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Air Force Ballistic Missile Division

Air Research and Development Command

11 February 1960

HISTORY OF

EVOLUTION

of the

AFBMD ADVANCED BALLISTIC MISSILE AND SPACE PROGRAM

(Prior to and immediately after Sputnik)

(1955-1958)

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11 FEB 1960

EVOLUTION  
of the  
AFBMD ADVANCED BALLISTIC MISSILE AND SPACE PROGRAM

(Prior to and immediately after Sputnik)

(1955-1958)

Among the areas of activity in which the Western Development Division (WDD) found itself involved as early as late 1955 were those of ballistic missile "product improvement," advanced ballistic missile weapon system study, and intensive thinking about potential space programs beyond WS 117L. In general this involvement was the result of direct and indirect WDD participation in Air Research and Development Command (ARDC) and Air Force studies in such areas.

The purpose of this essay is to attempt to trace the main outline of how WDD, an organization which was set up in mid-1954 to perform a specific mission, gradually found that mission expanded into follow-on missile and space activities. Although Air Force and ARDC directives specified that the mission of the Division was reorientation and acceleration of Project ATLAS, and after 1955 management of the TITAN, THOR and Advanced Reconnaissance System, the scope of technological advances and the scientific capabilities focused at WDD for furthering these complex programs rendered work in more advanced areas almost inevitable.

In establishing the original ATLAS, TITAN and THOR programs, possibilities for product improvement of various missile subsystems

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and components became evident as soon as engineering details were examined and test hardware was produced. Indeed, the recommendations of the Strategic Missiles Evaluation Committee (SMEC) in February 1954 had pointed out the desirability that the organization which should be set up for Project ATLAS also be responsible for follow-on projects in the area. These possibilities were reinforced by various proposals made by the Guided Missile Research Division (GMRD) and by the missile subsystem contractors. Such activity was normal for any development program.

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However, because of the urgency of the ICBM/IREM program, the incorporation of ballistic missile improvements had to be weighted against the overriding requirement for earliest availability of operational missiles. The time and effort required for reorienting and accelerating the ATLAS program, for selecting contractors and forming management relationships, for initiating the TITAN and THOR programs, and for planning the ICBM and IREM initial operational capabilities precluded thorough analysis or significant actions toward advanced ballistic missile or space development during 1954-1956.

Moreover, since the Division was not assigned any authorized mission responsibility for follow-on ballistic missile systems, the amount of work which the Division could undertake in such areas was severely limited. Indeed, the prevalent (1955-57) Headquarters ARDC attitude toward WDD activity in the advanced missile and space areas appears to have limited any assignments in these areas and to have

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stressed the Division's role as being limited in time and scope to the development of the initial ICEM and IREM.\*

In the field of space development, General Schriever's mission responsibility was limited to WS 117L, the Advanced Reconnaissance System, which was in the process of transfer to the Division by direction of General Power in late 1955. The reason usually advanced for this this transfer was that WS 117L depended upon the ATLAS program for boosters; therefore its development management should be tied to that program. From early 1956, when the Division took over the WS 117L program until 1958, this project was carried out at a far lower level of priority than that of the ballistic missile program. It did not possess expediting procedures similar to the Gillette procedures, nor did it receive funding adequate to support a full-scale system development program until 1958.

With respect to nuclear propulsion for rockets, in July 1956 General Schriever proposed to Lt General Thomas S. Power, Commander ARDC, that primary responsibility for managing nuclear rocket studies having potential for ICEM and Earth satellite application be transferred to WDD.<sup>1</sup> In his reply, General Power indicated that the mission of the Division should be primarily directed to attainment of an

\*Advanced missile and space responsibilities were placed elsewhere in ARDC; at HADC and WADC, for example. Of some interest is the fact that the original Air Force directives to ARDC, and ARDC directives to WDD, stressed only the first generation ballistic missile (ATLAS) development although the USAF Strategic Missiles Evaluation Committee had recommended that the group be given responsibility for an authority over the advanced research phase of a continuing IBMS program such as investigation of nuclear propulsion.

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early operational capability for the ballistic systems then under development, and that such advanced weapon system study efforts were under the responsibility of the ARDC Deputy Commander for Weapon Systems.<sup>2</sup>

Yet in spite of attention primarily focused on the needs of ATLAS, there was, beginning in 1955, active Division and GMRD recognition of the need for advanced ballistic missile and space development activity. Initial activity was largely concerned with product improvement efforts to simplify the subsystems and to make them more reliable, but in early 1955 the Division began to play a role in the analysis of advanced ballistic missile systems. This commenced when General Schriever became a member of a Board of General Officers appointed by Lt General Thomas S. Power, to study the possible establishment of an Air Force guided missiles development center. Major General Donald Yates served as Chairman of the Board, and other members included Brigadier Generals L. I. Davis, D. R. Ostrander, J. S. Holtner, V. R. Haugen of ARDC and C. H. Mitchell of AMC. Lt Colonel K. D. Vandayberg served as Recorder for the Board. In his activity as a member of the Board, General Schriever was aided by a Division working group composed of Lt Colonel Lawrence D. Ely and Major David L. Carter, and by studies conducted

\*Among the various improvement programs initiated at the Division was the original large solid propellant rocket engine program established in 1955 by General Schriever at the recommendation of Lt Colonel Edward N. Hall. This type of activity did not interfere with the liquid rocket development program. In a like vein, the Division undertook to place emphasis on development of inertial guidance for the ICBM, because of its obvious advantages. Again in this case the effort was viewed as a backup or follow-on one.

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by Mr. A. F. Donovan and personnel of his GMRD element.

During 1955 this Board studied the guided missiles area, noted serious Air Force deficiencies, and reported that further emphasis should be placed on guided missile development. However, it recommended that a guided missile center not be established; instead, that steps be taken to elevate missile weapon system management under a Deputy Commander for Systems, and that vigorous steps be taken to provide integrated research and development actions in the missile area.<sup>3</sup>

After reviewing this and follow-on reports on the same subject, General Power directed that the Board continue its activity and consider in further detail the feasibility and desirability of establishing a new missile complex with greater range area and room for expansion, and with greater freedom from encroachment by other interests than at Holloman Air Force Base.\* He requested that the Board be bold and imaginative in its concept of the scope and importance of future space vehicle development programs.<sup>4</sup> The Air Council was briefed on the results of this second study early in 1956, at which time the Board recommended creation of a ballistic missile and space center, possibly at Holloman Air Force Base, or at some alternate location.

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\*In the same general area, a study group recommended that the Holloman area be the site of an Institute of Space Technology. Colonels John R. Mitchell, Sidney K. Wold, Edwards A. Kane, Theodore B. Holliday, Charles A. Masson, USAF Reserve, Establishment of an Institute for Space Flight Technology. Baltimore, Md., 22 August 1956.

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In the fall of 1955 General Power established a series of ARDC Long Range Planning Committees as a follow-up to the Yates' Board's activities and to provide long range technical estimates and planning in the various technical areas. Among these was a Guided Missiles and Space Vehicles Committee. Again Generals Yates, Schriever, Davis, Haugen, Holtner and Ostrander were the Committee members.

In the course of their study this Long Range Planning Committee drew on material prepared at the Western Development Division. One of the major contributions of the Division and GMRD to the Long Range Guided Missiles and Space Vehicles Committee was a study, "Ballistic Missiles, Satellites and Space Vehicles 1956-1976," prepared by Colonel Lawrence D. Ely, Assistant for Technical Divisions, under Colonel Charles H. Terhune, Jr., Deputy Commander, Technical Operations.

This study, which drew on material from WDD, Mr. Donovan's GMRD element, the RAND Corporation and Holmes and Narver, Inc., presented a number of observations concerning both a "space" center and time-phased technical estimates of what could be done in the ballistic missile and space area.

In surveying the over-all development situation in the Air Force, the Ely study pointed out some of the problems which faced development agencies undertaking work in new areas. In particular it appeared that research progress in areas such as missiles and space lagged woefully behind the needs of the design engineer. One factor seemed to be that a development project or system had to be approved before

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the necessary research could be started, thus delaying the project until such research could be performed.<sup>5</sup> Lagging research thus slowed the development cycle. This situation was, it appeared, partially due to the problem of convincing personnel at various levels of management that applied research was necessary, or that the approach was sound. To lessen this lag, it was considered to be beneficial if one ARDC agency were given the mission of looking into the future, and of determining the applied research needed to support future ballistic missile, satellite and space vehicle programs. Western Development Division was continually confronted with problems the solutions of which were not necessary to its immediate mission, but which did apply to future space work. Consequently the Division was considered to be in the best position to perform such research until an ARDC space center was designated.<sup>6</sup>

With reference to state-of-the art work which should be undertaken, the Ely study pointed out that only a small velocity increment would be required over current ballistic missile velocities in order to provide Earth satellites, and after that, orbital paths to intersect the Moon, Venus, or Mars.

The study noted that the RAND Corporation had presented studies in early 1956 indicating that it was feasible to take test instruments to the Moon using propulsive and guidance components then under development:<sup>7</sup> for example, an ATLAS, series "B" with its General Electric guidance and a second stage VANGUARD second stage. RAND also

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# SPACE TRAVEL DEVELOPMENTS FROM BALLISTIC MISSILE PROGRAM

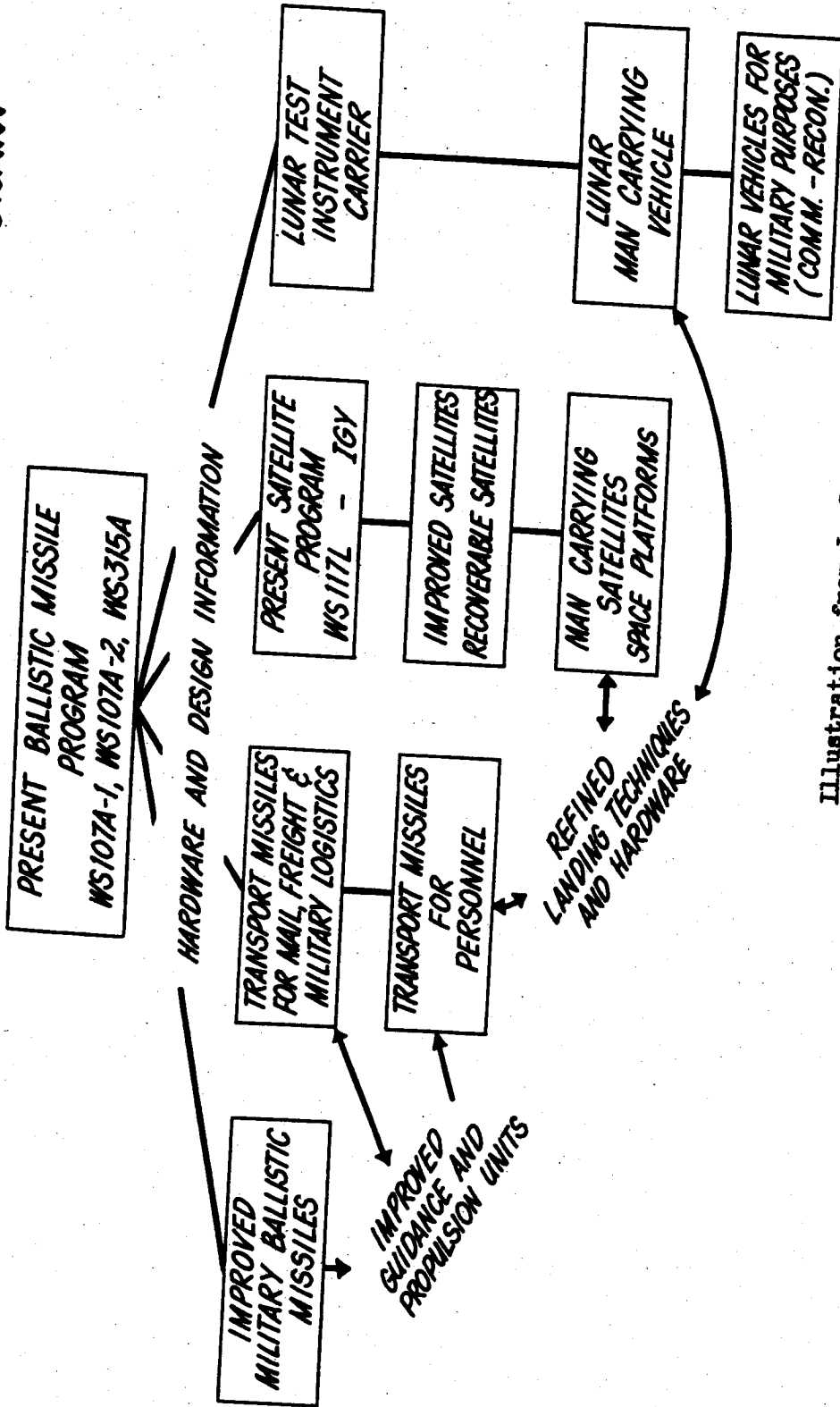


Illustration from L. D. Ely "Ballistic Missiles, Satellites and Space Vehicles, 1956-1975." (SECRET)

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# SPACE TRAVEL ESTIMATED DEVELOPMENT SCHEDULES

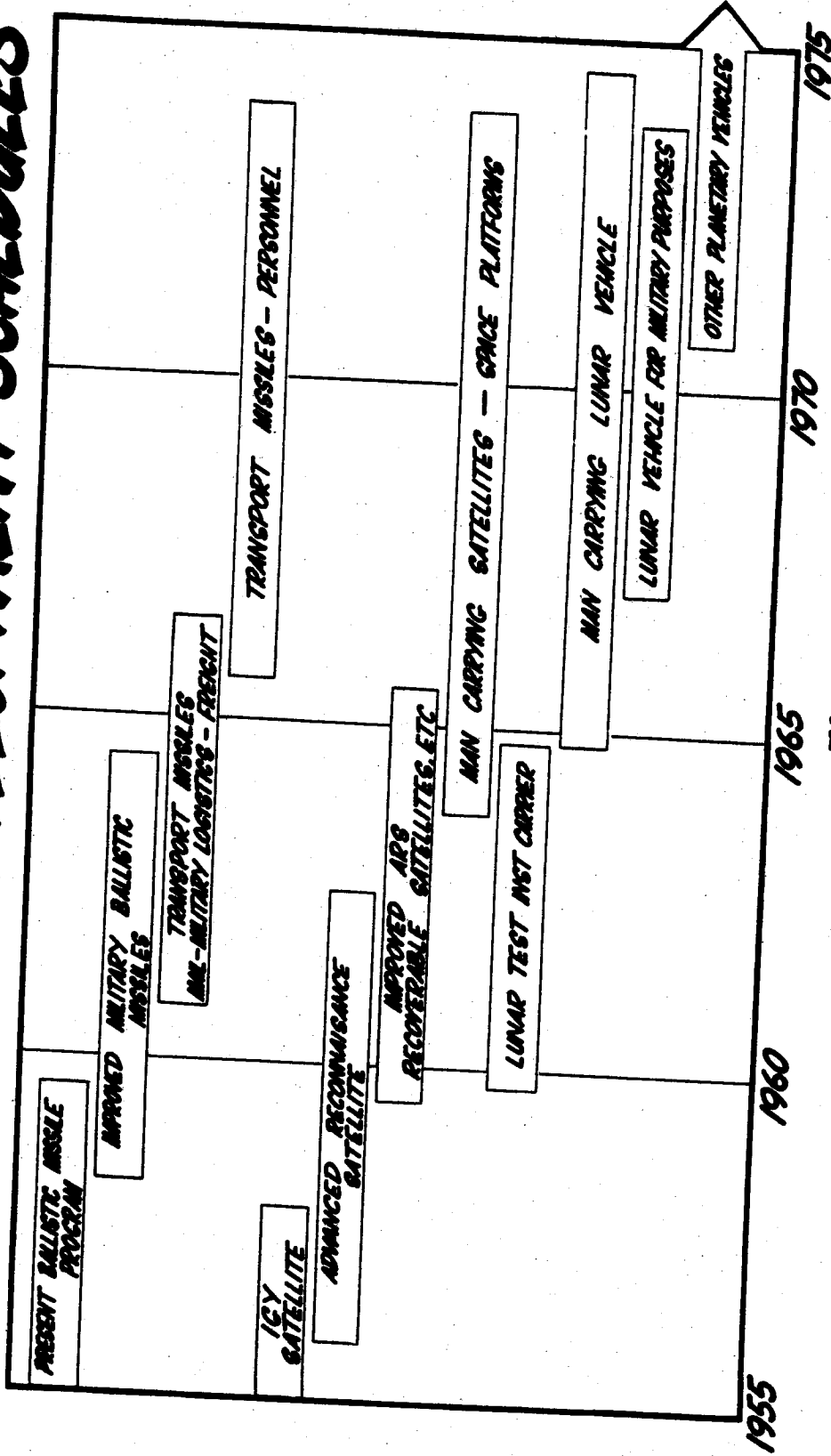


Illustration from L. D. Ely "Ballistic Missiles, Satellites and Space Vehicles. 1956-1975." (SECRET)

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noted that Soviet literature demonstrated much analytical interest in lunar and satellite vehicles.<sup>8</sup>

Pointing out that the ballistic missile program emphasized early operational capability rather than optimum design or development improvement, the Ely study of October 1956 emphasized the developments which were possible in range, propulsion, fuels, structures and warheads, and in guidance accuracy. Forseeing that in satellite development a similar emphasis on early operational capability could arise, the study pointed out that research could be started in such areas as recoverable satellite or reentry bodies, possibly using retrorockets and parachute recovery as a feasible step leading to manned satellites.<sup>9</sup>

The study presented a series of diagrams (opposite pages), which depicted technical estimates of what could be done in space flight for the next twenty years. It also made recommendations concerning special areas of investigation and development which should be undertaken in aero-thermodynamics, guidance and control, navigation, propulsion and space medicine areas. Activity in many of these areas was underway, but in widely separated locations and with varying priorities.

Material from this October 1956 study was widely used in the preparation of the Report of the ARDC Guided Missile and Space Vehicle Committee, which was presented to Lt General Power in late 1956. The group made vigorous recommendations concerning Air Force expansion of facilities and laboratories to meet the needs of the space age.<sup>10</sup>

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At the Committee's direction several additional studies had been prepared. Elements of these reports were also included in the final report. One, by Holmes and Narver, Incorporated, considered missile technical facilities required during the period 1961-1976.<sup>11</sup>

Another, prepared by the Guided Missile Division of the Ramo-Wooldridge Corporation in February 1957, considered the technical research and development needs, the instrumentation and facilities, and the management concept for such a guided missile center. This latter study, prepared under a contract issued by the Holloman Air Development Center, was based on the assumption that such a center would be located in the Holloman Air Force Base--White Sands Proving Ground area in New Mexico.<sup>12</sup>

This GMRD study represented a major survey of the problem of missile and space management in the Air Force. Significantly, it considered in detail the military need for space weapon system development, and the research and development requirements needed to support advanced missile and space programs.

It reiterated the problems inherent in the relative diffusion of space technology research and development in ARDC, and clearly stated the need for more centralized control and management of space research and development. It suggested that WDD was the organization best equipped to take on management of future space weapons, including follow-on ballistic missiles, Earth satellites, and other space vehicles, until such a guided missile center could be established.<sup>13</sup>

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The GMRD February 1957 study argued the need for space superiority, including development of an anti-ICBM. Flights to the Moon, Mars, Venus, and Jupiter were viewed as extensions of current and follow-on ICBM development, using staging techniques. In support of these activities the report laid out an R and D program to support such objectives. This program was to be carried out in propulsion, structures, guidance, reentry and recovery, attitude control, auxiliary power, communications and reconnaissance and space medicine, and was designed to provide missiles and space superiority for the nation.

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One result of this Division activity in advanced missile and space thinking during 1956 was the recognition and conviction on the part of Division staff members that such work should be supported and undertaken as soon as possible.

This conviction was probably best expressed in a speech, "ICBM - A Step Toward Space Conquest" given by Major General Bernard A. Schriever before an Astronautics Symposium at San Diego, California, on 19 February 1957. Pointing out that the ICBM development program provided the means of unmanned (and later manned) space conquest, he indicated that in the long run our safety as a nation might depend on achieving "space superiority," since the battles of the future may involve "space" rather than sea or air. Space programs would require spending some fraction of our national resources. They could start with artificial Earth satellites and instrumented

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lunar and interplanetary unmanned vehicles, while research to fill the gap of what was needed for manned space flights could also be pushed. As for ballistic missiles themselves, General Schriever high-lighted the obvious need for improving their reliability and operational procedures, their range, payload and accuracy, and for reducing their gross weight and cost. All these required advancing propulsion, structure and guidance techniques.

Through such ballistic missile and space thinking, by late 1956 and early 1957 a respectable body of exploratory material on advanced missile and space development possibilities was available at the Division. During the first half of 1957 this material was heavily reinforced by additional in-house generated studies and by the work of the RAND Corporation on space proposals.

The most important of these in-house studies was formalized by the publication in late 1957 of an Advanced Weapon System Study by the Space Technology Laboratories, Incorporated (formerly GMRD). This study, which drew heavily on 1955-57 work and studies undertaken for the Division, for the ARDC Long Range Guided Missiles and Space Vehicles Committee, and for the Holloman Air Development Center, was the outgrowth of a proposal made by the Ramo-Wooldridge Corporation to the Director of Development Planning, Office of the Deputy Chief of Staff, Development, USAF (AFDAP), in November 1956. This proposal encompassed study and recommendations of follow-on ballistic missiles, satellites, and other space vehicles.

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In February 1957 GMRD was authorized to proceed with Part I of this study. Because only limited funds were available, General Schriever authorized the study under joint WDD-AFDAP auspices, and assigned Lt Colonel David L. Carter as project officer for the study. Colonel Carter was assisted in special phases by Lt Colonel Dean H. Schuyler. GMRD work on the study was managed by Dr. R. F. Mettler and Mr. A. F. Donovan, but the work was a joint effort involving a large number of specialists.

As planned, the study was to consider technical development possibilities of large payload, long-range missiles; low payload, long-range missiles, and solid propellant and boost-glide missiles for the period 1960-1970. Parts II and III of the study were to consider development possibilities for satellites and space vehicles during the same period.<sup>14</sup>

The final version of Part I of the study, eventually known as Advanced Weapon System Study, Final Report, Part I, A Pilot Study of Advanced Ballistic Missiles,<sup>15</sup> was not available formally until the end of the year, but meanwhile preliminary material from the study became the basis for a number of presentations to key personnel. Among these were presentations to Panels of the Scientific Advisory Board to the Chief of Staff USAF, on 21 May and in July 1957. The study, together with earlier studies done at WDD and GMRD, also became the basis for presentations to ARDC, the Scientific Advisory Committee to the Secretary of the Air Force, and to Headquarters USAF in December 1957.

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Many and varied Air Force Ballistic Missile Division briefings on advanced missile and space programs were presented in the fall of 1957 as a result of national reaction to the Sputniks. Although the content of these briefings varied, in general they included sections on ballistic missile product improvements, state of the art advances, and recommendations for an Air Force space program which could be undertaken with current components.

In the first category, product improvements on THOR, ATLAS, and TITAN encompassed programs for significantly increased range and payload, lighter weight, ablation type reentry bodies, higher yield warheads, precision guidance, automation, and simplification of components. As a part of product improvement the Division also advocated the potential of an AFEMD-conceived\* three-stage solid propellant missile (then called Weapon System "Q", later MINUTEMAN), to be achieved by taking advantage of state of the art advances in solid propellants, guidance, warheads, and reentry techniques.

In the realm of space programs AFEMD pointed up Air Force needs for reconnaissance and communications satellites, a manned space flight program, and for technical development and experimental programs in space. The AFEMD position on space vehicles as presented by General Schriever and his staff was that the current generation of ballistic missiles (THOR, ATLAS and TITAN) and their guidance systems were

\*By Colonel Edward N. Hall. See other Division historical material for information on the background of MINUTEMAN.

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adequate or adaptable to space missions of primary interest for the next ten years. The most important need was additional stages which could be used as building blocks in combinations. Also, immediate action was recommended to define and develop space payloads and instrumentation (including those for manned space flight) and for concentrated research and technical development programs on critical problems and basic space phenomena.<sup>16</sup>

These AFEMD presentations, founded upon extension of established programs, became the basis for satellite proposals and space probes, as well as for follow-on ballistic missiles such as MINUTEMAN. Recommendations made were made on the basis of sound and realistic evaluation of what could be done. They played an important role in the assignment of follow-on ballistic missile responsibility, and of responsibility for selected space systems to the Division in early 1958.<sup>17</sup> Likewise, many of these proposals became the basis for Division programs undertaken for ARPA or NASA beginning in 1958.\*

This brief review of AFEMD activities in space and advanced ballistic missiles prior to and immediately after Sputnik may be summarized by pointing out that under its original instructions the Division had no direct mission or responsibility in either of these areas. Yet, because of the nature of the mission and the recognized

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\*As an example of the specific advanced missile and space proposals and their range, see "Briefing Chart Book, USAF Scientific Advisory Committee Meeting at AFEMD," 16-17 December 1957 (SECRET, RD).

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capabilities in the AFEMD-GMRD complex, as early as late 1955 the Division was making contributions in both areas through participation in Air Research and Development Command studies. The results of these studies were presented to various ARDC and Hq USAF personnel, and to such organizations as the Scientific Advisory Board to the Chief of Staff, USAF. \*

The U.S.S.R. Sputniks of 4 October and 3 November 1957 created an immediate demand for acceleration of work in these areas. The initial reaction to the Sputniks ranged from consternation and a felt need to match the Russians as quickly as possible, to searching examinations of the "how" and "why" of Sputnik, and of national failure to be first. In the October atmosphere of confusion and consternation many plans were presented to public and military officials. In this climate it became the Division's task to prepare and present an achievable space program to the Air Force; a program which was based on solidly, firmly established management principles tested in the ballistic missile program, on available ballistic missile booster hardware, and on experience with time-phased program possibilities and realistic required program funding. From such presentations, made informally in the last two months of 1957 and early 1958, originated the Air Force, and to a large extent, Department of Defense and civilian space programs of 1958.

\*They were used in the preparation of the Special Report Concerning Space Technology, produced by the ARDC Guided Missile and Space Vehicle Working Group in December 1957. This Special Report was concerned with reorientation of the ARDC technical program to insure that it was a "space technology" program.

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FOOTNOTES

EVOLUTION OF THE AFMD ADVANCED BALLISTIC MISSILE AND SPACE PROGRAM  
1955-1958

1. Ltr to Comdr ARDC "Nuclear Propulsion" 9 July 1956 (SECRET)
2. Ltr to Comdr WDD "Nuclear Propulsion" 29 August 1956 (SECRET)
3. Report [to Comdr ARDC] of Board of Officers to Consider a Guided Missile Development Center, 27 May 1955 (SECRET)
4. \*Ltr from Lt General Power to Major General Yates, "Board of Officers on Guided Missiles Development" 7 October 1955
5. "Ballistic Missiles, Satellites and Space Vehicles", 1956-1965, p. 3
6. Ibid.
7. RAND RM 1720, General Report on the Lunar Instrument Carrier, 27 May 1956.
8. Ibid.
9. Ibid.
10. Draft copy, Research and Development of Guided Missiles and Space Vehicles, 1955-1975 (SECRET)
11. "Feasibility Study for a Guided Missile Development Center," August 1956 (SECRET)
12. GMRD, R-W Corp. Study of Technical Programs and Management of an Air Force Guided Missile Center. GM-TR-138, 1 February 1957 (SECRET)
13. Ibid.
14. Lt Colonel J. A. Ryan, Jr., AFDAP, "Memorandum for Record" (SECRET), 25 April 1957
15. Space Technology Laboratories, Ramo-Wooldridge Corporation, 3 Vols., GM-TR-243-1, 31 December 1957 (SECRET)
16. For an example of the contents of one such briefing, see "Briefing Chart Book, USAF Scientific Advisory Committee Meeting at AFMD, 16-17 December 1957" (SECRET RD, WDPCP 57-9)

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Footnotes

17. Ltr, Comdr ARDC to Comdr AFEMD, "Proposal for Future Air Force Ballistic Missile and Space Technology Development" (SECRET)  
22 January 1958.

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