that the latter had the prestige of being commanded by a general officer and that this general officer could, if necessary, bypass the three commands to the extent of making sure that the Chief of Staff knew what he was recommending.<sup>1</sup>



Why the Air Council saw fit to launch ADSID with so weak a charter is a matter of speculation, but at least two reasons suggest themselves. For one thing, neither the Air Research and Development Command nor the Air Materiel Command cared to see yet another special organization which, like Schriever's Ballistic Missile Division, would usurp what they regarded as their proper missions. They would not have embarked on the ADSMO, let alone the ADSID, experiment if Air Force headquarters had not compelled them to do so, and they undoubtedly had some influence in the Air Council. Another consideration may have been that the Air Council, far from failing to see the need for systems integration, was quite alive to the need and also to the fact that a complete integrated air defense mission system would have to include Army and Navy as well as Air Force sub-systems. Since the kind of integration contemplated involved automation, the Army and the Navy were in danger of losing control of their own systems. A fully automated integration of the Army's Nike missiles with SAGE, for example, would mean that those missiles would respond instantly and automatically to instructions generated in an Air Force computer, with Air Force personnel sitting behind the consoles and pushing the buttons. While the Air Council probably did not object to a bit of Air Force aggrandizement at the expense of the other services, it may well have decided that as a matter of good generalship it ought to wait for a more propitious time in which to do battle. March 1958 was hardly a propitious time, for, as the Air Council must have known, a plan for a sweeping reorganization of the entire Department of Defense, including the creation of a new Department of Defense Directorate of Research and Engineering to supervise and coordinate the system acquisition activities of all three services, was then in preparation and would soon be introduced as a bill in the Congress. Until one knew the fate of that bill (it was finally passed in modified form in July and signed by the President on August 6),

one would not even know what the new ground rules would be. No doubt there would have to be an integration of the air defense systems of all services sooner or later, but it remained to be seen who would be in charge of integrating them. In the meanwhile, why rush things? A comparatively weak ADSID would do well enough for the time being, and could always be strengthened later on if the Air Force should find itself in a position to call the tune.

In effect, then, the Air Council was telling Bergquist in respect to ADSID substantially what McElroy and Quarles, at about the same time, told Stratton in respect to the proposed corporation which would become MITRE. Nothing was promised, but, just as McElroy had hinted that MITRE might very possibly find itself in an inter-service role after the Defense Department reorganization was completed, so Bergquist was given to understand that ADSID might eventually become an inter-service rather than merely an Air Force agency. Bergquist, at any rate, seems to have been under this impression, and to have remained under it for at least a year. Nor did he allow his superiors to forget. On the following August 1 he reminded General Thomas D. White, then Air Force Chief of Staff, that

ADSID and its support corporation were being formed with Air Force resources to do an Air Force job at this time but with the previously agreed assumption that they would most likely be given responsibility for the whole air defense system; and, further, that ADSID and its contractor could be placed in the DOD organization anywhere that the Secretary of Defense may decide.<sup>1</sup>

He knew that the problem he was pressing "could very well precipitate a 'roles and missions' session,"<sup>2</sup> but that was something that would have to be faced anyway, and, now that MITRE had just been incorporated and the Congress had just sent the Department of Defense Reorganization Bill to the White House for signature, he evidently felt it was time to face it.

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There were various ways in which this could be done. One would have been to make the Air Force responsible for the whole air defense function, including the operation of the Army's Nike missiles and the Navy's off-shore picket ships. This would have provoked the bitter resentment of the Army and Navy, but would have removed the need for ADSID (and for MITRE) to think about ways of transcending the limitations of the Air Force in order to achieve a fully integrated air defense system.<sup>1</sup> Some people in the Office of the Secretary of Defense, including Deputy Secretary Quarles, had another idea, which was to let the new Directorate of Defense Research and Engineering take charge through the instrumentality of an "associate director for air defense."<sup>2</sup> Had that been done, ADSID might or might not have been converted into an inter-service agency, for DDR&E might or might not have chosen to take over a former Air Force agency; and it is also uncertain what might have happened to MITRE, since Quarles, as already noted, was not at all sure that creating another permanent corporation had been a good idea.

Bergquist, although prepared to adjust to either scheme, favored a third one -- to attach ADSID in some way to the North American Air Defense Command. How this idea originated is not clear, but it had been recognized all along -- at Hanscom Field and in Cambridge, and probably in Colorado Springs, if perhaps not in Washington -- that ADSID and MITRE would eventually have to work so closely with NORAD that a physical move from Massachusetts to Colorado might be desirable. Writing to McCormack about a week after the Douglas-Stratton meeting in Cambridge in January 1958, at a time when ADSMO had not yet become ADSID and the proposed corporation was still informally called the Cape Cod Corporation, Dr. Overhage, Director of the Lincoln Laboratory, suggested that

While the present location of ADSMO at Lexington is highly desirable, it may ultimately be advantageous to establish both ADSMO and The Cape Cod Corporation in the vicinity of Headquarters NORAD at Colorado Springs.<sup>1</sup>

By the following summer Bergquist had managed to whet NORAD's interest to the point that General Earle E. Partridge, then Commander-in-Chief, NORAD, decided that he ought to have the ADSID-MITRE team or something like it under his direct control. On September 29 Partridge wrote to the Joint Chiefs of Staff that NORAD needed a "unified air defense engineering agency" (which could as well as not have been ADSID, reorganized to include Army and Navy representatives, and, of course, with MITRE in tow), arguing that "the unilateral efforts of the services in the air defense field" needed to be consolidated "into a clearly defined, unified, centrally-directed functional organization" directly responsive to NORAD requirements.<sup>2</sup>

The Joint Chiefs' failure to respond with alacrity was understandable enough. There were, to begin with, some formidable legal difficulties arising from the nature of NORAD. Like the Strategic Air Command and certain overseas theater commands, NORAD was one of the "unified commands" recognized by the Reorganization Act -- so called because, although no subordinate units were "assigned" to them in the sense of being placed under their administrative jurisdiction, they exercised "operational control" of all combat units, of whatever service, associated with their respective missions. They were headed by "commanders-in-chief" rather than mere commanders, and these commanders-in-chief reported directly to the Joint Chiefs of Staff. Thus, Partridge, although an Air Force officer, was in a chain of command proceeding from the Joint Chiefs rather than from the Air Force Chief of Staff. NORAD, moreover, was a unique case because it controlled Canadian as well as United States forces and had a Canadian

vice-commander-in-chief, and so was not purely an agency of the United States government. The law, in short, offered no basis for "assigning" any kind of unit to NORAD, and "operational control" was supposed to apply only to combat units. Aside from that, Partridge's "unified air defense engineering agency" would have had to represent not only the three United States services but also the Royal Canadian Air Force, and that might have required an amendment to the diplomatic agreement on which NORAD was founded.

A mere legal obstacle, however, can usually be surmounted or circumvented if there is a mutual desire to do so. The real difficulty was almost certainly political. The Air Force had already gained a certain preeminence among the armed services, thanks mainly to its near-monopoly of the strategic offense mission, was already hungrily absorbing the lion's share of the defense budget and wanting more, and had already aroused the jealousy of the Army and the Navy. The technology of electronic automation threatened to make it still more powerful since, in order to automate to advantage, it was necessary to integrate broad mission areas, and in air defense if not in other mission areas that could only lead to a situation where Air Force personnel would be in all the controlling positions (e. g., the case of SAGE and the Nike missiles). The Reorganization Act would eventually enable the Office of the Secretary of Defense to bring problems like this under control, but only after it had had a chance to develop the administrative machinery through which to assert its authority. The immediate effect of signing the Act into law on August 6 was to put all three services on notice that their prerogatives and their autonomy were in danger, and thus to make each of them more than normally suspicious of anything that looked like encroachment by one of the others. This mutual mistrust persisted and even deepened during the next few years, and was a

significant part of the climate in which MITRE was obliged to live. Even after the coming of Robert S. McNamara as Secretary of Defense in 1961, it was not so much allayed as forcibly restrained in its more dangerous manifestations. But the danger to the Air Force was not the same as the danger to the Army and the Navy. What the Air Force had to fear was not the theft of its systems but the possible consequences of a too reckless attempt to exploit its advantage. If it pressed the logic of mission area automation too forcefully and too brutally, it might cause such an outcry as to leave the Secretary of Defense no choice but to have the Directorate of Defense Research and Engineering take charge of all military systems management. That was a step permitted but not required by the Reorganization Act, and the Air Force had no more desire to see it taken than the other services had.<sup>1</sup> How, then, might the Air Force turn the situation to its advantage without alarming the other services or OSD? Probably there was no way, but in the latter part of 1958 there was apparently some thought that it might be done by encouraging and abetting the efforts of the "unified commands" (especially a command like NORAD, which, although inter-service, was dominated by the Air Force) to augment their functions and increase their authority.

Bergquist, at any rate, was under the impression that the political climate in Air Force headquarters favored moves of this kind,<sup>2</sup> and was quite aware of Partridge's letter to the Joint Chiefs.<sup>3</sup> But autumn passed into winter, MITRE acquired its technical staff and began to function, the super-combat center plan was afoot, the MITRE board met in Colorado Springs, NORAD was interested in MITRE's idea for an automated combat operations center -- and still the Joint Chiefs had not acted. On February 3, 1959, Bergquist made his own move. He took the occasion of one of his periodic "Status of ADSID" reports to recommend to General Curtis E.

LeMay, then Air Force Vice Chief of Staff, the outright assignment of ADSID to NORAD. He did not allude to the Partridge proposal, but, when his missive reached LeMay, it was not unsupported; it had the concurring indorsement of Lieutenant General Samuel E. Anderson, then Commander of ARDC.<sup>1</sup> Bergquist's idea was that someone somehow should give the NORAD commander-in-chief what he called "guidance authority" over "the three U. S. Services and the RCAF," and at the same time make ADSID an inter-service and presumably international agency under NORAD so that, with MITRE's assistance, it could prepare the systems integration "guidance" that NORAD would issue.<sup>2</sup> "Guidance authority," in this context, was a confused notion -- not quite the same as real authority, apparently, but clearly more than a mere right to give unsolicited advice. Yet, as a concept, it would have been no more of an innovation than the concept of "operational control" had been, and it was not unreasonable for Bergquist to expect a bit of innovative thinking from an Air Force and an OSD that had already demonstrated a veritable genius for inventing ways of doing things that "couldn't be done" -- witness not only "operational control" but also the weapon system concept, the joint system project offices, and the "Gillette procedures" for the development of intercontinental ballistic missiles.<sup>3</sup> A more serious fault in Bergquist's proposal was that it could only bring to a head the very "roles and missions" wrangle that he hoped to avoid. He may have been quite right in thinking that the Army would take vigorous exception to any move to have OSD formally invest the Air Force with responsibility for the management of all air defense systems, but what made him suppose that the Army (or the Navy, for that matter) would view his "guidance authority" idea as anything but a transparent device to accomplish essentially the same thing indirectly?<sup>4</sup>

It may be that by the time Bergquist wrote the Joint Chiefs had already

made up their minds not to support the Partridge proposal, or it may be that something went wrong soon afterward. Anyway, when Secretary Douglas replied on March 2 to Stratton's January report of progress in the organization of MITRE, he went out of his way to let Stratton know in advance that the idea was not going to be approved:

You are undoubtedly aware of the current discussions concerning possible reorientation of the ADSID/ Mitre organizational relationships to the rest of the Department of Defense. Our earliest conversations recognized the possibility of broadening the scope of the ADSID/ Mitre activities at some future date. General Bergquist has brought me up to date on the ADSID and Mitre and their relationships with other agencies. I am very gratified with the progress being made, and pleased that ADSID/ Mitre are working closely with NORAD and other Defense agencies. I personally feel that we can profitably continue the arrangements we have effected thus far for some time without radical change.<sup>1</sup>

Formal rejection came on April 7 in a more tartly worded letter to ARDC from the Assistant Vice Chief of Staff, Major General Jacob E. Smart:

The recommendation . . . concerning the transfer of ADSID/ Mitre to NORAD is not concurred in. This transfer is not considered desirable at this time. Further proposals concerning changes in Air Defense Systems Integration Division will be approved by this headquarters prior to discussion outside the Air Force.<sup>2</sup>

What was objectionable, then, was not so much the idea itself as its timing -- and the fact that there had obviously been prior collusion between Bergquist and NORAD. Partridge, after all, had made his proposal to the Joint Chiefs in September, and the fact that the Joint Chiefs had not been able to reach a decision in four months suggests that the Army and Navy had grave reservations about creating a "unified air defense engineering agency," especially since ADSID, an Air Force organization, would almost have to be the principal component of that agency. Their part in such an agency, as in NORAD itself, was sure to be a rather secondary one, and they may well have feared that the whole maneuver would end by relieving them of some of



their systems. Even though some Air Force officers were known to sympathize with Partridge's proposal, the prudent attitude for the Air Force to take officially was one of disinterested neutrality, but Bergquist had been indiscreet enough to put his superiors in a position where they had to take a stand, and in writing. If the idea of transferring ADSID to NORAD was not already dead when Bergquist wrote, it would seem that he himself inadvertently administered the lethal blow.

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There were undoubtedly other reasons why the Air Force, even though it may at first have seen some merit in what Partridge and Bergquist were urging, decided in the end that it did not wish to go that road. It could hardly have cared to establish a precedent that might in time have led to the complete erosion of the ARDC mission. Moreover, both Air Force headquarters and ARDC were then in the throes of rethinking the whole problem of Air Force management of research and development, and this thinking had already taken a direction incompatible with what Partridge and Bergquist wanted to do. The agonizing reappraisal of ARDC had begun in November 1957, about six weeks after the first sputnik launching, when General White as Chief of Staff had asked the Air Force Scientific Advisory Board to make a second comprehensive study of the Air Force's research and development activities and procedures (the first having been the one conducted by a committee headed by Dr. Louis N. Ridenour in 1949 and leading to the creation of ARDC and also of the position of Deputy Chief of Staff, Development, in Air Force headquarters). The Scientific Advisory Board accordingly asked Dr. H. Guyford Stever, Professor of Aeronautics and Astronautics at the Massachusetts Institute of Technology, (who, incidentally, had been a member of the Valley Committee in 1950) to form another committee to take a look. Many of the recommendations in the Stever Com-

mittee's report of June 1958 were never adopted, but at least one of them had a traceable influence on later developments. Stever and his colleagues thought that a part of ARDC ought to be addressed to the development of complete weapon systems. They distinguished three classes of weapon systems -- aerodynamic, ballistic missile, and air defense -- and proposed the creation of a deputy commander for each. By "air defense systems" they did not mean interceptor aircraft, which would fall in the aerodynamic category, but "ground environmental systems" such as SAGE. It is questionable whether any ground environmental system may be properly called a weapon system, but anyway the Stever Committee was asking, among other things, that someone be appointed to give concentrated attention to the whole family of ground environmental air defense systems.<sup>1</sup> The approach, however, was quite different from the ADSID approach. To set things up this way would be to create a vested interest in getting as many such systems as possible developed as rapidly as possible, and perhaps even in multiplying them, but not necessarily in seeing that they were properly integrated. Indeed, fussing over the integration of systems, although it should lead to sounder results in the end, is more likely to retard than to accelerate their development. It would be an ARDC deputy commander who would be responsible for the development of air defense systems, and that arrangement would tend to clash with any effort by ADSID to intervene in the development of specific systems for the sake of their integration with other systems -- especially if ADSID were detached entirely from ARDC and became an agency of NORAD.

As regards ballistic missiles, the Stever Committee recommendation was already virtually accomplished. Since 1954 General Schriever's organization at Inglewood, California, had been planning and supervising all phases of the development process, and the first United States intercontinental

ballistic missile, the Atlas, would be ready for use in 1959. If ARDC had a resounding success to its credit, this was it -- even though it had been possible only because Schriever had enjoyed an unusual degree of independence from ARDC headquarters. It is hardly surprising, therefore, that nearly everyone concerned with Air Force systems in this post-sputnik era tended to take it for granted that Schriever had come upon a success formula suitable for universal application; and no doubt this was why ARDC was inclined to favor the three-fold management structure that the Stever Committee report had recommended, despite the fact that it thought less well of some of the other recommendations in that report.<sup>1</sup> The formula was a natural outgrowth of the already developed weapon system concept. It involved some important innovations in system development procedures, and also a concentration of system management responsibility at a fairly high organizational level. It therefore accorded well with the idea that the various weapon system project offices, and also the project offices in charge of ground environmental systems (or "electronic and supporting systems," as they were usually called at the time) should be gathered into groups so that a general officer immediately subordinate to the ARDC commander could be placed in charge of each group. An ARDC headquarters staff study in February 1959 advocated this three-fold structure, and General Anderson would probably have adopted it if it were not for the fact that he was about to leave ARDC and preferred to defer major decisions to his successor -- who proved to be General Schriever.<sup>2</sup>

Thus, the idea of transferring ADSID to NORAD could hardly have come at a less opportune time, for it was essentially an idea about how to achieve a sound integration of systems whereas the need of the hour was, or was tacitly assumed to be, simply to get on as expeditiously as possible with the business of producing new systems. Indeed, the very need for an organization

specifically devoted to systems integration tended to be lost sight of (if it had ever been really appreciated), and ADSID was something of a nuisance anyway because, cutting across command lines as it did, it did not lend itself to absorption into the new organizational structure that ARDC was getting ready to adopt. On assuming command of ARDC in May 1959, Schriever immediately set about to make his own reorganization plans, and again a three-fold systems management structure was proposed. This time, however, one spoke, not of "electronic and supporting systems," but of "command and control systems" -- a new term then coming into vogue, especially in the Office of the Secretary of Defense -- and it was explicitly proposed that ADSID as then constituted would cease so that its ARDC component could be used as the nucleus of the new command and control systems organization, and, even more important, so that MITRE could become the new organization's technical contractor.<sup>1</sup> Indeed, it was precisely because MITRE was already situated at Hanscom Field (there was no more talk of moving it to Colorado) that the ARDC planners assumed that the command and control systems organization should also be either at Hanscom or, if Hanscom's limited facilities proved insufficient, as near to Hanscom as possible.<sup>2</sup>

An essential part of the idea was that each system project office should be collocated with the appropriate division and that its ARDC component should be assigned to that division. This required the cooperation of the Air Materiel Command, since a project office, like ADSID, was an inter-command organization. It invariably included an ARDC and an AMC component, and sometimes a component representing the command that would use the prospective system. As long as it was primarily engaged in developing its system, it was under ARDC "executive management" (i. e., its chief would be an ARDC appointee), but would nevertheless have an AMC contingent to prepare for the Air Force's eventual procurement of the system; but, when

emphasis was deemed to have shifted from development to procurement (or installation, in the case of ground systems), the situation was supposed to reverse itself, even though there was likely to be a substantial amount of development yet to be accomplished. This obviously awkward arrangement had been found necessary in the early 'fifties, first in the management of weapon systems and then in the management of ground systems like SAGE, because the development function (an ARDC responsibility) and the procurement and installation function (an AMC responsibility) tended to overlap and had to be performed in conjunction with each other.<sup>1</sup> Consequently, before Schriever committed his own command to a systems management structure involving three development divisions, he needed to be sure that AMC would adopt a parallel structure. As it happened, AMC had already set up its Ballistic Missile Center at Inglewood and its Aeronautical Systems Center at Wright-Patterson before Schriever became the ARDC commander, and was willing enough to set up an Electronic Systems Center also -- although it had to be talked out of the idea of locating that center at Griffiss Air Force Base near Rome, New York, rather than at Hanscom Field.<sup>2</sup> This, incidentally, was another reason why ADSID had to go: its AMC component would be needed to form the nucleus of a new AMC center just as its ARDC component was needed for a command and control organization.

One of the assumptions in all of this was that MITRE would broaden its "scope" from air defense to the whole field of "command and control," and another was that its raison d'etre would thenceforth be to assist the command and control system project offices in the development of their respective systems. Why else should it have been so important to move the project offices from New York or Wright-Patterson (and some of their AMC personnel from Griffiss) to Hanscom, if not to let them enjoy the benefit of a day-to-day working relationship with that pool of electronic wizardry that ARDC

tended to see in MITRE? Was not MITRE, after all, a systems engineering contractor, and had it not already offered some critical comments on several of the command and control systems then being developed?<sup>1</sup> What was overlooked was that "system engineering" can mean one thing in one context and something quite different in another context. MITRE's experience had been in the development of SAGE, and SAGE not only was not a weapon system but was not even a system in the same sense that a weapon system was a system. The latter, even when all of its adjuncts were taken into account, was essentially a tool that a military organization would use, but SAGE was not so much a tool that the Air Defense Command would use as it was an electronic description of what ADC was in process of becoming. The MITRE tradition was one of designing and developing semi-automated organizations -- "organisms," in the Valley Committee's simile, though it is doubtful whether very many MITRE people had ever read the Valley Committee report. The systems in which MITRE was primarily interested and for which it may be said to have had something of a flair (the super-combat centers, the NORAD Combat Operations Center, and the prospective SAGE-like air traffic control system) were primarily ideas about organizations and their basic functions, and only secondarily about the gadgetry, electronic or other, that they might need in order to perform their functions adequately. On confronting most of the command and control systems then under development, the natural tendency of such a group of engineers was first of all to ask searching questions about the organization for which the system was intended, in order to reach independent conclusions as to which of the organization's functions needed to be automated, and they might easily end by saying that the system as conceived was a bad idea and recommending an entirely different approach. To ask them to put themselves at the disposal of project chiefs, who were not in the habit of questioning the concepts of

their respective systems, was to invite misunderstanding.

There was a real confusion of thought here, and the very term "command and control" was a symptom of the trouble. This obvious barbarism was apparently invented about 1959 by people who were in the first place used to thinking of a "system" as though it were either a weapon system or something like a weapon system -- a tool for an organization to use rather than the organization itself. They knew, of course, that some systems were not weapons and yet were quite as important as any weapon could be, and had come to see the need for a better generic name than "ground environmental" or "electronic" or "supporting" systems; but they still clung to the fallacy that such systems were tools, and so coined the term "command and control" as a name for a kind of tool that could not very well be called a weapon. Actually, there was supposed to be a difference between a "command system" and a "control system," but no one was ever able to say clearly what the difference was. After all, it is difficult to see how one can command something without controlling it, or control it without commanding it. Until 1961 or 1962, at any rate, there was a tendency to pronounce "command and control" as though it were one word, and to talk about it as though it were a recent invention, a new and revolutionary kind of weapon -- except, of course, that it was not a weapon. Nine years earlier the Valley Committee had hit upon a far sounder and more incisive way of thinking about this kind of system by likening it, not to a tool, but to an organism; but that simile had never taken hold and had long since been forgotten. Anyway, the post-sputnik era was not in a mood to think about systems as organisms or parts of organisms. It was fascinated with weapon systems -- especially with the kind of weapon system that exudes vaporizing liquid oxygen as it poises itself excitingly on its launch pad, thrusts itself aloft with a long beautiful tail of fire behind it, and arches its way

through hundreds of miles of outer space on its inertially guided trajectory. The psychological climate demanded that these non-weapon systems be forced, however unnaturally, into a mold that was essentially a weapon system mold.

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MITRE, of course, was not consulted about the impending reorganization of ARDC and dissolution of ADSID in the summer of 1959; but Bergquist had been aware of the direction of ARDC thinking at least since April, and he viewed the scene with deepening misgivings. In the first place, he was primarily interested in air defense and did not relish anything that might dilute the effort to integrate air defense systems. He did want something to say about the way specific air defense systems were designed and developed, but, despite his earlier remark about the need for ADSID to "function practically as a directive agency of Headquarters USAF, similar to AFBMD,"<sup>1</sup> he apparently did not wish to have air defense system project offices (let alone other command and control system project offices) assigned to him, and would have much preferred what he called "guidance authority" over them. He had already registered his opinion that ADSID ought to be continued as an entity quite separate from any development organization ARDC might see fit to establish -- partly on the ground that development and integration were separate functions, and partly because, despite the rejection of his NORAD proposal, he still cherished the hope that ADSID could somehow be converted into an inter-service air defense agency.<sup>2</sup> Nor could Schriever have simply overridden these objections, since ADSID had been created by an Air Force regulation and only Air Force headquarters could rescind that regulation. In order to persuade Air Force headquarters to do this, it would be necessary to show that such action would not amount to a negation of the objective of an integrated air defense mission system, to which Secretary Douglas had personally committed the Air Force only a little more



than a year before. Schriever needed to be in a position to argue that his reorganization scheme would be, among other things, a more effective way of doing everything that ADSID had been supposed to do.

It was probably for this reason that Schriever decided to seek the support of what was often called the "scientific community" before proceeding. Taking advantage of the fact that one of the annual ARDC-sponsored meetings of the National Academy of Science was about to occur at Woods Hole on Cape Cod, he asked Dr. Albert G. Hill, then Professor of Physics at MIT and a former Director of the Lincoln Laboratory, to bring together a few of the people present to consider "the background and concept" of his proposed command and control development organization and give him the benefit of their advice. In addition to Dr. Hill, this group comprised:

Dr. William O. Baker, Vice President for Research, Bell Telephone Laboratories

Dr. Ivan Getting, Vice President, Engineering and Research, Raytheon Manufacturing Company

Dr. R. F. Mettler, Executive Vice President and Director of System Engineering Division, Space Technology Laboratories

Dr. Emanuel Piore, Director of Research, International Business Machines Corporation

Dr. Allen Puckett, Vice President, Hughes Aircraft Corporation

Dr. H. Guyford Stever, Professor of Aeronautics and Astronautics, Massachusetts Institute of Technology

Dr. Jerome B. Wiesner, Director, Research Laboratory of Electronics, Massachusetts Institute of Technology

These eight men met at Woods Hole around the middle of August, and again in New York on September 16. It is not clear whether the implication that ADSID would have to be dissolved was specifically brought to their attention or whether Bergquist's point of view was represented, but at any rate they concluded that a command and control development organization as proposed

would be a good idea. Schriever not only thanked them for their help but, apparently with the whole pattern of up-coming events mapped out in his head, asked them to stand by for another request for assistance in the near future.<sup>1</sup> It would still take action by Air Force headquarters to dissolve ADSID, but, with the Hill group's testimony to support him, Schriever could now press his case without being accused of behaving arbitrarily or irresponsibly.

Meanwhile, all other snags in the way of the reorganization plan were either removed or in process of being removed. AMC's cooperation had been secured, and both ARDC and AMC staff officers at Hanscom were in the throes of figuring out where the project office people who were to be moved there might hang their hats.<sup>2</sup> On October 6 the Office of the Secretary of Defense and ARDC issued simultaneous press releases announcing, among other things, the reorganization of Schriever's former command, the Air Force Ballistic Missile Division at Inglewood, California; the creation of the Wright Air Development Division (for aeronautical systems) at Wright-Patterson Air Force Base, Ohio; and the creation of the Air Force Command and Control Development Division at or near Hanscom Field, Massachusetts.<sup>3</sup> The releases did not spell out the implications as regards ADSID and MITRE, but Schriever had come to Boston on October 1 to explain the situation to Gaither, Webster, and McCormack, and to indicate that he was prepared to ask MITRE to become the AFCCDD contractor.<sup>4</sup> He knew, of course, that MITRE could not very well accept until it had a reasonably clear idea of what its relationship with the still non-existent AFCCDD would be, and unless it could be assured of being able to continue its work on air defense integration. Besides, he had assumed all along that Bergquist would head AFCCDD and would therefore also need to be satisfied on these points. His approach was to let both ADSID and MITRE have a hand in writing their own ticket, and he

also thought it might be useful to secure some help from the Lincoln Laboratory. When he talked with Bergquist, Halligan, and McCormack at Mitchel Air Force Base on Long Island on October 13, he proposed that Lincoln and MITRE participate in two studies, one on the functions that AFCCDD would have to perform and on the relationships it would have to have with other Hanscom Field organizations, and the other on the conceptual soundness of the dozen or more command and control systems with which AFCCDD would be concerned. The two studies together would go a long way toward getting AFCCDD started. ARDC would supervise both of them, of course, and would have to approve their recommendations; but both of them would be conducted at Hanscom Field, with the ADSID staff acting as ARDC's local representative, and would thus involve the people at Hanscom, including MITRE, who would have to live with the recommendations when approved.<sup>1</sup>

As regards the second of these studies, Schriever called attention to a current Air Force headquarters effort which he apparently thought would make it possible to lay the integration problem to rest once and for all. It seems that Air Force headquarters had also become concerned about the need to integrate command and control systems, not only in air defense but in all combat mission areas, and had therefore established the Control Systems Integration Working Group, headed by William J. Becker of the Directorate of Requirements and including people from the various Air Force agencies concerned, from several of the principal Air Force industrial contractors, and from the RAND, System Development, and MITRE Corporations -- the MITRE representatives being Walter S. Attridge and William E. Holden.<sup>2</sup> It would be a month or two before an ARDC-sponsored study of command and control systems could get under way, and by that time the Becker group would have completed its work. Its recommendations, if approved, would constitute an authoritative statement of Air Force require-

ments that the ARDC group could use as criteria against which to evaluate the command and control systems. Some of those systems would no doubt have to be modified, and the "interface" between them and some weapon systems might very well need attention, but, once those matters were resolved, there should be no further need to worry about the systems integration question (except, of course, as regards certain Army and Navy systems relating to air defense). The exercise would also have a bearing on the organization and functions of AFCCDD, since AFCCDD could then know exactly what it had to do -- guide the development of command and control systems according to approved criteria.

Schriever's proposal put the executive committee of the MITRE board (Brace, Gaither, Halligan, McCormack, and Webster) in a quandary -- so much so, indeed, that they asked Stratton to join them as they considered it, even though he had withdrawn from the committee a year before. As the AFCCDD contractor, MITRE's "scope" would certainly be broadened, but not in the way originally anticipated. The new tasks would force the Corporation to increase its technical staff, and could distract it somewhat from its original purpose of designing and engineering a comprehensive air defense mission system. At the same time, an AFCCDD connection might actually prove to be unduly restrictive, for air defense integration was primarily a matter of integrating command and control systems like SAGE and the NORAD Combat Operations Center (within AFCCDD jurisdiction) with weapon systems (outside AFCCDD jurisdiction). Also, what effect, if any, would the change have on the Corporation's prospects of eventually extending air defense integration to Army and Navy systems? It had already been working informally, although with Air Force knowledge and approval, on the technical aspects of a master air defense plan desired by the Directorate of Defense Research and Engineering, and, as it happened, completed a study on this subject in Oc-

tober, about the time when Schriever broached his proposal. Would it be possible to continue this direct working relationship with the Office of the Secretary of Defense?<sup>1</sup> Nevertheless, it seemed unwise to reject Schriever's proposal out of hand, and the committee decided to participate in the two studies as requested (especially the second one, for which the work on the air defense master plan served as a kind of preparation), although without as yet committing the Corporation to accept an AFCCDD contract. After exploratory meetings at Lincoln and in Washington in November, MITRE agreed to act as "host" to the group that would conduct the second study, on command and control systems -- which was supposed to be conducted during the coming winter and was therefore called the Winter Study. By November 30 Schriever had approved a work statement for the Winter Study Group and ARDC steering committee had determined the group's panel structure, and Jacobs spent most of December recruiting the members of the panels.<sup>2</sup>

Meanwhile, a few days after the meeting at Mitchel, Schriever and Bergquist together discussed the proposed AFCCDD and its implication for ADSID with the three Air Force headquarters deputy chiefs of staff principally concerned. Schriever was, if necessary, prepared to establish AFCCDD without affecting ADSID, although the general awkwardness of such an arrangement must have been apparent all around. Bergquist held out for another six weeks, but on November 28 agreed to accept what might as well be called the inevitable. Once it was settled that ADSID would be "phased out" as soon as AFCCDD was organized and that Bergquist would command AFCCDD, it was possible to undertake the first of the studies that Schriever had mentioned at the Mitchel meeting, on AFCCDD's functions and relationships, and that study was completed by the end of December.<sup>3</sup> Even before Bergquist's actual decision, the MITRE board at its meeting on November 24 had taken it as a virtual certainty that ADSID would be discontinued and that the Corpora-

tion would therefore have no choice but to accept an AFCCDD contract. The board still cherished the hope, however, that MITRE might somehow continue to work directly with agencies other than the Air Force, especially with OSD, and wondered whether the best insurance against possible AFCCDD or ARDC obstructionism might not be a separate contract with OSD in addition to the AFCCDD contract. There was precedent for such a move. On October 1 MITRE had entered into a small contract with the Navy (hardly more than a "warm body" contract, since it consisted in lending the person of David R. Brown to the Commander-in-Chief, Pacific, for a period of eighteen months), and the SATIN contract with the Federal Aviation Agency had begun on October 19. MITRE was quite willing to work for AFCCDD, and had even begun to relish the idea, but knew it could not do what it had been created to do unless it also worked for OSD. It also knew that, if it did not soon establish an important non-Air Force connection, it would be branded forever as an Air Force captive contractor, and thus lose whatever chance it may have had of eventually winning the confidence of the Army and the Navy. That would not necessarily prevent it from planning and engineering a comprehensive inter-service air defense system, but would mean that Army and Navy cooperation could be secured only by OSD fiat.<sup>1</sup>



## CHAPTER SEVEN

### 1960: THE FATEFUL YEAR

What complicated the situation was the fact that around the beginning of December 1959 three important changes occurred in top Pentagon personnel. Thomas S. Gates replaced Neil H. McElroy as Secretary of Defense, Douglas became Assistant Secretary of Defense, and Dudley C. Sharp succeeded Douglas as Secretary of the Air Force. It therefore seemed highly advisable to acquaint Gates and Sharp with the Douglas-Stratton understandings of 1958 (and incidentally to remind Douglas). The board evidently felt that something like a "show down" was needed, and four members of the executive committee (Gaither, Halligan, McCormack, and Webster) and Stratton (presumably because he had been a party to the 1958 negotiations) arranged to call on Gates, Douglas, and Sharp in the Pentagon on January 7-8, 1960. So crucial was this visit to the whole future of MITRE that it is worth quoting in full the points on which the board hoped to secure agreement:

A reaffirmation that, to serve the Country most effectively, MITRE's work should continue to be directed toward the ultimate objective of the advancement and integration of the overall Air Defense system.

The Air Force has the major responsibility for Air Defense, and therefore MITRE's principal effort will continue to be for the Air Force. Since several major Air Force commands are involved, MITRE must continue to have access to the Air Force Secretary and the Chief of Staff, to insure maximum coordination of Air Force programs.



To a lesser degree, Air Defense also involves Army and Navy programs, and these services should be encouraged by DOD and the Air Force to support MITRE's work.

The overall Air Defense program requires coordination and direction by OSD. In order to be fully effective in the support of this function, MITRE's work for OSD should be done under a separate contract. We hope that an immediate pilot contract can be arranged for this purpose.

That DOD looks with favor on MITRE's plan to continue to contract with other government agencies for appropriate related work, as for example the work that will be done under the present contract with FAA.<sup>1</sup>

Of these objectives, the only one which, if gained, would make an immediate and tangible difference was the separate contract with OSD. What was at stake was not whether MITRE might work for OSD, since it was already doing that through its Air Force contract and no one was suggesting that it ought not to continue to do so, but whether it would be able to remove that part of its work from the Air Force's jurisdiction. It is a commonplace of business management that a multi-customer organization is less vulnerable and therefore healthier than a single-customer organization, and the board was trying to put the Corporation in as sound a posture as possible. The Navy and Federal Aviation Agency contracts had already established a separate-contract precedent, and a contract with OSD, even if only a "pilot contract," would significantly strengthen the precedent. If, in addition, the Air Force and OSD could be persuaded to assent explicitly to the principle that MITRE might also enter into contracts with any number of other government agencies, the Corporation would be in a fair way to gain the degree of independence from the Air Force that it instinctively felt it needed. The need in this case, moreover, was not merely a need for insurance against a possible sudden reduction in

the volume of Air Force work but also a professional need. The Air Force was not so much MITRE's customer as its client, and the service it rendered to its client was essentially that of an architect-engineer: it gave its client a special kind of technical advice and then monitored the efforts of private industrial contractors engaged to execute that advice. The relationship was a professional one, and it is inherent in a professional relationship that one responds to one's client's wishes only insofar as that is compatible with one's own professional judgment. There had been little danger that ADSID would precipitate a professional-conscience problem for MITRE because it was not responsible for system development and therefore had no motive to insist that MITRE help a system project office develop a system that MITRE regarded as conceptually unsound, but with AFCCDD this would not be the case. MITRE would be better able to resist the importunities of the system project offices (which, be it remembered, were about to be moved to Hanscom precisely in order that they might be nearer to MITRE) if it were not completely at AFCCDD's mercy. Hence the need to have as much of its work as possible covered in non-Air Force contracts.

But the Air Force could not very well see things this way because the nature of its need for MITRE virtually demanded that MITRE be its captive. It never said that in so many words, however, and usually avoided giving explicit reasons for its preference. It wanted to administer a single MITRE contract that would embrace both its own work and the OSD work, thereby making MITRE its captive, but the only cogent reason it cared to avow was that the cost to the taxpayer would be less if there were only one contract to administer rather than two.<sup>1</sup> The real reasons were deeper and subtler, and there were at least two of them. One had to

do with the delicate relationship that would have to exist if MITRE were to be worthwhile from an Air Force standpoint. The Air Force, after all, could have purchased any amount of competent technical advice and engineering talent by contract with private industry, but only in MITRE could it find a team of engineers who had worked on SAGE continuously from the beginning, who had conceptualized or were then conceptualizing the super-combat centers, SATIN, the NORAD Combat Operations Center, and the air defense master plan, and who by this time had acquired a more than superficial knowledge of other command and control systems. The point was to keep this team on the job so that it would be there, year in and year out, with its accumulated background and experience, as each critical juncture in the evolution of command and control systems came along. It would not do to substitute another team, even if the engineers composing the second team were men of outstanding ability, because "two cooks spoil the broth." It was for this reason that the Air Force extended itself in 1958 to make the creation of MITRE possible, and the purpose would be defeated if MITRE were allowed to become too deeply interested in projects that were not Air Force projects. The SATIN contract with the Federal Aviation Agency was all right because the integration of SAGE and air traffic control was at least as much an Air Force as an FAA objective, but AFCCDD would need the continuous assistance of this particular team, and would need to see that its primary attention continued to be focused on AFCCDD business.

The other reason may as well be called political. The last thing the Air Force wanted to do was to discourage MITRE from working for OSD, even in the unlikely event that might entail some retardation of effort on specific systems. It was in the Air Force's interest to maintain and, if

possible, enlarge its system management establishment, but the Defense Directorate of Research and Engineering, that creature of the 1958 Reorganization Act, had authority to take charge of all military system management. In the winter of 1959-60, however, the OSD directorate had yet to hit its stride, and could still be influenced. The best way to influence it was to encourage it to make a habit of depending on the Air Force as a principal source of system concepts and of system management experience, and, as an "avenue of influence"<sup>1</sup> on OSD, MITRE was one of the Air Force's prime assets. MITRE's value as an "avenue of influence" would not necessarily cease if it had a direct contractual link with OSD, but the desired psychological effect on OSD was likely to be stronger if the Air Force remained in the position of graciously accommodating OSD by means of task assignments under the Air Force-MITRE contract, and if OSD continued to pay for MITRE's services, not directly, but through a transfer of funds to the Air Force. Again, a captive MITRE was preferable to an independent MITRE.

Even as Messrs. Gaither, Halligan, McCormack, Stratton, and Webster were preparing for their trip to Washington, ADSID and ARDC had apparently learned that they intended to seek a direct contract with OSD, and had decided to oppose that move. It is probably significant that the December 31 report of the ARDC-appointed study group on AFCCDD functions and relationships explicitly assumed that, except in the FAA case, MITRE's services

to agencies outside the USAF, such as the Director of Research and Engineering of the DOD, the JCS and unified commands, would continue to be furnished under a single USAF contract under direct control of AFCCDD.<sup>2</sup>

More significant is the fact that General Schriever was present on January 7 when the MITRE representatives called on Dr. Joseph V. Charyk, Assistant Secretary of the Air Force for Research and Development, and again when they called on Secretary Sharp. The meetings were amicable enough, and no one demurred at the review of the 1958 understandings or at the truisms listed above concerning the nature of the air defense problem and the importance of MITRE's efforts to deal with it. Moreover, everyone agreed that MITRE's work for OSD ought to continue and ought to be put on some kind of formal basis, but Schriever indicated that, while not adamantly opposed to a separate contract, he would rather see MITRE's OSD work handled as "a specific task or work statement in the Air Force Contract." The MITRE trustees countered with the observation that

. . . the CCDD work would tend to identify MITRE more strongly than ever as an Air Force-oriented contractor, thus limiting its effectiveness in overall planning, unless there was in DOD a clear expression of intent to develop this broader role for MITRE.<sup>1</sup>

They covered much the same ground at a subsequent meeting in the office of Assistant Secretary of Defense Douglas, where Gates joined them long enough to hear them summarize their case, and both Douglas and the Director of Research and Engineering, Dr. Herbert F. York, were apparently initially predisposed in their favor. Indeed, when Stratton and McCormack later conferred privately with York, York went so far as to talk about "an annual contract level of about \$5,000,000." Nevertheless, Douglas ended by saying that

. . . while a direct contract with OSD appeared to be the proper means for covering MITRE's OSD work, he would discuss this

matter with Secretary Sharp and see to it that General Schriever's preference was given proper consideration. <sup>1</sup>

After this series of meetings, apparently before leaving Washington, the five MITRE trustees drew up a six-point summary of what they thought had been agreed to: (1) that "MITRE's ultimate role in air defense planning" was "fully re-affirmed"; (2) that its future work would not be limited to air defense but would extend to offensive, intelligence, and other command and control systems; (3) that there ought to be "some visible evidence" of OSD's desire to make regular use of MITRE's services, preferably a direct OSD-MITRE contract, but that, in view of the Air Force's preference of a single omnibus contract, OSD would make "a comparison of the relative advantages of the two procedures" before committing itself; (4) that OSD would encourage the Army and the Navy to avail themselves of MITRE's assistance; (5) that OSD recognized that "MITRE may, when appropriate, contract with other government agencies, such as FAA"; and (6) that MITRE would probably continue to work primarily for the Air Force and would "continue to have direct access to the Air Force Secretary and the Chief of Staff," and that, "while effort in air defense may decrease, the support of CCDD will require a large expansion of MITRE's Air Force work." Douglas and York, on examining this document at leisure, agreed in the main but indicated that they would expect an opportunity to express OSD views before MITRE concluded another non-Air Force contract, and that the "expansion of MITRE's Air Force work" was merely a possibility, not a certainty. <sup>2</sup>

In short, neither OSD nor the Air Force had committed themselves to anything to which they were not already committed. On the contrary, it was the MITRE trustees who had conceded something: they had not previously said that MITRE would accept an AFCCDD contract, but that was the

clear implication of the second item of their six-point summary. Yet, in reporting on these proceedings to the full membership of the board, Halligan ended on a hopeful note:

The reaction of the DOD people during these discussions was distinctly re-assuring, and we believe that there was general concurrence with our objectives. Further, we believe that Secretary Gates now understands, and is in sympathy with, these objectives.<sup>1</sup>

Such optimism seems unwarranted in retrospect because no OSD contract materialized, so that nothing was accomplished except to call MITRE's existence to the personal attention of certain key officials in the military establishment. It may even be argued that MITRE had lost ground — not so much because its trustees had committed it to an AFCCDD contract (short of corporate suicide, there was no choice) as because, by seeking confirmation of its right to contract with other government agencies, they had given Douglas a convenient opportunity to compromise that right by asking to be informed in advance before any new contract was negotiated. Yet it is difficult to see how, under the circumstances, the five trustees who journeyed to Washington in early January could have represented the Corporation's interests any more effectively than they did. It was not their fault that the odds were somewhat against them.

Besides, it was not as though the OSD-contract idea had met with sudden death, for Dr. York's office continued to be willing to consider a specific proposal by MITRE. Indeed, the question remained open through at least the first half of 1960, and the Air Force was in a quandary. It had been assured that OSD would listen to its objections before proceeding with a separate contract, but its objections might always be overruled, and, even if they were not, it might find that it had alienated the very people in

OSD whom it hoped to influence. Sober reflection suggested the wisdom of circumspection. As Bergquist explained to some members of his staff on February 29,

. . . we are in the ticklish position that, if we become too obsessed [ sic ] with a single contract, we may lose ground over the long haul. It is true that the Air Force should initially favor, and strive for, a single contract; but, if this jeopardizes in any way our "avenue of influence," we should then give in and permit at least one separate contract with the Department of Defense, and preserve our "avenue of influence" through a show of good faith. <sup>1</sup>

Colonel Wilfred H. Tetley, the ADSID Deputy Commander, Engineering, had already seen that the only avowable argument in favor of a single omnibus contract — that one contract would cost slightly less to administer than two — was not very compelling, and therefore considered that the Air Force's best strategy would be to see to it that MITRE bore the burden of proving the advantage of multiple contracts. He also thought that the Air Force should take a more direct route to its objective, and therefore proposed the following formula:

The Commander, CCDD, will designate which government agencies are authorized to use the services of The MITRE Corporation. Direct dealings are then authorized and encouraged between the specified organization and The MITRE Corporation, with no stipulation that the Commander CCDD must concur or approve the MITRE opinions expressed to the specified organizations. <sup>2</sup>

From the Air Force's point of view, this had the great advantage of separating the essential from the inessential. It tacitly assumed that any MITRE services to a non-Air Force client would be covered by augmentation of the existing Air Force contract, but sought to reassure any such client that the Air Force would not intrude itself into the client's working



relationship with MITRE or seek to censor any MITRE report — all of which it had no wish to do anyway. At the same time — and this was the important thing — there would still be an Air Force hand on the handle of the valve marked "MITRE," so that the Air Force would remain in the position of graciously acceding to requests for MITRE's services that it had no real intention of denying.

It was not until June that MITRE submitted an actual proposal. The presumable reason for the delay was that the Winter Study was in progress during the intervening months and any such proposal ought to take the Winter Study recommendations into account. When it came, the MITRE proposal contemplated three distinct projects — some exploratory work in connection with a then contemplated amalgamation of Army, Navy, and Air Force communication systems into a single Department of Defense system, a one-man study of existing and proposed air-ground data-link systems, and assistance to NORAD in developing operational employment plans and in related technical matters, the last two of which were already in progress. The NORAD work would involve sending not more than four technical personnel to Colorado Springs, but the other projects would be accomplished in Bedford since the Washington office was as yet no more than a small liaison office. The estimated cost of the three projects, together with a six-percent fee, was slightly in excess of \$1,500,000, of which the work on the Defense Communication System alone accounted for slightly more than \$1,000,000.<sup>1</sup> This, of course, was a drop in the bucket as compared with the Air Force contract (then over \$22,000,000) and was substantially less than the \$5,000,000 contemplated by Dr. York when he talked with Stratton and McCormack in January. At this point OSD was undecided whether to support these new MITRE projects through augmentation of the

existing Air Force contract or through a new contract to be administered by its own Advanced Research Projects Agency, although Dr. Ralph Clark of Dr. York's office was understood to favor the latter course — as did the MITRE board. Both AFCCDD and ARDC had in the meantime taken their stand on the Tetley formula, except that AFCCDD, as an afterthought, had decided that it wanted courtesy copies of any MITRE reports to non-Air Force clients.<sup>1</sup> Yet the Air Force, although it could and did exert pressure, could not dictate in this matter. Perhaps this was why Schriever saw fit on July 20 to retreat slightly. Instead of insisting that a would-be non-Air Force client apply to the AFCCDD commander for permission to use MITRE's services, he would be satisfied if MITRE would give formal assurance that the new work would in no way impair its performance of tasks under the Air Force contract.<sup>2</sup> This modified version of the Tetley formula tacitly recognized that ARPA might contract directly with MITRE despite Air Force objections, and was an effort to preserve as much as possible of the Air Force position in that contingency. The concession proved to be unnecessary because no separate contract materialized. Dr. Clark was said to have assured MITRE on July 29 that "action on the new contract would probably be initiated within the next few weeks,"<sup>3</sup> but that was apparently an inexact way of stating the case. On August 4 Halligan reported to the board of trustees in terms that may perhaps be construed as a gentle hint that the question had already been resolved according to the Air Force's wishes:

We do not yet know who will administer the OSD contract. This may be done by ARPA, or OSD may request that it be done by the Air Force. We feel that this matter is not of basic importance to us so long as OSD funds the contract and controls the work done under it.<sup>4</sup>

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If service politics "reared its ugly head" in respect to the separate contract question, it did so even more nakedly in the story of the Winter Study, which took a turn that Schriever had apparently not anticipated and that many in the Air Force regarded as inimical to Air Force interests. The first faint sign of trouble came in November 1959, before the study had even begun, when the Lincoln and MITRE representatives on the ARDC steering committee that drafted the initial work statement and established the initial panel structure complained that the study group ought to be established on a "Project Charles-like basis."<sup>1</sup> Project Charles, it will be recalled, had been a comprehensive study of air defense in 1951 by a group of academic and industrial scientists whom the Massachusetts Institute of Technology had drawn together at the request of the Air Force Scientific Advisory Board. What was meant in this case was not necessarily that the Winter Study should be conducted on a university campus, but that its principal participants should be part of the country's "scientific establishment" serving at the request of some such body as the Air Force Scientific Advisory Board or, even better, the President's Scientific Advisory Council.<sup>2</sup> The point was not only to give it prestige but also to remove it from Air Force control and especially from the intellectual influence of Inglewood. The subject, after all, was what for want of a better term were called command and control systems, and, for reasons already touched upon, no study of command and control systems was likely to be worth while if it thought of those systems as analogous to weapon systems — if it failed to recognize that a command and control system was not a tool for a military organization to use but an electronic description of the organization itself. But the study had been conceived in the first

place as an ARDC-sponsored effort, and Schriever did not intend to let it get out of his control. He had, however, arranged for the Hanscom Field people (mainly MITRE, as it happened) to do most of the work of organizing it, apparently without yet fully grasping the fundamental difference between the Hanscom point of view about systems and his own, and so inadvertently launched it in such a way that it was more likely to document the conflict of viewpoints than to resolve the command and control problem.

One result of this state of affairs was that John F. Jacobs, who was in charge of MITRE's part in making the preliminary arrangements, was obliged to draw largely on the military and civilian agencies directly involved in system management in order to fill the panels, and thus to fill them with people who, while they may have been able enough, were not widely known.<sup>1</sup> But Schriever, as usual, had foreseen the problem. In December, while Jacobs was recruiting the panels, he asked the new Air Force Secretary, Dudley C. Sharp, to appoint a small group of establishment people to oversee and guide the Winter Study Group. The Winter Study Scientific Guidance Group was accordingly organized in January 1960, when the Winter Study itself had barely begun, and it comprised the same eight men who had advised Schriever the previous summer concerning AFCCDD, plus Halligan as President of MITRE and Drs. Carl F. J. Overhage and William H. Radford, Director and Associate Director of the Lincoln Laboratory — again with Dr. Albert G. Hill as chairman.<sup>2</sup> Perhaps Hill's most important contribution was to prevail upon Gordon N. Thayer, an American Telephone and Telegraph Company vice president, to join the Winter Study Group in mid-February as its full-time director. Thayer promptly added several new people to the panels, mostly from the telephone company or its subsidiaries, established three new panels, including the

very important concepts panel, and managed the whole effort until the completion of the final report in September.<sup>1</sup> The Winter Study thus received abler direction than it might otherwise have had, and the introduction of industry people broadened its composition and perhaps improved its average calibre. Yet it was still a far cry from Project Charles, for ARDC remained in control and the Hill group, although representing a part of the establishment, was composed of men whom Schriever already knew and approved even if he had not actually picked them.<sup>2</sup> The Hill group, to be sure, was technically responsible to Secretary Sharp, and would have to report to him when the Winter Study Group submitted its final report to ARDC, but Schriever took action to forestall any serious divergence between the two groups. On February 8 he wrote Assistant Secretary Charyk that he

would appreciate all instructions to the two Groups being sent through the Secretariat I have established here in Headquarters ARDC in order that we may have a united front in our activities in this area.<sup>3</sup>

But the best laid plans can go awry, and something quite outside Schriever's control had already gone awry. The Winter Study Group was supposed to take the findings of the Air Force Headquarters Control Systems Integration Working Group, headed by William J. Becker, and go on from there, and the Becker group's three-volume report was ready on January 8, a few days before the first Winter Study Group meeting. When the Winter Study people assembled and looked around expectantly and inquired about the Becker report, they were told that it would be available at their next meeting. A week later they again asked where the Becker report was, and were told that unfortunately there had been a delay but that they would soon have it. There were a few repetitions of this, and even

the Hill group was apparently unable to obtain the release of the report. On February 23 the Winter Study Group was assured that it would "receive everything prepared by the Becker Committee which does not have political implications," but it was yet another month before there was an actual briefing on a part of the Becker findings.<sup>1</sup> Even the Hill group was not allowed to see the entire report, and what was finally made available to the Winter Study Group was only one of the three volumes — the one that dealt with the interfaces between command and control systems and did not contain controversial passages.<sup>2</sup>

What had happened was that the Becker group had found that it could not decide how command and control systems should be integrated until it knew how information was supposed to flow in a war situation. It had looked around for an authorized concept of wartime operations and, finding that there was none, proceeded to invent one. The 1958 Reorganization Act had given the Joint Chiefs of Staff operational control over the combat forces of all services, with the obvious intention that the line of command in combat operations would proceed from the President through the Secretary of Defense and the Joint Chiefs directly to the unified commands and thence directly to combat units, bypassing the service headquarters and their subordinate echelons. The Becker group not only assumed that this would be the line of command, but proposed to automate the whole line. In the case of support functions where the time factor would be less crucial, to be sure, it assumed that the line of command would detour through the appropriate service and major command headquarters, but the idea that the service and major command headquarters would stand on one side in the actual conduct of war gave offense, even though that was exactly what the Reorganization Act intended. The service headquarters were not in

immediate danger of being bypassed because the Joint Chiefs did not have a joint staff sufficient for the role in which the Reorganization Act had cast them, but the Becker report compounded its offense by suggesting things that might help to overcome this deficiency. It suggested, for instance, that the elements in Air Force headquarters that were knowledgeable in aerospace doctrine might advise the Joint Chiefs — not through channels, but directly. It even decided that System 473L (a system for the partial automation of Air Force headquarters only) was a bad idea and that what was needed was a single system integrating the functions of OSD, the Joint Chiefs, and the three service headquarters. There was rage in Air Force headquarters, and the fact that the Becker group happened to have both logic and the law on its side made its crime all the more heinous. Becker himself lost his job on account of this report, although he was reinstated after the furor died down.<sup>1</sup>

Meanwhile, the Hill group decided on February 5 that the Winter Study should proceed anyway, taking note of the Becker recommendations when and if divulged but with no obligation to be guided by them,<sup>2</sup> and by the end of June the panels, numbering about 120 people in all, had done their work and departed.<sup>3</sup> Within this time the Winter Study Group looked at all of the systems with which AFCCDD was concerned, and also, because it related to air defense, at that ultra-secret "spy in the sky" (MIDAS, or System 117L) being developed under the management of the Air Force Ballistic Missile Division. As expected, it found a great deal to criticize, and its criticisms of particular systems were, in general, to the effect that the functions to be automated had not been sufficiently thought out or that the design of the system involved compromises that might negate the expected benefits. Perhaps the worst case was the Strategic Air Command

Control System (465L), for which a subsidiary of the International Telephone and Telegraph Corporation was the prime contractor. The original 465L plan had called for four hardened centers (at Offutt, Barksdale, March, and Westover Air Force Bases), but the hardening had been abandoned because it would not have sufficiently enhanced the system's survivability: it would cost an enemy more to destroy four hardened centers than one, but not enough more to justify the expense of the hardening. When it was decided to reconfigure 465L to provide only token hardening, a fresh look at the whole system was in order, but it was not in ITT's financial interest to suspend operations because it had already committed itself to a major operation. When the Winter Study began, the system was already under attack in Air Force headquarters, to the embarrassment of all concerned, including SAC headquarters; but, because the Winter Study Group directed some of its sharpest criticisms at it, SAC conceived a grudge against MITRE that would last for about two years.<sup>1</sup>

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It was the Winter Study Group and not MITRE that criticized 465L and other systems, but the point of view was one that MITRE's technical staff tended to share. Partly because of its air defense integration mission and partly because it was on the lookout for ways to broaden its activities, MITRE had begun to look at a number of these systems in 1959, and had easily convinced itself that the system project offices needed a source of technical advice other than their prime contractors. They could put questions of rather narrow scope to certain government laboratories, but for advice concerning broad system design they could turn only to their contractors, who were thus in a position to dominate their thinking. Under a cost-plus-fixed-fee contract, a contractor had no interest in the conceptual



soundness of the system on which he was working, and was likely to use his influence to obtain authority to do things he wanted to do for reasons of his own.<sup>1</sup> Thus, the matter of System 465L not only illustrates one of the reasons why the Winter Study reports were not entirely welcome, but also says something about MITRE's view of its proper relationship with the system project offices. It wanted to help, but its idea of helping was not simply to fall to work doing whatever the project chiefs wanted done, but rather to take an independent look at what they were doing and perhaps confuse them by telling them that they were on the wrong track.

Unfortunately, when Schriever and his people at ARDC headquarters planned the reorganization that involved reorienting MITRE from ADSID to AFCCDD, they had taken it for granted that MITRE's role would be a much more subservient one, and, as the various steps in the reorganization process were taken in the early months of 1960, MITRE was under increasing pressure to adapt itself to their preconceptions. The Air Force Command and Control Development Division had been created on paper on November 16, 1959,<sup>2</sup> almost two weeks before it was settled that ADSID would be discontinued, but it took until April 1 to settle the details of AFCCDD's internal organization and accomplish the transition from ADSID. The original AFCCDD organizational plan was drawn up in January by members of the ADSID staff who would soon make the transition themselves, but ARDC headquarters objected to the emphasis on systems integration that their plan seemed to reflect and wanted to make sure that AFCCDD would proceed "full speed ahead" with the development of systems. Trivial in itself, but illustrative of the kind of wrangling that went on for a few weeks, was the matter of the AFCCDD office that would administer the MITRE contract. The original plan had proposed to call it the "Contract

Services Office" and to place it under the Director of Technology; but ARDC, apparently fearing that such a title might leave room for doubt as to who was "boss," thought it ought to be called the "Office of Contract Administration," and urged that it be under the Director of Systems Management — to insure that MITRE's efforts would be "systems oriented." In this case, Schriever saw fit not to insist on the question of the office's title, and, when AFCCDD went into operation on April 1, the "Contract Services Office" was attached to neither directorate but to the Deputy Chief of Staff, Plans and Operations.<sup>1</sup> Nevertheless, although this office was usually vigilant to keep MITRE "systems oriented," there would be recurring complaints that MITRE was not sufficiently "responsive" to the needs of the project offices. MITRE did its best to adhere to its own conception of service to the project offices, which did not always call for simple responsiveness, but it more and more found it necessary to compromise. Its own reorganizations of its technical departments in February and August, for example, reflected in part a recognition of the need to arrange its activities so that most project chiefs could find an appropriate MITRE office to which he could look for assistance.

Meanwhile, the Air Materiel Command had promptly established its Electronic Systems Center at Hanscom on January 1, staffing it primarily with the people who had constituted its ADSID contingent,<sup>2</sup> so that the way was prepared for AFCCDD and its AMC counterpart jointly to take charge of these project offices of what AMC still called electronic systems although ARDC then preferred to call them command and control systems — thirteen in all. The three project offices at 220 Church Street in New York City — DEW Line (413L), SAGE (416L), and BMEWS (474L) moved to Hanscom in

February and March. Eight others, originally at Wright-Patterson, moved either to Hanscom or to the former Murphy General Hospital in Waltham, about seven miles from Hanscom, on or before July 1:

412L	Air Weapons Control
425L	North American Air Defense Command Combat Operations Center
431L	Traffic Control and Landing
438L	Intelligence Data Processing
465L	Strategic Air Command Control
466L	Electromagnetic Intelligence
473L	Air Force Control
480L	Air Force Communications

The remaining two — Weather Observation and Forecasting (433L) and Space Track (496L) — had been at Murphy all along and did not need to be moved.<sup>1</sup> The eleven newly arrived project offices lost many of their civilian personnel in consequence of their moves, and it took about a year to find suitable replacements;<sup>2</sup> but it was all supposed to be worthwhile because now they could enjoy ready access to MITRE's technical brilliance, and that, after all, was the only specific reason ever given for putting them to all this trouble.<sup>3</sup> MITRE, of course, did not like to think of itself as a project office troubleshooting agency, but the project offices were under exactly that impression, and ARDC had been at pains to organize AFCCDD in such a way that it would give first priority to the project offices' needs.<sup>4</sup>

Nor was this all. Even as these actions were in progress, the Weapon Systems Management Study Group, established by General LeMay on May 29, 1959, and headed by Lieutenant General Samuel E. Anderson, the former ARDC commander who was then Commander of AMC, was at work on a

comprehensive schematization of the whole process of system acquisition from conception to operational use. Unlike the Becker group or the Winter Study group, this was an intra-Air Force affair, and therefore fairly free from the heretical influence of outsiders. Its seven members, all general officers, included Anderson and Schriever, representing the two major commands principally concerned, and the heads of the five Air Force headquarters staff elements involved in systems management:

Lieutenant General Dean C. Strother, Deputy Chief of Staff,  
Operations

Lieutenant General Roscoe C. Wilson, Deputy Chief of Staff,  
Development

Major General Mark E. Bradley, Deputy Chief of Staff,  
Materiel

Lieutenant General Manuel J. Asensio, Air Force Comptroller

Lieutenant General Elmer J. Rogers, Air Force Inspector  
General<sup>1</sup>

Working with the Anderson group were a number of lesser figures, also Air Force officers for the most part — notably, Brigadier General Charles H. Terhune, Jr., who had been at Inglewood with Schriever since the beginning of the missile development enterprise in 1954, and who in August 1960 would arrive at Hanscom to assume his new duties as Deputy Commander of AFCCDD.<sup>2</sup> Its recommendations, which it presented to LeMay in July and August 1960, called for a tightening up of existing procedures rather than for a radical change, even to the point of assuming that the awkward division of responsibility between ARDC and AMC would continue, but were sufficiently detailed to remove much of the vagueness that had hitherto characterized those procedures. They took the form of a series of proposed new Air Force regulations which precisely defined the parts to be played not only by ARDC and AMC but also by the "using command," by the Air Training Command, and by Air Force headquarters, and

specified the manner in which each part would be played. The life cycle of a system was analyzed into a conceptual phase (ending with the issuance of a "specific operational requirement" by Air Force headquarters), an acquisition phase (beginning when the specific operational requirement was issued, embracing both development and production, which were recognized as necessarily overlapping in time, and ending when the last unit of the system was produced and accepted), and an operational phase (beginning well before the end of the acquisition phase and continuing until the Air Force decided to discard the system). If the system were to be composed mainly of "off-the-shelf" items, so that not much development would be required, the "system program office" (a new term, in lieu of "system project office") would from the start consist primarily of AMC people and AMC would appoint the "system program director" (in lieu of "project chief"). Otherwise, ARDC would appoint the director and play the dominant role initially, and there would be a change of directors when the system was ready for quantity production. There was nothing new in this, for the old project offices had been conducted the same way, but the Anderson group also proposed that there be at all times a staff officer to act as the system's focal point in Air Force headquarters — in the office of the Deputy Chief of Staff, Operations, during the conceptual and again during the operational phase, and in the offices of the Deputy Chiefs of Staff for Development and for Materiel, as appropriate, during the acquisition or development-production phase.<sup>1</sup>

This was all very commendable, but it made sense only in respect to systems for which both the need and the basic design were already established. It recognized the conceptual phase as the initial phase in a system's life cycle, but it did not propose criteria for determining what

systems should be conceived and certainly did not call for any review of the conceptual soundness of systems already under development. This last, to be sure, was not its business; groups like the Winter Study Group were supposed to settle that kind of question. The Anderson group, however, like Schriever when he instituted the Winter Study, tacitly assumed that questions of conceptual soundness could and should be cleared up once and for all, and did not contemplate that a special operational requirement might need to be reconsidered. Moreover, despite its formal title, which seemed to indicate that it was concerned only with weapon systems, it intended that its recommendations should apply to command and control systems as well — the latter being tacitly assumed to be like weapon systems in every important respect. It drew entirely from weapon-system experience, and almost made a point of ignoring the equally valid experience accumulated through the development of SAGE, even though the latter was more pertinent in the case of command and control systems.<sup>1</sup> All this had an indirect effect on MITRE because it meant that not only ARDC but also much of Air Force headquarters was now dominated by a weapon-system bias, so that for a long time MITRE people found it difficult to obtain the sympathetic attention of Air Force officers as they sought to represent their own point of view, and, for their pains, tended to be regarded as "egg heads." More than ever, the Air Force tended to assume that the great urgency was simply to get on with the business of developing systems, and therefore to concentrate on furthering that effort and not to be forever wondering whether those systems, when developed, would in truth serve the purposes for which they were intended.

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In view of this reinforced weapon-system bias, it is not surprising that key officers in both ARDC and Air Force headquarters found the Winter Study disappointing. They could see that it had not done what Schriever had originally desired — i. e. , produce a set of ready-to-apply recommendations for modifying the various command and control systems so that all integration problems would be resolved and AFCCDD could know exactly what to do. Of course, it could not have done that, but this they did not see, or did not care to see. In order to have done so, it would first have had to decide how the war for which these systems were intended would be fought, and that, as the Becker group had already discovered, would have required a plan for the virtual remaking of the country's armed forces. For, to re-iterate, it is not primarily a set of "black boxes" that a command and control system engineer designs, but an entire organization. Only when the organization's essential functions are thoroughly thought out can there be a rational basis for deciding what kind and degree of automation is desirable; and, since no one service would fight a war all by itself, the logical unit to be analyzed, configured, and in some degree automated was not the Air Force but the whole military establishment. Moreover, planning a command and control system (or, in this case, an integrated network of such systems) is not like planning a building to be built from blueprints; rather, it is a matter of helping the affected organization adopt or evolve a new "life style," a process in which the affected organization must itself participate. When it is a question of developing a new weapon system, a thing external to its prospective user, it is probably better to keep the user "out of one's hair" until the development is fairly well along, as Schriever's people at Inglewood did in the case of the Atlas missile; but SAGE would never have been possible if the Air Defense Command had not taken an active interest in its development from the beginning. Thus,

although ARDC seems not to have grasped the fact, an intelligent overall plan for command and control systems would have to be a plan for a new life style for the nation's military establishment as a whole. The 1958 Reorganization Act offered only a rough outline for such a life style, and the only sensible approach for a command and control system engineer was to try to help the Office of the Secretary of Defense, the Joint Chiefs, and the three services together to grow into it. The point, once seen, is obvious enough, but one needed to have a SAGE background rather than a weapon system background in order to see it.

But, instead of making the Becker group's mistake of trying to formulate a concept of wartime operations which it was not authorized to formulate, the Winter Study Group (more precisely, its leadership, which scribbled away through the summer after most of the panel members had gone home) wrote an extended essay setting forth a point of view about war in an age of intercontinental ballistic missiles. The authors discussed at length some concepts of operations and of command, control, and sensor systems pertinent to an ICBM war, but did not presume to make doctrine for either the Air Force or the Department of Defense. Rather, they sought to lay before the reader some broad policy decisions that would have to underlie any adequate doctrine. They argued, for example, that, important as it was to be able to control fighting units in a pre-hostilities situation, it was perhaps even more important to make sure of being able to reach those units after an attack had precipitated. Automation designed to help a commander in a compressed-time situation (e. g. , between receipt of intelligence that an ICBM attack on the United States was about to be launched and the actual launching) was essential to a "first strike" capability, but a retaliatory or "second strike" capability need not be based on



quick reaction alone. The latter might be based on "back-up" forces or the dispersal of forces, and these forces might be protected either through hardening or through mobility. The authors held that there would have to be a choice between quick reaction and survivability before valid requirements for command and control systems could be generated, and suggested that perhaps the best solution to the compressed-time problem was not elaborate electronic equipment intended to make quick reaction safe, but a survivable and quite simple system to make snap judgment unnecessary. Evasion of this choice, they feared, might leave the country with systems neither reliable enough to permit an effective first strike nor survivable enough to control the force after being hit. They also contended that the benefits expected from a proposed system or combination of systems should be weighed against the probable cost to the taxpayer. The term "cost-effectiveness" did not come into vogue until the era when Robert S. McNamara was Secretary of Defense, but the Winter Study people (and MITRE, which established the Economic Factors Office under Norman Waks at about this time) had a clear appreciation of the cost-effectiveness principle.<sup>1</sup>

This discussion of concepts, supplemented with observations on research and development procedures pertinent to command and control systems, a summary of the work of the panels, and cost analyses of the specific systems considered, constituted the Winter Study Group's final report, which went through at least two preliminary drafts before publication on September 15, 1960.<sup>2</sup> Together with the other Winter Study reports on particular facets of the command and control problem, it constituted a fairly full statement of what may, without gross inaccuracy, be called the MITRE point of view. The Winter Study, to be sure, was by no means

wholly a MITRE affair: under Thayer's direction it was heavily influenced by people from private industry, especially from the American Telephone and Telegraph Company and the Bell Telephone Laboratories. But, although BTL had criticized SAGE in the past, chiefly on the ground that the SAGE engineers had been trying to do too much too rapidly, its own instinctive approach to system engineering was probably closer to MITRE's than to that of engineers who had cut their teeth on weapon systems. MITRE had itself become acutely aware of the need for circumspection in the planning of command and control systems as it began in 1959 to look at the then burgeoning family of such systems, and it was neither a MITRE nor a BTL man who, in the summer of that year, defined the need of the hour as "the rapid translation of technology into useful weapon systems" — this, moreover, in a context in which command and control systems were obviously meant to be included but were carelessly subsumed under the term "weapon systems."<sup>1</sup> In its rather prolix way, the Winter Study Group had challenged the whole weapon system point of view, thereby reinforcing and deepening the point of view that MITRE had inherited from its SAGE background.

On August 9 General Schriever and his ARDC staff were briefed on this Winter Study report for which they had waited so many months. They managed to find some courteous things to say about it, chiefly in praise of its sweep and penetration, but (here one can imagine the frowns beginning to appear on their faces) they noted that many of its recommendations called for action that was beyond ARDC's authority.<sup>2</sup> One can understand their disappointment and irritation. They had hoped to be told how the Air Force might clear up some technical interface problems involving its own systems, but the report, apparently unable to stick to the subject, wandered off into questions of operational concepts. They had looked for something

that would enable the Air Force Command and Control Development Division to get on with the urgent business of developing command and control systems, just as its sister divisions were getting on with the development of aeronautical and ballistic missile systems, but instead the report gave them philosophy — and subversive philosophy at that. Above all, they had wanted to see the Air Force's own command and control systems virtually completed before the Defense Directorate of Research and Engineering decided to step in and dictate what systems it and the other services should have, but the report, although it did not actually say so, implied that the OSD directorate ought to intervene immediately. It was, in short, an offensive report. It was tactless enough to criticize some important systems in which the prestige of some powerful people were involved. Its views concerning system development procedures were heresy to many members of the ARDC staff, especially to those who had been with Schriever at Inglewood during the heroic days when the Atlas missile was being developed. It was politically dangerous for the same reason that the Becker report had been politically dangerous.

Schriever undoubtedly knew even before August 9 what the general tenor of the report would be, and had probably already decided it would somehow have to be suppressed. Unfortunately, it would not do to lock it up and pretend it did not exist, as had been done with the Becker report, because far too many outsiders (industry people) would know that it existed because they had helped to write it. Moreover, the Hill group (five top-flight industrial executives and three MIT professors) would also know about it, and would have to submit a report of their own to the Secretary of the Air Force. Yet a few things could still be done. For industry consumption it would suffice to circulate only the non-controversial parts of

the final report, and even before the end of July Lieutenant Colonel John L. Lombardo, one of the two executive directors of the Winter Study Group (John F. Jacobs was the other) was talking about the need to prepare a "sanitized version" (delightful phrase) for this purpose.<sup>1</sup> Also, the report to the Secretary of the Air Force, which might prove to be more important than the report proper, had still to be written, and the Hill group evidently expected someone else to draft it. On September 5 Dr. Hill and his colleagues considered and rejected two digests or abstracts of the report proper, one by W. Thornton Read of the Bell Telephone Laboratories, who had been chairman of the Logical Concepts Panel, and one by Jacobs, who had organized the original panels and had become the group's Executive Director after Thayer was made Director.<sup>2</sup> Neither of these did anything to mute the controversial aspects of the report proper; but Brigadier General Charles H. Terhune, Jr., a Schriever man who had been at Inglewood from 1954 to 1960 and had just become AFCCDD's Deputy Commander,<sup>3</sup> may have been instrumental in having yet another draft prepared — this one being the joint work of William J. Sen, a former member of ARDC's Directorate of Systems Management who had since become Special Assistant to the AFCCDD Commander, Peter J. Schenk, MITRE's Executive Vice President, and the Hill group's recorder, Colonel George H. Duncan. This Sen-Schenk-Duncan paper, at any rate, was given to Terhune, who promptly forwarded it to Schriever as a possible report for the Hill group to submit to Secretary Sharp, although it is not clear whether the Hill group ever saw it.<sup>4</sup> It was a still different paper that Hill and Thayer finally sent to Secretary Sharp on September 26 as the report of the Winter Study Scientific Guidance Group, but that document had been drafted by Colonel Duncan, and was hardly a clarion call for anything.<sup>5</sup>

General Bergquist, as unreconstructed as ever and as lonely as ever, did his best to treat the final Winter Study report as though it were some kind of clarion call — at least for the functional as well as the technical integration of command and control systems and for the development of the "Hanscom Complex" (AFCCDD and its Air Materiel counterpart, the Electronic Systems Center, together with the system project offices, MITRE, Lincoln, and the Air Force Cambridge Research Laboratories) as a center for this purpose. He gave an unclassified summary of the report at a joint seminar of the Air Force Association and certain industrial organizations at San Francisco on September 23, and formally transmitted it to Schriever on October 7 with his enthusiastic approval. Three days later the New York Times summarized some of the Winter Study findings in a two-column article by Richard Witkin under the heading "Wide Defense Shift Urged to Ease 'Command Crisis.'" <sup>1</sup> But this sort of thing was soon stopped, and it has been suggested that some members of Bergquist's own staff, including Terhune, had something to do with stopping it. <sup>2</sup> Jacobs found it necessary on the 14th to notify those who had received copies that neither the report itself nor certain related papers were to be considered official Air Force documents or released to outsiders. The Air Force Scientific Advisory Board met at Hanscom Field on October 24-26 with an agenda entirely devoted to command and control systems, but Bergquist was the only one at the meeting to talk at any length about the Winter Study report. <sup>3</sup> On November 9 Air Force headquarters, which disliked the report as much as ARDC did, forbade that either it or Bergquist's October 7 summary be circulated outside the Hanscom Complex. <sup>4</sup> Even General Laurence S. Kuter, who had succeeded Partridge as Commander-in-Chief, NORAD, was unable to obtain a copy, and MITRE found itself with some seven hundred printed copies that it had to keep under lock and key. <sup>5</sup>

Until December 15 there was not even authority to proceed with the "sanitized version" that had been proposed primarily for circulation in industry, but ARDC then agreed that AFCCDD or MITRE might draft such a document — which, however, would have to be perused in both ARDC and Air Force headquarters before it could be published. MITRE thereupon engaged the editor of Air Force and Space Digest, John F. Loosbrock, as a consultant to work with its own new Information Services Officer, Lester R. Allen, Jr., and with William Sen of AFCCDD on this emasculation exercise. The two-hundred-page Winter Study report was reduced to thirty innocuous and platitudinous pages during the course of the next month, and a catchy title was devised: "The Challenge of Command and Control." A copy was sent to Thayer, who was invited to revise the preface if he cared to take the trouble. Loosbrock had hoped that this, at least, could be kept unclassified (the Winter Study reports themselves had been stamped "Secret"), but it was not to be. Someone in ARDC headquarters, perhaps as a reflex action, took the precaution of treating as "Confidential" the copies that were sent there for coordination, and Bergquist acceded to this classification before the end of February. The document still had to run a coordination gauntlet in Air Force headquarters, and it was not until March 31, 1961, that "The Challenge of Command and Control" was finally issued. Although it did summarize some of the material in each chapter of the real Winter Study report, a reader who had not already read the latter could scarcely have guessed what the furor had been all about. Even so, Air Force headquarters insisted that a prefatory statement be included cautioning the reader that the contents reflected the opinions of the Winter Study Group and not of the Air Force.<sup>1</sup>

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For MITRE, the year 1960 opened on an ominous note and grew more ominous with each passing month. At the beginning of the year there was ground for hope as well as alarm. The board of trustees saw that the transition from ADSID to AFCCDD might distract the Corporation from its original air defense mission, but also saw that a direct contract with the Office of the Secretary of Defense, in addition to the AFCCDD contract that it could not afford to decline, might enable it to continue to work on the inter-service air defense master plan in which it was still primarily interested. Meanwhile, the Winter Study was a golden opportunity for some members of the MITRE technical staff to stimulate their thinking concerning the whole field of "command and control." That experience enabled them to develop the insights they had already acquired from their work on SAGE into a comprehensive philosophy of the military applications of automation. In the early months of the year it did not seem entirely unrealistic to anticipate that MITRE, armed with both an OSD and an Air Force contract and intellectually refreshed by its participation in the Winter Study, might become a powerful and semi-autonomous force in national military planning. But toward the end of the year the outlook, while not completely black, was significantly darker. The fact that no OSD contract materialized did not mean that MITRE would not continue to render important services to the OSD Directorate of Research and Engineering, but it did mean that it would do so under the cold and piercing eye of an AFCCDD contract manager and that it would have to pay the closest attention to his views and preferences, even in respect to the management of its internal affairs. Its financial tether was an Air Force tether, since reimbursement for its OSD work passed through Air Force hands. Suppression of the Winter Study final

report was another blow, not because so crude an act of censorship could really keep the Directorate of Research and Engineering from knowing what the Winter Study Group thought, but because that directorate, in 1960, was still unwilling or unready to do anything it knew the Air Force would not like. The Anderson group, meanwhile, had managed to reinforce and render articulate the weapon-system bias that was much more congenial to most of the Air Force than the SAGE-MITRE bias. The Air Force had served notice that it did not intend to let MITRE influence its thinking in any fundamental way, but on the contrary expected MITRE simply to concentrate on serving AFCCDD and the system program offices. As though to emphasize the point, it temporarily suspended the funding of the MITRE contract in September, and then in December, after MITRE had been pinched to the point that it had to howl, explained that it would consider releasing funds earmarked for specific system tasks but would continue to freeze the bulk of the funding a while longer.<sup>1</sup> There could hardly be a plainer message that the Air Force expected MITRE to be precisely what it did not want to be and was not originally supposed to be — a "job shop" for miscellaneous tasks for the system program offices.

This new pressure on MITRE to put itself at the disposal of the system program directors was in keeping with the Anderson group's recommendations. The Air Force proceeded to enact these recommendations in the form of five new regulations which the Anderson group itself had drafted. The first three, issued on August 31, and taking effect on January 1, 1961, defined the basic conception of "weapon/support systems management" (a few months later, as an afterthought, the expression was changed to "weapon/support/command and control systems management") and set forth the functions of the system program office and the system program director. A



fourth regulation, in October, established procedures for determining a system's reliability; and in January the fifth and last of the series required each system program office to assemble a complete documentation of all facets of a system and all major actions regarding it in what was called a "proposed system program package" — a voluminous compilation which, when later approved by Air Force headquarters, would become a "system program package."<sup>1</sup> Thus, after a decade of imaginative but often confused improvisation, the Air Force had at last succeeded in putting its "research and development house in order," in the expression of the Stever Committee. It had reduced system management itself to a system, and had done so in such a way as to place almost all of the emphasis on getting systems developed and almost none on determining whether a particular system made good sense in the context of a thought-out concept of operations.

Only one step remained to complete the great reorganization on which the Air Force had embarked in 1959, and that was to bring the entire acquisition phase of system management, production and installation as well as development, under the control of one command, and by the spring of 1961 everything was in readiness for this step. AMC had been induced to organize its systems centers in parallel with the new ARDC development divisions, and the Anderson group had prescribed a similar parallelism for the internal organization of the system program offices. A new President had been inaugurated and the Senate had confirmed the appointments of new service secretaries and a new Secretary of Defense, the latter being Robert S. McNamara. On March 17 McNamara announced that

All activities concerning the acquisition of [ Air Force ] systems, some of which are now carried on by the Air Research and Development Command, and some by the Air Materiel Command, will

be consolidated in a new Command to be known as the Air Force Systems Command.<sup>1</sup>

This took effect on April 1. At Inglewood, Wright-Patterson, and Hanscom the former AMC systems centers were merged with the former ARDC development divisions to form what were now called systems divisions, under Schriever's new Systems Command. Bergquist became Commander of the new Electronic Systems Division as a matter of course, but in less than a year was replaced by Terhune.<sup>2</sup>

The period of major organizational changes in the Air Force was at last at an end, and the resulting situation, which proved to be fairly stable, was one which tacitly assumed that MITRE would be essentially a pool of engineering talent on which the Air Force would draw for miscellaneous purposes as it saw fit. If this had been foreseen in 1958, the whole effort to create the Corporation would probably have failed. It was not for this that Everett and Jacobs had left the Lincoln Laboratory, and it was not on this basis that they had persuaded a substantial number of their Lincoln colleagues to follow them. Nor is it likely that the trustees would have cared to have anything to do with an organization destined for so subservient a role, and it was probably the pattern of events in 1960 that caused them to wonder whether a corporation as tightly controlled by the Air Force as MITRE would apparently have to become even needed a board of trustees.<sup>3</sup> It may or may not have been significant that the board asked for an analysis of changes in the technical staff during the two years ending January 1, 1961, especially in respect to the number of staff members holding advanced degrees and the number of years of professional experience of each staff member, but the situation was one which would naturally prompt a board of trustees to take a close look at the engineering competence of the staff.<sup>4</sup>

It was surely significant, however, that in December 1960 the trustees were talking about bringing in an outsider to review the Corporation's "top management," especially Halligan.<sup>1</sup> It seems that one of Halligan's former associates in the Bell Telephone Laboratories, who then held an influential Pentagon position, had questioned Halligan's competence and had even gone so far, on his own initiative, as to sound out certain individuals who he felt would be suitable replacements. At least one of the MITRE trustees, on learning of this officious indiscretion, realized that MITRE's future might be affected and wondered whether the board ought not to take appropriate action.<sup>2</sup> At this rather dismal juncture in the Corporation's history, the board might well have felt anyway that some kind of "agonizing reappraisal" of top management was in order. The first thought was to ask Dr. Marvin Kelly, President of BTL, to undertake the desired review, one trustee offering it as his opinion that Kelly "would do a more discerning job in a few days than most management firms would do in many man-months,"<sup>3</sup> but in the end another telephone company executive, William H. Martin, was chosen. Martin spent two weeks at MITRE in the early summer of 1961, interviewed most of the Corporation officers and department heads, and on August 7 submitted a brief report in confidence to Charles A. Coolidge, who had by then succeeded William Webster as board chairman. The report was on the whole reassuring, although it included a scathing comment on one Corporation officer (not Halligan), who resigned about a month later.<sup>4</sup>

CHAPTER EIGHT  
SHORTENING THE TETHER, 1960-1962

What had happened to MITRE was hardly the fault of its officers or its board, and was probably inevitable. The basic trouble was a certain ambiguity in its status as an Air Force contractor. It could not be treated as an ordinary contractor because the nature of its work necessitated a much more intimate and privileged working relationship with its successive clients -- the Air Defense Systems Integration Division, the Air Force Command and Control Development Division, and the Electronic Systems Division -- than is usually considered proper for a contractor. In this respect, it was comparable to the recently created Aerospace Corporation at El Segundo, California, which had a similar confidential relationship with the Air Force Ballistic Missile Division, and which was also an Air Force-sponsored non-profit corporation.<sup>1</sup> The Air Force needed to control both Aerospace and MITRE far more closely than it controlled any industrial contractor, and yet was trying to rationalize what it was doing under the accepted forms of contract management.

One of the most illuminating observations ever written on this problem was the work of a member of the MITRE board -- Oliver G. Haywood. Haywood was also a colonel in the Air Force Reserve, and had had a wealth of experience in the management of military research and development projects, his last assignment before his retirement from active duty in the Air Force having been on the headquarters staff of the Air Research and Development Command. In August 1960, when the system project offices had just been moved to Hanscom and the Anderson group and the Winter Study group

were nearing the end of their respective labors, and when the trend of the tide in MITRE's affairs was already clear enough, he spent his annual tour of active duty at AFCCDD under assignment to suggest how AFCCDD should order its relationships not only with MITRE but also with the Lincoln Laboratory and with the Rome Air Development Center -- the latter being an Air Force organization at Griffiss Air Force Base near Rome, New York, which had recently (kicking and screaming) been made subordinate to AFCCDD. After making it clear that his recommendations did not necessarily reflect the opinions of the MITRE board and, further, that he himself might take a different view in his capacity as a member of the board,<sup>1</sup> he proceeded to argue that what the Air Force was trying to do to MITRE made no sense even from an Air Force standpoint because it involved a misunderstanding of the nature of system engineering:

The historic relationship of a contractor to the government would be relatively non-controversial and probably understood by all concerned. Such a relationship would require that the CCDD staff have the technical competence to prepare detailed performance specifications for each MITRE task and the competence to evaluate whether MITRE performance satisfactorily meets the specifications. A systems engineering study is quite different from the buying of hardware or even development work. In the case of hardware or development, the specification can be an operational performance spec. The detailed design of equipment to meet the spec can then be left to the contractor.

The technical study of a command and control system on the other hand requires a detailed understanding and analysis of military organizational structure and concepts, command requirements for information, the nature and transmission requirements for command decisions, and the relative degradation of the organizational efficiency (as distinguished from the command and control system efficiency) as a function of system performance, reliability, capacity and information flow turn-around time. In other words, the judgment of the adequacy of such a systems engineering study requires a scope and depth of analysis commensurate with that

required for the making of the study itself. If the CCDD staff had the capacity, both numbers and competence-wise, to make such detailed analyses of all studies of the MITRE group, it would be questionable whether MITRE would be required in the first place.<sup>1</sup>

So far, this was simply a restatement of what MITRE had been saying all along, but he then drew an inference which must have disconcerted his MITRE colleagues (if, indeed, they ever had a chance to read his report). Far from seeking contracts with government agencies other than the Air Force and thus maintaining some degree of independence from the Air Force, Haywood reasoned that MITRE ought to work only for AFCCDD -- ought, indeed, to regard itself as simply a part of the AFCCDD staff and accept all of the constraints incumbent on any AFCCDD staff member. AFCCDD, for its part, should stop thinking of MITRE as a "government contractor" -- i. e., as an agency external to itself:

It is my opinion that the MITRE Corporation should perform on a continuing basis an internal staff function of the CCDD -- that of making and having primary responsibility for technical analyses and implementing recommendations with respect to the assigned mission of CCDD. The essential feature is that MITRE would be making technical judgments, not as advice to some decision-making element of the Government, but in its own right as an agency of the Government. . . . .

The role of MITRE in performing an internal function of the Government requires acceptance of such an assignment by both individuals in the CCDD staff and by individuals in MITRE. There is not general understanding of the nature of this responsibility, nor acceptance of it, in either organization at this time.<sup>2</sup>

Haywood's proposal was never seriously considered, and there are several reasons for doubting that it could ever have been adopted. Its legality was arguable; it would have met political opposition from the Civil Service Commission; it would have gone against the grain of both AFCCDD and MITRE,

neither of which was inclined to make so complete a sacrifice of its own identity. Yet Haywood had at least laid hold of a fundamental truth about the nature of the service that MITRE was providing. The conceptualization and designing of a command and control system is only secondarily a technical activity; primarily, it is the formulation of a concept of military operations, and therefore of military policy. Now policy formulation, as the Air Force and the whole tribe of Federal civil servants never tired of insisting, is an inherent and inalienable function of government. Thus, MITRE was engaged in an essentially governmental activity. Unlike an industrial contractor, it did not produce or install something according to received specifications, but proposed the specifications; and, since AFCCDD usually had no practical alternative to accepting what it proposed, it was, in effect, formulating the details of a conception of the way the Air Force would have to fight a war. It is also an inherent function of government to supervise the execution of policy -- in this case, to monitor the production, installation, and checking out of system components by industrial contractors -- but here, too, MITRE was the Air Force's only means of discharging this responsibility. The logical inference, of course, is that MITRE as such should not have existed. Instead, its technical personnel should have been incorporated as individuals in the AFCCDD staff so that AFCCDD could itself have done the things it depended on MITRE to do. Haywood was surely right in thinking that that would not have worked, although he does not seem to have understood why it would not have worked. He apparently thought that the only reason was that civil service pay scales were not high enough, and therefore proposed to keep MITRE, making it a kind of collective member of the AFCCDD staff, and to obviate the obvious morale problem (high-paid MITRE people working side by side with low-paid civil service people, both doing much the same kind of work) by putting the AFCCDD civil service people on the MITRE payroll.<sup>1</sup>

But Haywood, although he saw farther into the problem than most people, did not see far enough. Although it is true that MITRE was formulating policy and then helping to execute it, thus acting as though it were a government agency, it is also true that the heart of MITRE's work -- the conceiving, designing, and critical evaluation of command and control systems -- involved independent thought of a kind that cannot be sustained in the environment of a headquarters staff. A staff officer may advise his commander that one course of action is preferable to another, but, when his commander overrules his advice, he swallows his opinions and does as he is told; indeed, he usually finds it easier not to have opinions of his own. No doubt, there were people in the Air Force who would have been happy to see MITRE take the same attitude, but, had it done so, it would have quickly acquired the intellectual sterility of any good headquarters staff and would no longer have been a stimulating place in which to work. This was the real flaw in Haywood's idea -- a flaw that would have remained even if the legal and political obstacles had been somehow overcome. There was both a paradox and a dilemma here. MITRE was indeed engaged in a governmental kind of activity, and the case for treating it as an Air Force staff agency rather than as an ordinary Air Force contractor was therefore a strong one; yet this same activity involved and depended upon an uninhibited exercise of intellectual independence such as ordinarily found only in institutions of higher learning. The activity itself was one which fell between two stools: it needed to be intellectually uninhibited, and therefore to be conducted in an environment of academic independence, and at the same time to be responsible, and therefore to be subject to the restraints of a headquarters staff. Perhaps the two needs were incompatible. Anyway, one can understand both why the Air Force felt it had to keep MITRE subordinate to itself and why MITRE felt it had to resist.



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MITRE's chances of maintaining the internal environment it knew it needed depended in part on its ability to avoid petty bureaucratic surveillance. There had been a time when it not only intended to do things its own way, but said so. On one occasion in February 1959, when some ADSID representatives were trying to force it to submit periodic reports on its exact state of progress on each of several assigned tasks, a responsible Corporation officer not only objected, apparently on the ground that such reports would take an inordinate number of man-hours to prepare and would be of no real significance when prepared, but went on to say that MITRE had its own way of working and that, if ADSID did not like it, it should find itself another contractor.<sup>1</sup> That, of course, was when MITRE was still young and its key people still expected to be able to work more or less as they had been accustomed to working in the Lincoln Laboratory, which had never had to tolerate this sort of thing. But during the course of the next two years they came to realize, reluctantly, that the Lincoln days were gone and that it was not a good idea to invite the Air Force to get another contractor. They learned the virtues of adroit compromise. As a rule, they acquiesced in Air Force requests that were merely annoying and, even where an issue of substance was at stake, relied on "gamesmanship" rather than direct opposition to gain their point. They had learned something of gamesmanship in Lincoln, to be sure, but with a difference. In Lincoln they had generally found themselves in a strong position, not only because the Massachusetts Institute of Technology had stood between them and the Air Force but also because the program in which they had been involved, SAGE, had been authorized at a level of the government well above Air Force headquarters. Once they had joined MITRE, neither of these conditions obtained and their position was significantly weaker.

Although they proved to be far from unresourceful as they adapted themselves to their new circumstances, those circumstances were such that they could only retard, not arrest, the erosion of that atmosphere of independence in which they had been nurtured and on which they still depended. In the long run, this took its toll of them.

The erosion began as soon as the Corporation was fully organized in January 1959. Within a month, as already noted, the ADSID staff was asking for progress reports at frequent intervals. About the same time it also began to insist that, instead of simply purchasing working equipment (anything from ordinary office furniture to oscilloscopes and other electronic engineering tools) when and as needed, and then treating the cost as a reimbursable working expense, MITRE should apply for these items through Air Force procurement channels. On August 30, 1960, MITRE reluctantly entered into a facilities contract with the Air Force (in addition to its primary contract, and back-dated to March 22) whereby it would requisition all such items from the Air Force, with the usual detailed "justification," and then in due course receive them on loan.<sup>1</sup> No doubt, a dollar saving to the Air Force resulted, but from MITRE's point of view the facilities contract was a nuisance since it meant either a long wait for something that might be needed right away or a long lead time that was almost equally awkward. With enough lead time and a sufficient number of typewritten pages of "justification," government procurement channels can nearly always produce a desired item, and, in the case of a rather cut-and-dried operation, one can usually see far enough ahead to anticipate the need for the item as of a certain date and requisition accordingly. But system engineering is not cut and dried; it is an expedition of thought into uncharted territory, and is therefore likely to encounter unforeseen obstacles along the way. As the system engineer confronts such an obstacle, various possible ways over or around it may occur

to him, and he may well wish for the means -- perhaps some equipment for which it had not occurred to him to ask initially -- to test the relative feasibility of alternative courses. But, if he finds that he can have this equipment only if he stops and laboriously "justifies" his request, and then waits six months, he is likely to abandon that line of approach as hopeless and turn to a second-best approach that at least permits him to keep going. The difference, of course, is invisible. One can never know what things MITRE might have done better than it did if there had been no facilities contract to discourage its technical people from acting on their first impulses. The Air Force authorities at Hanscom Field who had imposed the contract were never troubled by such thoughts, and even flattered themselves that they had saved the taxpayer "millions of dollars".<sup>1</sup>

Hardly less of a menace to the internal working environment that MITRE wished to maintain was the persistent demand for reports of progress. A certain amount of progress reporting is necessary and even wholesome: once in a while one needs to extricate oneself from the welter of detail and take a panoramic view. The time to do this, however, is when one has completed a coherent segment of one's project, and such moments are not likely to occur at regular intervals. To pester a man to account for and "justify" what he has been doing at short intervals is, as it were, to interrupt him while he is thinking and demand that he describe a thought he has only half formed, and thus to inhibit his whole thought process. The first instinct of the MITRE people was to resist this sort of thing, but they soon found that they would have to endure a great deal more of it than they had been used to in Lincoln. The divisions of the Lincoln Laboratory had been accustomed to preparing quarterly progress reports, but ADSID and, later, AFCCDD wanted MITRE to report monthly and, moreover, to report not only on each assigned task but also on each item of work within each task. For a while in 1959

and 1960 MITRE did submit such reports, but it finally succeeded, in December 1960, in persuading AFCCDD to let it report quarterly and by tasks rather than by items. It was able to do this because it was able to show that AFCCDD had no real need for the fussy detail in the monthly reports and was getting all genuinely needed information in other ways. It was anyway keeping appropriate AFCCDD personnel informally apprised of what it was doing, and was routinely providing copies of the technical memoranda it prepared on specific projects when those projects reached a definitive stage. Also, because it had reorganized itself the preceding summer so that there was generally a technical department corresponding to each authorized system, it was able to keep its still continuing SAGE responsibilities organizationally separate from its new work on other command and control systems, and thus to identify thirteen distinct SAGE tasks and twenty-two distinct non-SAGE tasks, each capable of being costed separately. The quarterly reporting of progress by tasks was therefore sufficient for purposes of fiscal control.<sup>1</sup>

But, unlike the Lincoln reports, the series of MITRE quarterly progress reports that began with the January-March 1961 quarter were part of a system whereby AFCCDD (ESD after April 1) understood to regulate in detail what MITRE did. An AFCCDD-MITRE meeting on January 13, 1961, produced an agreed list of MITRE tasks (most of the tasks corresponding to particular command and control systems then under development) and provided that each task would be described in general terms but also subdivided into specific items of work, and that

AFCCDD and MITRE will appoint by name and publish a list of officers to be responsible for the overall direction of each task. These officers, to be designated task officers, will be responsible to their respective organizations for all activities being pursued within the task.<sup>2</sup>

Significantly, it was also agreed at the same time that

MITRE is authorized to perform work based on the task description. This work may be suggested by MITRE but is subject to the prior approval of the appropriate AFCCDD task officer before work or resources are expended. AFCCDD will direct specific work by means of items.

and, further, that

Prior to the beginning of the fiscal year, AFCCDD will identify the specific items to be accomplished within each of the tasks. These items will be submitted to MITRE who will cost the effort for each task in terms of manpower, subcontract, and equipments. Then, in conjunction with AFCCDD . . . MITRE will distribute the available resources, in accordance with priorities, to the tasks. The resulting program when approved by AFCCDD will be the basis for justification to ARDC, USAF, etc.<sup>1</sup>

It took a year or more of wrangling over minor points before these "operating procedures," as they were called, were fully spelled out and mutually accepted. Eventually, in 1962, another element in the system of control was added -- a Joint Operations Board representing ESD (successor to AFCCDD) and MITRE, and meeting once a month.<sup>2</sup> It was in the interchanges of the winter of 1960-61, however, that the main features of the Air Force's management structure for regulating MITRE were hammered out.

Although the Air Force was inclined to keep as much as possible of MITRE's activity keyed to specific systems, MITRE had never considered that it should be so narrowly constrained. The reader will recall that as early as February 1958, nearly a year before it was fully organized, Everett and Jacobs had outlined a plan for a total technical staff of 690, of whom 100 were to engage in "non-programmatic research" and another 100 in "system and component development." Their argument was that system engineers who lose contact with component development and with research that is not tied

to a specific system eventually become sterile even as system engineers.<sup>1</sup> It was not until July 1960 that MITRE succeeded in persuading AFCCDD to allow it to devote ten percent of the annual funding of its contract to the independent research program it then established under Glenn R. Frantz and F. Robert Naka,<sup>2</sup> and this arrangement was recognized in the operating procedures negotiations of the following winter. A particular program of independent research had, of course, to hold out some promise of relating eventually to some on-going or anticipated system effort, and, indeed, there were Air Force task officers to keep an eye on each such program just as there were for the progress of work on each system.<sup>3</sup> In some years the actual sum allowed for independent research was a little less than ten percent of the total appropriation for the MITRE contract, but MITRE was thus able to keep itself stimulated by means of original work of its own choosing on at least some of the fields in which it had an interest -- notably in interferometry and in the development of computer programming techniques.<sup>4</sup> On the other hand, whenever it was a question of spending money on something that had fairly obvious pertinence to the development of systems, the Electronic Systems Division, far from opposing MITRE, encouraged and supported it. One of the Winter Study recommendations that ESD had never been inclined to question, for example, was the one that called for a computer facility at Hanscom for exploring the feasibility of possible new command and control systems and determining their optimal design features. It would not be until the end of 1963 that the System Design Laboratory was completed, but ESD consistently urged the appropriation of the necessary funds, and meanwhile supported MITRE in the experiments it conducted from 1960 on with make-shift equipment.<sup>5</sup>

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It may seem that the Air Force authorities at Hanscom Field were merely officious in their efforts to control and regulate, and that they might better have left the Corporation to its own devices. Indeed, the pertinent documents do betray a certain animus on the part of the junior Air Force officers and the civil servants directly concerned -- almost, one suspects, a desire to control MITRE simply for the sake of controlling it. Moreover, MITRE was a nest of heresy. Had it not played a critical part in the Winter Study? And had not the Winter Study report questioned whether there needed to be so many command and control systems, and expressed a philosophy of system management at variance with that of the Anderson group? Was it not almost a theological imperative to control so subversive an organization? Nor was the desire to control confined to Hanscom. It also existed at Andrews Air Force Base (headquarters of the Air Research and Development Command and its successor, the Air Force Systems Command) and in some Pentagon offices, where there was, if anything, even less willingness to wink at heresy than at Hanscom. Besides, ARDC had always resented the independence that the Lincoln Laboratory had enjoyed, but had had to swallow its resentment because Lincoln, as a part of the Massachusetts Institute of Technology, had had the firm and consistent support of the Secretary of the Air Force. MITRE had no such advantage, and there were several people at Andrews and in the Pentagon as well as at Hanscom who were determined not to let MITRE be another Lincoln. Yet even this will not do as a complete explanation. Human beings are almost never actuated by a simple statable motive, but do what they do out of a complex combination of considerations, some rational and some nonrational, some conscious and some unconscious. In this case there was also the conscious and avowable motive to be good stewards of the

taxpayer's money -- a quite genuine motive in most military officers and civil servants even if it also serves as a convenient rationalization of an unconscious desire to control for the sake of controlling.

In 1961 the good-stewardship motive was significantly reinforced by pressure from the highest levels of the government. There was a new Administration in the White House, and therefore a new Secretary of Defense (Robert S. McNamara) and a new Secretary of the Air Force (Eugene Zuckert). These men knew that all of the Air Force-sponsored non-profit corporations except RAND had been born in the time of the previous Administration, a suspect circumstance in itself. It was elementary political prudence for them to seek to master the situation as quickly as possible, and, on top of that, some members of the Congress were prodding them to master it. The sources of this pressure seem to have been two. There were government officials who had always felt that the activities of these corporations properly belonged to the Civil Service, and there were business executives who had always felt that the same activities (especially the system engineering activities of the System Development, MITRE, and Aerospace Corporations) were somehow part of the birthright of private enterprise. Both positions, of course, were unrealistic. If the work in question had been given to civilian employees of the Air Force, it would have suffered because of the then inadequate civil service pay scales, and even more because of the inevitable intellectual sterility of any government agency concerned with policy formulation.<sup>1</sup> It is a sufficient answer to the complaints of business executives to observe that, in the case of every one of these corporations except SDC, there had been an initial effort to establish the activity as a subsidiary of some specific business concern, and that the effort had had to be abandoned because of difficulties raised by the business community itself.<sup>2</sup> Anyway, regardless of the merits of the question, McNamara and Zuckert could



scarcely ignore the pressures that they found themselves confronting as soon as they took office and that had, indeed, been gathering force for some time before they took office.

It was Aerospace, not MITRE, that bore, rightly or wrongly, the brunt of specific suspicions of malpractice. For propaganda purposes Aerospace was an attractive target because, although the youngest, it was already the largest member of its tribe in budget appropriations and in staff, and also because it was a descendant of the Ramo-Wooldridge Corporation, a privately owned and frankly profit-making concern that had been created in 1954 to engineer and master-mind the development of inter-continental ballistic missiles, and that had been a center of controversy from the beginning. Ramo-Wooldridge had been chosen as a "sole source" contractor (i. e. , there had been no competitive bidding), had enjoyed the privileged and intimate relationship with Schriever's headquarters at Inglewood that the work necessitated, and had received a fee that was defined as a percentage (substantially larger than the six percent to which RAND was accustomed) of total costs. Apparently, no one questioned its technical competence (after all, the Atlas missile was an operational reality by 1959), but there were those who wondered why it should have been allowed to make such a good thing of its relationship with the Air Force. When it merged with Thompson Products to form Thompson-Ramo-Wooldridge, the ballistic missile and space exploration enterprises, including the work for the Air Force, were segregated from TRW's other interests by being made the responsibility of a subsidiary, the Space Technology Laboratories; but this involved no renunciation of profit, STL being quite as much a profit-making concern as the parent company. Criticism continued, and the only apparent solution was to carry out yet another reorganization so that the engineering team working on Air Force ballistic

missile and space projects and enjoying the controversial privileged relationship with the Air Force Ballistic Missile Division (after April 1961, the Ballistic Systems Division and the Space Systems Division of AFSC) could be reconstituted as a non-profit membership corporation. In June 1960, therefore, the non-profit Aerospace Corporation was carved out of STL, which thereafter became simply another private industrial concern.<sup>1</sup> But suspicion was not allayed even then, for there were soon complaints that Aerospace was using taxpayers' money to maintain a lobby in Washington and to pay for certain personal conveniences for some of its officers.<sup>2</sup>

But the object of attack was never Aerospace alone, but the whole family of Air Force-sponsored non-profit corporations. Indeed, there was some disposition to look critically at all non-profit institutions engaged in research and development for military purposes under Federal contract, including such institutions as the Lincoln Laboratory and the Jet Propulsion Laboratory, which were staffed and managed by universities, as well as at corporations modelled after RAND; but the latter kind of institution seems to have been the primary focus of interest. The main driving force behind the attack was apparently the Military Operations Subcommittee (chaired by Chet Holifield of California) of the House of Representatives Committee on Government Operations, but President Kennedy also took an interest. On July 31, 1961, he asked David E. Bell, Director of the Budget, to look into all government-supported research and development programs, advisory services, and supervision of the acquisition of military systems, whether accomplished "in house" (i. e. , directly by military or civil service agencies) or under Federal contract; whereupon Bell established a committee for the purpose and submitted a comprehensive report the following April 30.<sup>3</sup> The Holifield Subcommittee, however, had had its hand in for a longer time.

Even in the later years of the Eisenhower Administration it had been following developments, especially the evolution of the ballistic missile effort at Inglewood, and had had something to do with the decision to carve the Aerospace Corporation out of Space Technology Laboratories in the summer of 1960.<sup>1</sup>

On May 1, 1961, the Holifield Subcommittee produced a report dealing chiefly with Aerospace but also indicating that it expected the Air Force to take a good look at all such corporations.<sup>2</sup> A little later some one in the Congress, probably the Holifield Subcommittee, asked the Office of the Secretary of Defense to establish policies governing the use of all non-profit institutions working under contract for any part of the military establishment.<sup>3</sup> The office of the Air Force General Counsel, Max Golden, was evidently already at work on the problem, and had already decided or was on the point of deciding (a) that, if any of the Air Force-sponsored corporations were dissolved, its assets ought to revert to the Air Force, (b) that such corporations should not be allowed to include depreciation of facilities as a reimbursable item of contract cost, and (c) that their fees, instead of being a fixed percentage of total contract costs, should be annually negotiated on the basis of an estimate of their respective foreseeable needs.<sup>4</sup> The first stipulation would assure that whatever part of their fees they might invest in durable assets such as real estate (and it was only with their fees that they could acquire durable assets) would be ultimately recoverable by the Air Force. This would not only protect the taxpayers' interest but would also tend to establish the principle that the Air Force "owned" them — in spite of the fact that no one "owned" them in the sense of holding stock in them. This was apparently the reason why a clause specifying that the Secretary of the Air Force would direct the disposition of assets in the event of dissolution was written into the Aerospace

charter in June 1960,<sup>1</sup> but the corresponding clauses in the charters of the other four corporations, all of which were earlier than 1960, provided otherwise. Typical was the language of the MITRE charter, which, as already noted, provided that the members would deed any net assets to a "successor charitable or nonprofit corporation" or, if there were no successor, to any "charitable or nonprofit corporation."<sup>2</sup> The depreciation question had primarily to do with buildings, the Air Force's position being that

As a general rule the Government should provide these corporations with the buildings required for the performance of their contracts. There may, however, be circumstances which justify the acquisition of facilities by these corporations with their own resources . . . . In the case of company furnished facilities, the costs of maintenance and repair, but not depreciation, can properly be charged to Air Force contracts.<sup>3</sup>

The ideas that fees should be negotiated according to need had been first advanced in the course of the Air Force-Massachusetts Institute of Technology contract negotiations in the autumn of 1958, and had been accepted by Golden at that time.<sup>4</sup> It meant that the corporations (MITRE or other) had to negotiate every year for their fees — by telling the Air Force how they intended to use the money and winning Air Force approval. This was what MITRE had been doing all along in an effort to obtain funds for its building program (see Appendix C), but it was nevertheless a subversion of the original purpose of fees, which was to give the corporations a certain margin of discretionary latitude. The fees were no longer fees in the true sense of the word, but simply Air Force payments for certain extra-contractual but Air Force-approved purposes.

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It was only gradually during the summer of 1961 that MITRE became aware of the extent and implications of this evolution of Air Force policy. The Air Force had asked the Corporation in June to consider a change in the dissolution clause in the charter, and this disposition-of-assets question had apparently been touched upon at the trustees' meeting in Ottawa in early July, but it was not until July 27 that Edward Reynolds, the new Treasurer, wrote to the trustees exploring the implications and soliciting their views. Although most of the trustees were at first willing to consider a change, the board's executive committee discussed the matter more thoroughly on August 10 and voted unanimously against any change.<sup>1</sup> The Air Force Deputy Chief of Staff, Materiel, Major General Mark E. Bradley, had meanwhile instructed Air Force contracting officers to insist on all three of the points described above. Around the middle of September the MITRE management decided that, if the Air Force wished to introduce such fundamental changes as these, it should make its representations at a higher level than that of the contracting officer, and asked General Bergquist for a formal statement of the Air Force position. When Bergquist reiterated in writing on September 20 what MITRE had already learned informally, and indicated orally that he was not in a position to negotiate on these points, some MITRE representative (probably Halligan and one or two other members of the executive committee) went to Washington to see Max Golden on September 22. Golden not only assured them that the Air Force had indeed decided to insist on these points, but handed them a copy of Secretary of the Air Force Zuckert's famous policy statement on the subject, which had just been released that day.<sup>2</sup>

Except as regards the charter amendment, there was little that MITRE could do because, on all other points, the Air Force was acting within its prerogatives. Nevertheless, MITRE considered it worth while to argue the matter, taking the view that

Some of the Air Force policy proposals, as for example the disposition of assets, are largely a matter of principle; others, such as the elimination of depreciation charges, involve both principle and substance. In total, the enforcement of these policies would, in our opinion, run in direct opposition to some of the basic principles upon which MITRE and similar companies were founded. We believe that in the long run acceptance of these policies would not only impair our ability to perform the mission assigned to us, but would also react unfavorably on the Air Force position vis-a-vis Congress and other interested agencies. [ This last apparently alluded to the possibility that, if the corporations were so completely deprived of discretionary latitude, the Air Force might find it difficult to convince anyone that they were anything more than transparent devices to evade the Civil Service. ] Both of these effects are of vital concern to General Schriever as the "customer" and sponsor of such companies, and it is therefore essential that he understand our point of view.<sup>1</sup>

In order to argue the matter, the executive committee called on General Schriever at Andrews Air Force Base on October 11, at a meeting also attended by Major General Clyde H. Mitchell, then the Systems Command Deputy for Procurement and Materiel and, until the preceding April, the Commander of the Air Materiel Command Electronic Systems Center at Hanscom Field. Schriever supported the Zuckert policies (after all, he had been in touch with Golden throughout the period when they were being formulated)<sup>2</sup> as "necessary to provide a defense against criticism from private industry, the Congress, the Bureau of Budget, and other agencies." He was at pains to stress the importance of MITRE and other such

corporations to the Air Force, and said that the Air Force did not intend to treat them as "captives" (a word with unpleasant connotations), but explained that the Air Force had to be sure that they would not "dilute their resources" to its disadvantage.<sup>1</sup> Neither he nor anyone else ever explained how the Air Force could make sure they would not "dilute their resources" (i. e. , assume major commitments to clients other than the Air Force) without making them captives; and the MITRE representatives replied that, disclaimers to the contrary notwithstanding, the Zuckert policies (which had already been released to the press and were therefore public knowledge) "created the definite impression that these corporations were in fact being treated as captive companies."<sup>2</sup> They went on to observe

. . . that rigid controls such as those suggested would not only make it very difficult to attract the quality of management and technical personnel that is needed, but it might also defeat the efforts of the Air Force to provide a defense against outside criticism. Special treatment of these companies, as compared with profit making companies, might only serve to strengthen the charge that they were set up as a means to circumvent the civil service. Further, while the Air Force has in all cases stressed the importance of having a highly competent Board of Trustees for such companies, an effort to regulate their operation to the degree indicated might well result in making it clear that the direction of a competent Board was not really essential.<sup>3</sup>

The meeting with Schriever having failed to produce anything more than an attempt to say in a nice way what the Air Force had been saying quite clearly for the past several months, the executive committee was at first inclined to go directly to Zuckert, but apparently never did so. Sober reflection probably suggested that no good could come of that because Zuckert himself was obviously reacting to political pressures far too powerful to be resisted. Through the following winter MITRE was still

talking a good fight (to itself), but one has only to read between the lines of Halligan's interim report to the board in January to see that it was in fact getting ready to accept the situation. Instead of talking about an adamant refusal to amend the charter, that report commented:

There have been indications that the Air Force may be agreeable to the designation of someone above the level of the Secretary of the Air Force (probably the Secretary of Defense or even the President) as the agent to direct the disposition of property under these circumstances. The Air Force remains adamant, however, in insisting that our charter must provide for the return of the assets to the Government in the event of dissolution.<sup>1</sup>

As regards the need theory of fee, which Schriever was then on the point of spelling out in fuller detail than the Zuckert policies had done,<sup>2</sup> it appears that there had been informal discussion with the Air Force contracting officer at Hanscom in December and that the MITRE management had developed "a schedule showing anticipated 'needs' over the next several years."<sup>3</sup> At about the same time a MITRE trustee, responding to a request for enlightenment from one of the newer trustees, wrote an able and vigorous apologia for the MITRE point of view in respect to the questions then at issue — a statement that was apparently influenced in part by Everett, since it referred to him and incorporated several of his favorite points.<sup>4</sup> But the board meeting in Washington on February 1-2, 1962, produced no electrifying decisions. Instead, it apparently gave a lot of its time to the conflict-of-interest question, another matter of considerable current political interest and one that Zuckert had also covered in his statement of policies.<sup>5</sup>

If the MITRE board failed to act boldly and vigorously in late 1961 or early 1962, it was because the available options — except for acquiescence on the one hand and some desperado move that might have caused the



Corporation's sudden death on the other — were not easy to discern. What might have happened, for instance, if the board en masse had carried out the threat implied at the meeting with Schriever in October, and had simply resigned on the ground that MITRE would soon be so tightly controlled that it would not need a competent board? Although it is difficult to imagine the trustees actually doing this, they could have done so with no loss of personal dignity, and their case would have been unanswerable. The circumstances of the early 1960's, however, were such that their case would also have been largely ignored. The Air Force would have been momentarily embarrassed, no doubt, but would not have found it too difficult to make suitable readjustments, and would certainly not have had to face the wrath of anyone in a position of power. Where were those friends in high places to whom the Lincoln Laboratory, through the intercession of the Massachusetts Institute of Technology, had been able to appeal with such decisive effect in the 1950's? MITRE's status was, to be sure, entirely different from that of the Lincoln Laboratory, but it is also true, and probably more important, that the times had changed. In the 1950's it had usually been the armed services that urgently needed something, whereas this was not true, or was less acutely true, in the 1960's. It must surely signify something that the MITRE trustees, whenever they faced a crisis, got on an airplane and flew to Washington, whereas a Killian or a Stratton used to receive important government officials in Cambridge.<sup>1</sup>

The next board meeting occurred on May 3-4, a few days after Budget Director Bell submitted his report to the President — a comprehensive analysis of all facets of government-sponsored research and development with far-reaching recommendations that would be felt for the rest of the decade. Although its coverage was far broader than corporations

of the MITRE type, it was also a milestone document in the evolution of that curious institutional form that Gaither had invented, and its views concerning the use and regulation of those corporations were in general harmony with the Zuckert policies. Bell's committee had included the Secretary of Defense, the Chairman of the Atomic Energy Commission, the National Aeronautics and Space Administrator, the President's Special Assistant for Science and Technology, and the Chairman of the Civil Service Commission — in a word, had represented all of the government agencies involved.<sup>1</sup> Thus, the whole weight of the government was now mobilized in support of just the kind of management controls that the Air Force was in process of imposing on MITRE. The moment was hardly propitious for gallant resistance, and it was even less propitious the following summer when the Holifield Subcommittee summoned the president of every non-profit corporation and the directing head of every important non-profit research laboratory to Washington for extensive testimony, and required those organizations to submit full documentation of all of their policies and actions bearing on the points at issue.<sup>2</sup>

Meanwhile, in June, the Air Force was able to prevail on the question of the disposition of MITRE's assets by taking advantage of an urgent financial need that MITRE then faced. Since 1959 MITRE had been having its own buildings erected on some land it had acquired in Bedford about four miles from Hanscom, and since 1961 the Electronic Systems Division had encouraged this policy because it was also a means of providing needed office space for Air Force personnel (see Appendix C). MITRE had financed the construction partly by applying the bulk of its fee and partly by negotiating short-term loans; but, in order to complete its building plans, it needed a longer-term loan, and therefore needed to be able to assure a mortgagor

that, if the Air Force contract should be terminated during the life of the mortgage, the Air Force would indemnify it with an amount sufficient to pay off the balance. It happened that the supplemental agreement to the contract covering the Federal fiscal year ending June 30, 1962 (corresponding to the MITRE fiscal year ending July 31, 1962), and providing a fee that MITRE badly needed, was on the point of being (in governmentese) "definitized." The Air Force was willing to provide the fee and also include an indemnification clause -- provided the MITRE board promised to amend the charter at its next meeting. It would be all right if the board preferred to have it that the President rather than the Secretary of the Air Force would direct the disposition of assets, but it had to be unequivocal that all assets could be recovered by the Government. So anxious was the MITRE management to conclude the contract negotiations, secure the indemnification clause, and thus proceed with the remainder of the building program, that it polled the trustees by telephone and obtained a majority in favor of the change.<sup>1</sup> At the board meeting on September 20-21, 1962, the pertinent clause in the charter was amended with the proviso

. . . that in case of dissolution written notice thereof shall be given to the President of the United States and if the said President shall within 60 days so request in writing, said remaining property and assets shall be transferred to the United States of America as the said President shall direct.<sup>2</sup>

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MITRE was for all practical purposes a one-client organization, and was therefore vitally dependent on that client. The converse was not true: if MITRE had not existed, the Air Force would have been impeded in the attainment of some of its objectives, but the effect would not have been

lethal. Hence the paradoxical position of the MITRE board. In form and appearance the board controlled MITRE, but the instrument of real control was the Air Force contract administered by the Electronic Systems Division of the Air Force Systems Command. Since the ESD commander (Bergquist until February 16, 1962; Terhune thereafter) could exert virtually coercive pressure merely through the exercise of his prerogatives of contract administration, it was really he who controlled MITRE. One thinks at times of the toy steering wheel sometimes attached to the baby seat in the family car so that Junior can have fun pretending to steer while Daddy all the while has his hands firmly on the real steering wheel. It was not quite that way, of course. The MITRE board did do some genuine steering, especially in obtaining a tract of land in Bedford in 1959 and having some buildings erected on it to give the Corporation a permanent home (see Appendix C), but by mid-1960 at the latest it was clear that the Air Force could and would keep MITRE from straying very far from the path it wanted MITRE to follow. The relationship had not appeared in this light when the Corporation was founded in 1958 because it then seemed that the Air Force's need for MITRE would be just as acute as MITRE's need for the Air Force; but later, especially after 1960, for reasons to be explored in the next chapter, the Air Force was in truth much less anxious about its need for the kind of service MITRE could render (despite its frequent protestations to the contrary), whereas at all times MITRE would have faced sudden death if the Air Force had abandoned it. If the trustees had succeeded in 1960 in obtaining a major direct contract with the Office of the Secretary of Defense, they might have liberated the Corporation from its captive status -- or they might have found that they had merely changed masters. At any rate, they did not succeed, so that, from the summer of 1960 on, there was no longer a chance that MITRE could escape the implications of captivity to the Air

Force, even though it was not until the end of 1962 that the Air Force managed to spell out all of these implications.

When MITRE found in 1960 that it would have to broaden its interests from air defense to the whole field of command and control, it foresaw that the rapid increase in staff that this entailed might easily cause it to grow to the point where it would lose its original character as a well integrated engineering team and where it would find itself devoting more and more of its energy to internal problems of staff management. As it was, its technical staff of 205 in January 1959 had doubled by mid-1960 and its original total population of 550 had more than doubled in that time; and the post-1960 increases, mostly occasioned by its broadened responsibilities, would leave it at the end of 1963 with a technical staff of 756 and a total population of 2,081 (see Appendix A). If MITRE had tried to do itself all of the things the Air Force expected of it, the rate of increase would have been even steeper and the resulting personnel indigestion even more acute. One way to keep the situation under some degree of control was to have as much as possible of the work that lay outside its own expertise done under contract by other concerns or by individual consultants. As long as it could get away with this, it could protect itself somewhat against the undesirable consequences of acceding to Air Force pressures on it, unremitting since the transition from the Air Defense Systems Integration Division to the Air Force Command and Control Development Division in April 1960, to put its people at the disposal of the system program offices and thus degenerate into a mere job shop. Unfortunately, the costs of these sub-contracts had to be treated as reimbursable expenses under the main contract, so that Air Force approval was necessary, and in the summer of 1961 ESD made it a matter of policy, "in order to obtain a maximum MITRE capability,

. . . to encourage MITRE to procure the necessary resources within the MITRE staff to accomplish the requirements which are placed on them." Not all MITRE requests for outside assistance were denied, but ESD, when and if it approved such requests, made it a point to contract directly with the source of assistance (except in the case of individual consultants, whom it encouraged MITRE to engage) rather than let MITRE do the contracting. ESD did all this, incidentally, in conscious imitation of the policy that Schriever's old ballistic missile organization had applied to Ramo-Wooldridge and the Space Technology Laboratories and that was already being applied to the Aerospace Corporation.<sup>1</sup>

Related to this anti-subcontracting policy was the policy that ESD developed regarding the System Development Corporation. Before MITRE was incorporated in 1958, as the reader will recall, SDC had hoped for at least a share in the air defense system engineering enterprise, and had been somewhat taken aback to discover in May of that year that the new corporation that Stratton and McCormack were on the point of creating would have the whole job. MITRE was described both in the 1958 contract between the Air Force and the Massachusetts Institute of Technology and in the direct Air Force-MITRE contract that began in August 1959 as the "principal systems advisor" to ADSID, the implication being that it should have no competition from SDC or anyone else in its role as the architect-engineer for the nation's air defense system; and the expression was retained when the latter contract was reoriented from ADSID to AFCCDD and then to ESD.<sup>2</sup> SDC continued to program the SAGE computers under its original contract with the Air Defense Command, and later entered into a subcontract with the International Electric Corporation to do essentially the same kind of work on the Strategic Air Command Control System (465L),

but never reconciled itself to this "second fiddle" status. In May 1960 it offered to become a captive to AFCCDD, with all of its existing contracts superseded by a single AFCCDD contract. After seeking the advice of higher headquarters, AFCCDD decided that it could afford only one captive contractor (indicating, incidentally, that it already frankly regarded MITRE as its captive), but that SDC might well serve it from time to time via a MITRE subcontract, with the result that for about two years SDC did a fair amount of work for MITRE. In the following October, when work on the North American Air Defense Command Combat Operations Center (425L) was on the point of being resumed, it again tried to achieve a direct relationship with AFCCDD, proposing this time to design that system, but this overture was very coolly received, and in January 1961 it withdrew its proposal and decided instead to work through MITRE.<sup>1</sup> A year or so later the SAGE computer programming was completed but there was a continuing need for SDC. By that time ESD was discouraging MITRE subcontracts, and so was of a mind to give SDC the comprehensive contract for which it had asked AFCCDD in vain in May 1960. Such a contract took effect July 1, 1962.<sup>2</sup> The intended effect was to give ESD two captive contractors and to make the ESD contract management office the focal point for the convenient management of both SDC and MITRE.

But from ESD's point of view there was still an unresolved problem: MITRE, despite the fact that in 1960 it had reorganized its technical departments so that most of them corresponded with a particular AFCCDD (later, ESD) staff office, was still not sufficiently "responsive" to the needs of the system program offices. To be sure, MITRE had not been created with these offices in mind, and, even when the transition from ADSID to AFCCDD occurred in 1960, it was under the impression (or clung to the illusion) that

it was simply assuming the same architect-engineer role in respect to all command and control systems that it had previously had in respect to air defense systems only. But neither AFCCDD nor ESD had been entirely comfortable with this idea, which suggested that MITRE existed primarily, not to do miscellaneous technical chores for the system program offices, but to act as a technically informed and intellectually independent critic of what they were doing -- a kind of permanent Winter Study Group. Then something happened in the spring of 1962 concerning the relationship between the Space and Ballistic Systems Divisions and the Aerospace Corporation -- in southern California where, as everyone knew, they did things the right way. On April 30 Dr. Ivan A. Getting, President of Aerospace, and Lieutenant General Howell M. Estes, Jr., Deputy Commander for Aerospace Systems (then the immediate superior of the commanders of both SSD and BSD) adopted a method of operation whereby Aerospace's technical departments became in effect simply extensions of the various space and ballistic missile system program offices. Each system program director had his Aerospace counterpart, with rather precise rules governing their interrelations. The two were supposed to work intimately together "as a team" and hopefully "by mutual agreement," although the Air Force system program director, vested with the delegated authority of this commander, was expected to make the decisions. If the Aerospace man believed a particular decision to be unsound, he could appeal through Aerospace channels and, if the Aerospace president saw fit to support him, the matter would be taken to the SSD or BSD commander -- whose decision, of course, would be final.<sup>1</sup>

Not long afterward ESD decided to do two things to MITRE: force it to accept a working-relationship system similar to the one imposed on Aerospace, and rewrite the contract. It did not immediately tell MITRE



what it had in mind, however. The first inkling MITRE had that something was afoot came (perhaps coincidentally) around the time of Halligan's appearance before the Holifield Subcommittee on August 9, 1962, when ESD, intimating that a funding freeze might be in the offing, asked it to submit a cost proposal for the first five months of the MITRE fiscal year that had just begun on August 1.<sup>1</sup> In September MITRE learned that the real reason for asking for the five-month estimate was that ESD wanted to be able to end the existing contract on December 31 "without an overrun or underrun of funds," so that a new contract, drafted more to its liking, could take effect on January 1, 1963.<sup>2</sup> It was also in September that Terhune and Halligan "agreed to the necessity for issuing a memorandum of understanding on relationships between ESD and MITRE."<sup>3</sup> The explanation given to the board was:

During the last nine months, we have increased the responsibilities placed on our Project Leaders. A "project" has come to be our basic work unit and the Project Leader our operating manager responsible for the supervision, resource allocation and the products within the projects. He is also the principal contact with our customers through a "Project Officer" in ESD. The majority, but not all, of the Project Leaders are either Sub-department Heads or Department Heads in the MITRE organization. This emphasis on the project has led to a modification of the roles of the Department Heads. In the future they will be concerned more with project planning and management than with direct supervision of the staff within the projects.

Along with the strengthening of the role of the Project Leader, we have improved his communication with his Air Force counterpart. This improvement has been effected through better definition of the MITRE role, improved work statements, and where appropriate collocation of the ESD and MITRE project groups.<sup>4</sup>

By the end of the year all of this had come to pass. The memorandum of understanding that Terhune and Halligan signed on December 19 went beyond the Estes-Getting agreement of the preceding spring in that it called for a MITRE "project leader" to assume the same intimate working relationship not only with the ESD program director in charge of each system for which ESD had seen fit to assign any responsibility to MITRE, but also with the ESD officer charged with overseeing each technological development program and each advanced system planning program in which MITRE was engaged.<sup>1</sup> As for the new contract, it omitted the phrase "principal systems advisor" and instead defined the purpose as "research and development for system design, system engineering, technical direction, inter-system integration, and research and experimentation to achieve continuing advances in the complete field of Command and Control Systems."<sup>2</sup> It contained no general statement of work, but provided for the inclusion of specific statements of work for each assigned task or project and the addition of new statements of work as needed. Its preamble defined MITRE's mission in terms that were a far cry from the original idea in 1958 but were much more in keeping with the way ESD liked to think of MITRE:

The primary mission of the MITRE Corporation under this contract is to provide general systems engineering, engineering support and system integration support to the Air Force and to assist ESD in applying the whole spectrum of science and technology to the continuing advancement of military electronic systems. In performing this function, the MITRE Corporation will be a vital link between the Air Force and the scientific and engineering community, with the objective of providing the soundest technical basis for the conception, analysis, selection, design, and evaluation of Command and Control Systems. The Corporation, through its unique role, will explore all pertinent resources to insure the maximum degree of accomplishment of known military requirements, and to

provide a basis for the conception of new requirements as improved capabilities are projected from new technical knowledge.<sup>1</sup>

## CHAPTER NINE

### THE END OF AN ERA, 1961-1963

The MITRE Corporation as it entered 1963 was a far cry from what it had been in those brave months of 1959 when it dreamed of a rejuvenated SAGE that would be placed underground in ten super-combat centers, equipped with improved computers and given an air traffic control as well as an air defense function, and when it was talking to the North American Air Defense Command about an underground and automated command operations center and had high hopes of becoming the architect-engineer to the Office of the Secretary of Defense for a coherent and comprehensive national air defense system. It was doing some interesting things in 1963, and its technical personnel still had about them a strong touch of Veblen's "instinct of workmanship," but there was a difference. An unwonted miscellaneousness had overtaken the Corporation's work by 1963 -- a piling on of an assortment of projects, many of which had no particular link with the others except that they all had something to do with electronics and were related (or hopefully might become related) to some authorized command and control system. Although still doing some things because it genuinely wanted to do them, MITRE more and more found itself in the position of consciously looking for new work rather than of finding new work that arose, as it were, unbidden as a natural offshoot of other work already in progress. Sometimes it found itself virtually obliged to do things for no better reason than that the Air Force had asked it to do them.<sup>1</sup>

In Project Whirlwind, in the SAGE enterprise in Lincoln, and in the original MITRE, it had been otherwise. Then there had been a master idea -- the general-purpose computer that could function reliably in "real time" for extended periods, and that had no end of potential applications. SAGE, the super-combat centers, the proposed integration of air traffic control with SAGE, the NORAD combat operations center, the air defense master plan submitted to the Directorate of Defense Research and Engineering in October 1959 -- all of these things may be seen as applications or attempted applications of a seminal idea that had originally inspired the Project Whirlwind people in the nineteen-forties. As long as the MITRE engineers were primarily engaged in work like this, deriving from an idea that was ultimately their own, they had a kind of dignity that always attaches to inner-motivated people. But all of the great efforts to which MITRE had applied itself in 1959 and 1960 were either completed or nearing completion in 1963, and, although there were plenty of new projects, few or none of them offered MITRE comparable opportunities to take the bit in its teeth and go with an idea that had evolved naturally out of its own prior work. A brief summary of MITRE's principal technical activities in the early nineteen-sixties will substantiate this.

The last of the SAGE direction centers, for the Sioux City air defense sector, was completed and accepted by the Air Defense Command on December 15, 1961, but by then the Air Force (or the Office of the Secretary of Defense) had already decided that SAGE would be too expensive to maintain in its entirety for very long, mainly because of the number of trained personnel needed to operate a direction center, and was looking for ways in which the number of SAGE centers might be reduced. The solution seemed to be to improve what the Air Defense Command called its Mode III capability, whereby, if the SAGE centers were destroyed, it could direct an air battle from the

radar sites. This called for a degree of automation at the radar sites -- in effect, a return to the principle of the Willow Run system which the Air Force had rejected in 1953 in favor of the Lincoln system. It says something about the changing relationship between the armed services and the Office of the Secretary of Defense that the latter intervened in September 1961 to direct the Air Force to develop what was now called the Back-Up Interceptor Control System and to use it in place of SAGE to the extent feasible. The Air Defense Command issued a BUIC operational plan the following January, and MITRE was at work on this partial undoing of SAGE for the next few years. Meanwhile, an interesting adjunct to SAGE which MITRE had been developing since 1959 -- the Airborne Long-Range Input program to use radars on aircraft to cover low-altitude air space in areas between the main radar stations, formerly covered by the so-called gap-filler radars, and also off-shore air space formerly scanned from Texas towers and picket ships -- was making heartening progress, with the result that in September 1963 even this carry-over from the old days ended in successful completion.

As for the ten proposed super-combat centers, it will be recalled that the Air Force decided not to build the nine scheduled for construction in the United States. The Canadians, to be sure, went ahead and built their underground center at North Bay, Ontario, modifying it so that it had radar coverage of all but the far-western part of their country and also of adjacent parts of the United States, and this North Bay center went into operation on September 26, 1963. But the excision of the nine United States centers killed the greater part of the plan and, along with it, the original version of the SATIN (SAGE-air traffic integration) concept, which was to take advantage of the enlarged capacity of the super-combat center computers by making

them serve an air traffic control purpose in addition to their primary air defense purpose. The ink was hardly dry on MITRE's SATIN contract with the Federal Aviation Agency when the disappointing news came. The contract was promptly modified to the effect that MITRE would explore the possibilities of adapting the existing SAGE centers with their computers of more limited capacity, and it was on this basis MITRE pursued the SATIN project through 1960 and 1961. For reasons already touched upon, however, FAA had lost most of its enthusiasm, and in 1961 the new Administration took a step that resulted in the quashing of the whole idea.

In March of that year President Kennedy asked the new Federal Aviation Administrator, Najeeb E. Halaby, to take a fresh look at the entire air traffic problem, whereupon Halaby established a task force known as Project Beacon and headed by Richard R. Hough. On November 1 Halaby submitted the Beacon Report to the President, and a few days later received a Presidential directive to carry out its recommendations. The Beacon Report advocated a rather thorough-going automation of all facets of air traffic control and thus did not give much comfort to the old fashioned airline pilot who, as captain of his ship, wanted maximum freedom to maneuver according to his own judgment, but it did not think that the Federal Aviation Administration's air route traffic control centers ought to move into the SAGE direction centers and share the same computers. At first glance, this may seem to reflect the same conservatism in the face of an innovative technical idea that had animated the Bell Telephone Laboratories' evaluation of the Lincoln Transition System in 1953, and perhaps there were some lingering traces of that point of view in the Hough committee. The Beacon Report, however, nowhere questioned the technical feasibility of a fairly complete automation (on that score, after all, SAGE had vindicated itself by this time), nor did it say that there was anything technically unsound about SATIN. It objected

to SATIN on the non-technical ground that it might be unwise in the long run to entangle air traffic control with air defense in such a way that the Federal Aviation Administration would thereafter be unable to introduce any desired modifications from time to time in its own system without first securing the Air Force's cooperation, and would have to accept changes forced upon it by Air Force decisions to alter the air defense system. Since the Air Force was even then preparing to reduce the number of SAGE centers, the point was difficult to refute. As for the radars and communications associated with SAGE, the Beacon Report saw no reason why FAA centers should not draw some of their data from them as long as the centers themselves remained physically independent of the SAGE centers.

The effect was to kill SATIN, the contract for which was allowed to expire at the end of the year, but there were still things MITRE could do for air traffic control, and in December the Federal Aviation Administration, with the concurrence of the Electronic Systems Division, offered MITRE a new contract for assistance in planning and designing an air traffic control system that would agree with the Beacon Report recommendations. It was under this new contract that MITRE furnished technical assistance in 1962 in an exercise in which FAA air route traffic controllers used the facilities of the Grand Forks, Minot, and Great Falls SAGE direction centers -- the so-called Northern Tier Project (NOTIP). The idea, of course, was that, even though the SAGE and air route traffic control centers were not to be merged, it was still necessary for air traffic control system designers to learn more about the detailed problems of operating a semi-automated system. The NOTIP agreement evoked the bitter protest of Representative Joseph E. Karth of Minnesota on August 10, 1962, about a month after it had been signed, but the project went ahead anyway, and MITRE's association with the Federal Aviation Agency was destined to continue. On May 15,



1963, the part of the MITRE staff engaged in this FAA work moved to Washington, where it remained. The work itself, however, differed from the kind of work in which the MITRE engineers had made their original reputation in that it was not a matter of beginning with a master conception and then working with FAA to make necessary modifications and adaptations, but rather of beginning with no master conception and simply helping FAA grope its way toward one. SAGE had not been developed that way.

Aside from SAGE and projects directly or indirectly connected therewith, MITRE's greatest single effort in the early nineteen-sixties was the designing of the NORAD Combat Operations Center in Cheyenne Mountain in Colorado (System 425L), together with the technical monitoring of its installation. Work on that system had been suspended during the time of the Winter Study, but had been resumed soon after the completion of the Winter Study Report, and in the summer of 1961 the 425L system project office selected the Burroughs Corporation as the prime contractor, but with the clear understanding that MITRE would design the system. Because NORAD needed as much of the promised capability as soon as possible, the Air Force decided to introduce some of the intended automated features into the existing non-automated combat operations center at Ent Air Force Base in Colorado Springs without delay -- i. e. , to enable the existing center to receive up-to-the-minute displays of data from the Space Air Detection and Tracking System and from the Ballistic Missile Early Warning System -- and this was done by June 1962. Concurrently, a temporary facility was built at Ent for experiments and testing of all parts of the system. This system, unlike the super-combat centers, was not to have a specially designed computer but, by Air Force direction, was to use an already existing or "off the shelf" machine, and the machine that the 425L system program office chose on the advice of MITRE and of the Rome Air Development Center was

the Philco "2000". Burroughs was developing a machine of its own, which it designated the "D-825," and made two attempts to gain permission to introduce the D-825 instead, carrying its approval to Air Force headquarters each time, but was twice denied -- in January 1962 and again the following September. (This, incidentally, should be an interesting case for those who question whether non-profit corporations like MITRE are worthwhile). At last, in February 1963, enough of Cheyenne Mountain had been hollowed out for the Army Corp of Engineers to award a contract for the construction of the eleven three-story buildings to be erected in the mountain's interior. The final phase of the work -- actual installation of system components and final check out -- did not begin until the summer of 1964, when the system program office and the associated MITRE personnel moved from Bedford to Colorado Springs; but here, again, MITRE was involved in a major effort which was steadily approaching its inexorable end.

MITRE from the beginning had tended to embrace system ideas that called for digging deep holes in the ground -- witness the abortive super-combat centers as well as the hole in Cheyenne Mountain. Perhaps this bias may be traced back to the early days of SAGE, when, to the anguish of some of the people involved, the Air Force decided not to harden that system, and the Winter Study reinforced it by stressing the importance of survivability as against quick reaction. One of the systems which the Winter Study report had criticized (and which some people in Air Force headquarters had already criticized) was the Strategic Air Command Control System (465L) -- a system which originally was to have involved four hardened sites but which before the time of the Winter Study had been reconfigured as a soft system to save expense. This, of course, left unanswered the question of what the Strategic Air Command was supposed to do with itself after the first swapping of nuclear-armed ballistic missiles. If it was to have a second-strike

capability, obviously some part of it would have to be protected against the consequences of a first strike, and there seemed to be two possible ways of doing that. One was to place a post-attack command post in an aircraft, probably a KC-135 B, and keep it in the air; and the other was to bury it somewhere deep inside the earth. The Strategic Air Command itself formally recognized the need in December 1960, and MITRE, although resented by some people in SAC headquarters on account of its part in the Winter Study, managed to have a hand in drafting the specific operational requirement that Air Force headquarters issued on August 31, 1961, for a SAC Post-Attack Command Control System (PACCS). In one week in mid-September some two hundred people, representing a number of agencies including MITRE, drafted a proposed system package proposal for PACCS, and by the end of the year they had progressed to the point that the tentative approval of the Secretary of Defense had been secured and ESD had established a PACCS program office (481L). Early in 1962 the Deep Underground Support Center received tentative approval as one of the features of the system, and there followed a consideration of possible sites, SAC itself being in favor of placing the center under Offutt Air Force Base at a depth of 5,000 feet. Meanwhile, it was MITRE's task to design the electronic features of the underground center, so that by August 1962 it was talking to representatives of the International Electric Corporation, the 465L contractor, concerning the necessary interfaces between the two systems. Some difficulty seems to have developed at this point, since SAC wanted the two systems to be compatible and did not want to have to have another computer program written. Besides, SAC was beginning to wonder whether its headquarters at Offutt really needed a 5,000-foot-deep basement, and in April 1963, after the matter had been carried to the Joint Chiefs of Staff, the Secretary of Defense, and the President's Scientific Advisory Committee, the whole effort to design

a deep Underground Support Center was sharply cut back in manpower and funds, and was finally eliminated the following December.

It would be tedious to recount all of the system projects in which MITRE was engaged, but there was one more that is too important to be omitted, and that is what eventually came to be called the National Military Command System. Among the future lines of effort that the Winter Study report had recommended was an exploration of the possibility of developing such a system so that the Joint Chiefs of Staff could effectively discharge the responsibility, which the Department of Defense Reorganization Act of 1958 had laid on them, to direct the nation's entire military establishment in case of war. MITRE regarded this as a piece of unfinished business, and gave it a great deal of thought from 1960 on. In early 1961 it formulated various concepts for achieving both survivable command posts and survivable communications. Indeed, its conceptual contributions to PACCS were a by-product of this effort. In 1962 it was working with the Air Force headquarters Directorate of Requirements on several facets of the problem, although the problem was really one that transcended the Air Force. In June of that year it evaluated the advantages of a rocket communication system as against other possible system in terms of both effectiveness and cost. In August it briefed General Schriever and various Pentagon officials on the problem of integrating specific Air Force command and control systems with a national command system. In December it presented other reports and briefings analyzing the functions of a possible National Emergency Airborne Command Post. While this was going on, the Air Force had been so far won over to this part of the Winter Study recommendations that it wanted to be given charge of the effort, but the Secretary of Defense determined otherwise. The job was assigned to the Defense Communications Agency of the Office

of the Secretary of Defense, and in the summer of 1963 it was arranged that MITRE would assist DCA in the technical planning and design of the National Military Command System and in the integration of the same with existing command and control systems. This work, some of which MITRE began on August 1 and some on October 31, was funded through the existing Air Force contract, but the working relationship with DCA personnel was to be a direct one, and it was partly for this reason that the MITRE personnel involved, under Charles A. Zraket, then moved to Arlington, Virginia. The major assignment of work for the Office of the Secretary of Defense, for which MITRE had been so long aspiring, had at last come to pass, although not the separate contract.

Now MITRE had inherited from its Lincoln past a way of going about such large undertakings as these. At an early stage in the development of what became SAGE, Lincoln had erected a test bed which it called the Cape Cod System, and, at a later stage created a SAGE prototype known as the Experimental SAGE Sector. In 1959 MITRE was planning a new experimental sector for the super-combat center program, but, of course, this was abandoned when the Air Force decided not to proceed with the super-combat centers. Yet in 1961 the XD-1 computer which had been the heart of the Experimental SAGE Sector was still in Lincoln's F Building and still under MITRE's operating control. There was no more SAGE "shake-down" testing to be done, but MITRE was not long in discovering that with suitable adaptation, it could use this still useful facility to help solve some problems in some other command and control systems -- for example, computer programming techniques to manage some information handling problems that had arisen in the development of the Air Force Headquarters System (473L). It chose the Military Air Transport Service's transportation planning function "as a manageable, educational, and relevant task"; and by January 1962

had created the initial version of what it called its Experimental Transport Facility, comprising file generation programs written for the IBM 7090 computer, on-line querying programs written for the XD-1, an adapted SAGE console, and certain other hardware. In the following June it conducted certain PACCS experiments in the same facility.

What MITRE really wanted, however, was not a makeshift but a permanent facility that could be adapted to any number of similar system experiments. In a word, it wanted a complete System Design Laboratory. With ESD's approval and support, it had already ordered an IBM 7030 STRETCH computer as the principal element of this laboratory, and the 7030 machine was delivered in November 1962 and installed temporarily in rented quarters pending completion of a special building for the laboratory (see Appendix C). Meanwhile, in August 1962, as part of its plans for using its new System Design Laboratory, it conceived and began to design what it called the Advanced Data Management (ADAM) System as "a software tool to be used as a design aid for military information processing systems," which R. A. J. Gildea of MITRE would later describe as "the most sophisticated general purpose data management system yet realized." The System Design Laboratory functioned for nearly a year in the building where it was initially installed and then had to suspend its operations for about two months while it was being moved to its new building (an extension of the Lincoln F Building), but the move was at last completed and the new building was dedicated on December 3, 1963. The System Design Laboratory then comprised not only the 7030 machine but also an IBM 1410 computer, an Electronic Associates PACE analog computer, and five display consoles. By the end of 1963 MITRE was at last fully equipped to perform the system designing and evaluating service on any number of authorized and proposed command and control systems that ESD wanted it to be able to perform.

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All in all, these were commendable and impressive achievements -- and, of course, there were still others, not mentioned here. Yet, as one looks at them in the aggregate, one can hardly fail to note that they were, after all, a miscellany of only superficially related efforts. In its former incarnations as Project Whirlwind and as the SAGE team in Lincoln, the MITRE technical staff had also applied itself to a considerable variety of tasks, but then there had been a clear central purpose to give meaning and direction to all subsidiary efforts, no matter how various. What might have given a comparable clarity of focus to MITRE's admittedly prodigious labors in the nineteen-sixties was the National Military Command System, but unfortunately the relationship that MITRE had achieved with the Defense Communications Agency gave it no license to take the bit in its teeth, with a great seminal idea in its head and a gleam in its eye. It had no call to produce a radical and direction-setting document comparable, say, to Lincoln's Technical Memorandum 20 in January 1953. The Air Force had already made it clear, in its reaction to the Winter Study report, that it was no longer in a mood, as it had been a decade earlier, to listen respectfully while some scientists and engineers told it what it needed, and then extend itself to enable them to do what they proposed. Neither was DCA in such a mood, and neither, for that matter, was the Federal Aviation Agency.

Why had this situation come about? It is only a partial explanation to point to the Air Force's sleepless and methodical campaign, discussed in the preceding chapter, to impose ever tighter management controls on MITRE. If the Air Force had not done that, someone else would have. There had come, as it were, a change of climate, so that the style of life which the MITRE engineers had known in their former incarnations was no longer

possible. In the Whirlwind days when this team formed itself, just after the Second World War, the armed services knew or suspected that the great technological revolution which had begun during the war was far from completed, and that it behooved them to keep abreast of it. They therefore made a number of research grants, contracted with both private industries and universities for the development of new military systems, and organized and maintained several government research laboratories; but they lacked the seasoned management apparatus to control all this and, moreover, were so anxious to get this activity under way and keep it under way that they were willing, for the time being, to give civilian scientists and engineers a normally unthinkable degree of freedom. In the nineteen-fifties they were beginning to evolve the management apparatus to apply tighter controls -- witness the creation of the Air Research and Development Command in 1951 -- but still did not dare to control with too heavy a hand lest they kill or stifle some research and development programs in which they felt they had a vital interest. The military research and development scene therefore presented a disorderly and even chaotic appearance, and for that very reason had for a while a remarkably protean and seminal quality.

But toward the end of the Eisenhower Administration things began to change. The Department of Defense Reorganization Act of 1958 (coming, incidentally, at almost exactly the time of the birth of MITRE) must be taken as one of the principal heralds of change, since it proved to be the legislative basis of much that followed. In the Air Force there was a thorough overhauling of both the organization and the procedures for managing research and development and the acquisition of systems. Once the Anderson group's recommendations went into effect and the old Air Research and Development Command gave way to the Air Force Systems Command, the Air Force was



quite able to manage and control and regulate its whole systems empire, including any directly or indirectly related research and development, and was quite uninhibited in doing so. Meanwhile, the Office of the Secretary of Defense was at last finding out how to assert itself, so that the Air Force's empire was steadily and inexorably subordinated to a yet larger empire. Well before Kennedy's assassination, this formerly chaotic and protean scene had become orderly, tidy, well managed -- and sterile. The nineteen-sixties saw massive expenditures for military research and system development, but did not encourage independent-minded engineering teams with a spark of originality, and cannot compare with the preceding decade in the generation of exciting new technical ideas. But, again why? The answer would seem to be somehow bound up with the "cold war", or, more precisely, with the declining seriousness with which the cold war was taken. Whether a sober evaluation of the facts of world politics in the years after 1945 really justified the apprehensions of imminent disaster so characteristic of the period is, perhaps, arguable; but there can be no doubt that government officials and much of the public at large saw things in that light. It is also possible to argue whether the true facts of world politics in the nineteen-sixties really warranted the more relaxed attitude toward the cold war which then began to manifest itself, but there can be no doubt that there was such a relaxation. Even before the election of 1960 there were signs that a significant number of people were beginning to be as concerned about something called the "military-industrial complex" as about the enactment in reality of some RAND Corporation scenario of general war. The Cuban missile crisis in 1962 may have had the paradoxical result of deepening the skepticism because it was about as close to a RAND Corporation scenario as one is likely to come in the real world, and yet did not end in general war. By October 1963 things had reached the point that even the President's science

advisor, Dr. Jerome Wiesner, was among the skeptics. It was then that he told the House Science Research and Development Committee that the "scientific-military revolution" had stabilized and that military research and development had lost its former urgency. When he was taken to task for this remark a week later, he drove the point home by explaining that he had meant that "we are not running behind, we are not running from danger" and by speaking of "a relatively comfortable feeling about our military posture."

A great deal falls into place in the light of this change of mood. Military and civilian officials in the nineteen-sixties often talked as though they still believed in the cold war, but what counts is not their words but their behavior. If they had felt genuine alarm, as their predecessors in the nineteen-fifties had, they would not have had time for Anderson-group procedures, questions about the need for fees, cost-effectiveness studies, and the like, but would have been all too ready to induce civilian scientists and engineers to do what seemed necessary on whatever terms the latter desired. The Air Force would probably never have attempted the reorganization that it carried out in the eighteen months from the autumn of 1959 to the spring of 1961 and, if it had, someone above it would have forced it to desist.

This is by no means to say that MITRE in particular or Air Force-sponsored non-profit corporations in general were not still needed in the nineteen-sixties. There was still a need for a kind of service that was technical in content but policy-formulating in purpose that could not very well be performed by any other known kind of institution. Government agencies could not do it, not so much because of civil service pay scales (which, anyway, were considerably improved in the nineteen-sixties) as because of the unavoidably hierarchical structure and authoritarian atmosphere of any

government organization, which militates against the intellectual freedom that the activity requires. Private industrial organizations, although no less authoritarian and hierarchical, could and sometimes did create subsidiary organizations and endow them with the needed atmosphere of intellectual freedom, but, as the Ramo-Wooldridge case illustrates, could rarely satisfy outsiders, including other industrial organizations, that they were not somehow abusing the special confidential relationship that the activity also required. Seemingly, a university could meet both tests, but here the trouble was that the business of formulating and advocating policy decisions is incompatible with the atmosphere of intellectual detachment that a university must maintain in order to continue to be in truth a university. The Gaither type of corporation thus met a genuine need. As a form, it is still in its infancy, but the record so far would seem to indicate that it is likely to function better and do more valuable work under a regime of loose controls than under a regime of tight controls. In either case, however, the need is likely to remain as long as the modern state has to make policy decisions based on specific kinds of technical expertise.