B-II

APPENDIX TO CHAPTER II

THE CONGRESS AND THE PUBLIC DIALOGUE

TABLE OF CONTENTS

Appendix B-II (cont'd)

B-II-8 <u>NASA and USAF, A Space Age Partnership</u>, James E. Webb, <u>The Airman</u>, August 1964

B-II-9 <u>Foreign Policy Reasons for U.S. Space Program</u>, Letter from Dean Rusk, Secretary of State, to Senator Robert S. Kerr, June 14, 1961

A GUIDE TO THE NASA BUDGETARY PROCESS
FY 1965 thru FY 1969

Future students of NASA's history during the Johnson Administration who are not already thoroughly familiar with the NASA budgetary process prevailing in those years may find a few words of technical guidance helpful. In the following pages, an effort will be made to show at what points in the budgetary process, and in what form, material of interest to the historian is likely to be produced and emerge as part of the public record.

The process is long, involved, and to a considerable extent ritualistic. But the end result, of course, is a national decision that not only determines the fate of this or that project, and the ways and places for spending billions of dollars, but also helps determine in no small way the fate of the American people and the future of our free society. Or so it was in the decade of the Sixties -- or so we thought it was.

The NASA appropriation is usually not approved by Congress until well into the new fiscal year -- that is, in July or after. By that time, the NASA budget makers are already hard at work on next year's budget. So the budgetary process is a continuous part of NASA's activity in which NASA management, the Bureau of the Budget, and the White House, as well as key members of Congress, are almost constantly involved.

The process has several main steps or phases:

1. The various offices in NASA, each with a special interest in one or more programs, let NASA's top management know what they want to do and the funds they think are necessary to do it. Competition can be keen and internal debate spirited. But in the process top management gets a good feel for the value of the respective proposals and how well their proponents will be able to justify and defend them in Congress. Sometimes issues in this debate spill over -- or leak -- to the trade press, the professional journals, or the major newspapers.

But on the whole, internal documents on these matters are not yet available to the historian, and probably would be of little interest unless the investigator had some special reason for wanting details on a particular project, or personality, or management issue.

It should be recognized, however, that in this in-house competition for funding, difficult decisions had to be made on some fundamental questions. This has been true particularly because of Mr. Webb's insistence on a balanced program despite the top priority for the manned lunar landing. In general, NASA references to a balanced effort have meant a proper, equitable, or wise distribution of available funds among the offices working on manned space flight, space science, applications, and advanced research and technology. Each of these general areas has had its own proponents in the Congress, in the scientific community, in industry, or among the public.

In the long run, the nation can have a space program that meets its needs and opens up new horizons only if the internal program selection process is sparked by imagination and genius, spurred and tested in competition, and arbitrated and guided by wise managers.

Proposals from the scientific community and industry are also an important part of the NASA program selection process.

2. Concurrently with Step One, the Bureau of the Budget and/or the White House keep the NASA Administrator posted on what over all amounts and what major new commitments can be expected to get Presidential approval. (The reactions of the Congress to the President's request for the current year must also be taken into account.)

3. The Bureau of the Budget usually sets a date in September for a formal submission of NASA's budget proposals or recommendations. Usually (as for FY 1964) NASA describes what can or cannot be done at several different levels of funding.

Administrator Webb or other NASA officials sometimes disclose to the press or to Congressional Committees what NASA's "original" proposal was (or proposals were), but have never produced the actual documents for the record or discussed them in detail.

In addition to this formal submission, there are, of course, a number of memoranda and notes in the NASA files that reflect the dialogue between NASA and the White House and the Bureau of the Budget on budget preparation.

4. Discussions and negotiations between NASA on one hand and the Bureau of the Budget and the White House on the other may go on for weeks or months and perhaps right up to the deadline for getting the Budget printed before its submission to the Congress. Sometimes a difficult decision may be deferred even past this deadline, with the understanding that a special request will be submitted to Congress later, or a supplemental appropriation requested.

Note: During these first four steps or phases, the trade press (and sometimes the general press) try to keep their readers informed with what they claim is authentic information about what NASA is asking and what the Bureau of the Budget position is.

5. The President's Budget is made public on delivery to Congress, along with his Budget Message. The Message usually gives a brief statement on the President's space policy, and the Budget gives more details. The State of the Union Message delivered some days earlier is also carefully studied by those seeking clues to the President's current thinking on the importance of the space effort.

6. Press reporters get an advance briefing on the President's Budget and Message from the Bureau of the Budget and from NASA several days before the Budget is officially released.

NASA's budget briefing is followed by a question and answer period, and often produces important statements on NASA policy or explanations of NASA thinking.

NASA makes a transcript of the briefing and the questions and answers. The transcript is available for reference in the files of the Public Information Division of the Office of Public Affairs, NASA Headquarters.

The background material distributed at the budget briefing also includes NASA's operating plan for the current year--that is, how the appropriation for the current year is actually being used.

7. The annual NASA Authorization Act is a law of Congress defining the activities for which funds may be appropriated for the fiscal year and setting a ceiling on the funds that may be appropriated. The first draft of the bill is prepared by NASA.

Hearings on the authorization bill are conducted by the House Committee on Science and Astronautics and the Senate Committee on Aeronautical and Space Sciences, beginning in February or March. Sometimes "posture" hearings are held before the sessions on the bill itself.

NASA plans and programs are explained in great detail to the Committee and Subcommittees, and a voluminous printed record is published.

Important explanations of NASA policy are usually made by Webb and other key officials at the opening hearings. These are made either in a formal statement or during the question and answer sessions.

Each Committee prepares a recommended version of the bill for action by the House or Senate. The Committee bill is accompanied by a detailed Report which explains Committee actions and recommendations and is an important part of the legislative history of the act.

Debate on the bill in House and Senate produces a great deal of background material for the record, as well as major speeches by proponents and opponents. Much of the debate is generated by one or more amendments to cut the authorization substantially, and the votes on these amendments often reveal Congressional opinions more clearly than does the final vote on passage of the bill.

Although the annual authorization process is arduous, it does give the legislative (authorization) Committee members much greater opportunity to examine NASA programs in detail than the Appropriations Committee members would have; and it works to NASA's advantage by enabling experienced, knowledgeable Committee members to speak with authority and commitment during debate on the floor of the House or Senate when either authorization or appropriation bills are up for passage.

8. NASA's annual appropriation is usually provided in the annual Independent Offices Appropriation Act.* Hearings are held by Subcommittees of the House and Senate Appropriation Committees, and printed records of the hearings are published. Mr. Webb makes a formal statement before both House and Senate Subcommittees. Questioning of Webb by Subcommittee members is usually lengthy and often of especial interest because Committee members are in general more concerned with Whys than the Whats of NASA activities.

As in the authorization debates on the floor of the House and Senate, the key votes and the significant divisions come on amendments rather than on final passage of the bill. This requires careful reading of the Congressional Record if this original source is referred to, and precise knowledge of what the import of a given amendment is.

9. Signing of the NASA Authorization Act or the Independent Offices Appropriation Act may generate a statement by the President on space policy.

10. After the legislative process is complete in Congress each year, NASA adjusts its Operating Plan in accordance with the authorizations and the funding, and after formal apportionment of appropriated funds to NASA by the Bureau of the Budget. (Originally the Operating Plan for a given fiscal year is the same as the President's Budget request, but adjustments are necessary in such a dynamic effort as the space program over a period of time, in addition to the changes required by Congress.)

---

*Because the NASA Authorization Act was delayed, there was a separate appropriation act for NASA for FY 1968. NASA's appropriation for FY 1969 was in the Independent Offices and Department of Housing and Urban Development Appropriation Act.

NASA's final Operating Plan may then be submitted to the authorization Committees of Congress, and may be made the subject of a special hearing. (For example, the Senate Committee on Aeronautical and Space Sciences held hearings on the NASA Operating Plan for FY 1968 and published a printed record.)

The annual budgetary process, ending in an adequate appropriation, is essential to the success of any government undertaking. This is obvious. For NASA, however, the budgetary process in the 1960's has probably been a much more important part of the agency's life and history than for most federal institutions or endeavors.

Here are some of the reasons why this was so:

The level of NASA's budget was directly related to the national policy of achieving and maintaining pre-eminence in space exploration and use.

The effort required to be pre-eminent in space was dependent, of course, on the current efforts, the successes and failures, and the long range plans of the Soviet Union, which were often obscure and usually open to conflicting interpretations.

NASA programs have been dynamic and fluid; they could not always be defined with precision as to cost or schedule, even for Congress; yet they often required what amounted to long-range commitments for spending over a number of years.

There were certain levels of funding for major NASA programs which had to be maintained for reasons of efficiency and economy, as well as for attainment of established national goals. These levels were difficult for NASA to define; and more difficult for NASA to explain to Congress.

Sometimes heavy funding commitments had to be asked of Congress for a vital program while the program was temporarily (but quite publicly) faced with technological or managerial problems. The Ranger program or the Centaur rocket program are examples.

In the mid-Sixties it became necessary for NASA to seek commitments and funding for major new programs for the future even while the biggest bills for current programs were still coming due; and while the success of the most important current program, Apollo, was yet to be demonstrated.

Both the policy of pre-eminence itself and the major goal set to help achieve it (the Apollo lunar landing in this decade) remained controversial, subject to the influence of day-to-day events, and open to public debate at many points each year during the budgetary process.

NASA's budget debates came to involve fundamental contradictions, real and artificial, between peaceful uses of space for all mankind and national security; between possibly competing or duplicating civil and military programs; between current and long-range needs; between so-called earth needs and space needs; and between relative priorities for near-earth space and exploration of the moon and planets.

NASA's most critical budget years, so far as starting new programs for the 1960's was concerned, coincided with the rising costs of the war in Viet Nam, the political question of increased taxes versus decreased expenditures, and increased national interest in greater federal spending on education, welfare, and urban affairs.

Congressional hearings on NASA budgets have been used by Webb as a principal forum for elaborating NASA policy and explaining NASA's ongoing programs and future plans.

From the foregoing it can be seen that the budgetary process in NASA is an important part of NASA's history involving NASA's relations with both White House and Congress, and with the all-important element of public opinion.

SUMMARY OF ACTIONS ON THE NASA BUDGET

- FY 1964 to FY 1969 -

SUMMARY OF ACTIONS ON THE NASA BUDGET -- FY 1964

NASA's Recommendations to the President: NASA prepared four different "schedules of operation" at levels of about $5.2 billion, $5.6 billion, $6.2 billion, and $6.6 billion. NASA recommended the $6.2 billion level. (See NASA budget briefing transcript, pages 21-22.)

NASA Budget Briefing was held January 16, 1963. Transcript and background material available.

President's Budget requested $5,712,000,000 for NASA (new obligational authority).

Congress authorized $5,350,820,400. Public Law 88-113 signed by President Kennedy September 6, 1963.

House Committee approved $5,238,119,400; House voted $5,203,719,400. Roll call vote, 335-57.
Senate Committee approved $5,511,520,400; Senate voted $5,511,520,400. Voice vote.

Congress appropriated $5,100,000,000. Public Law 88-215 signed by President Johnson December 19, 1963.

House Committee approved $5,100,000,000; House voted $5,100,000,000. Roll call vote, 302-32.
Senate Committee approved $5,190,000,000; Senate voted $5,100,000,000. Roll call vote, 72-1.

NASA Operating Plan submitted to Congress on January 15, 1964. (Webb letters to Speaker of House and President of Senate)

Authorization Hearings:

House Committee on Science and Astronautics opened authorization hearings on March 4, 1963. Printed record in 1964 NASA Authorization, 4 parts, 3,540 pages. Index in Part 4.

(House posture hearings were held during week of February 25th. Printed record in Space Posture, 238 pages. A staff report was prepared by Joseph M. Felton entitled Posture of the National Space Program, 68 pages.)

Senate Committee on Aeronautical and Space Sciences opened authorization hearings on April 24, 1963. Printed record in NASA Authorization for Fiscal Year 1964, 2 parts, 1,154 pages.

(Testimony of scientists on goals of the nation's space program was heard on June 10 and June 11, 1963. The record of these hearings was published separately under the title, Scientists' Testimony on Space Goals, 260 pages.

Appropriations Hearings:

House Appropriations Subcommittee opened hearings on August 19, 1963. Printed record in "Independent Offices Appropriations for 1964," Part III, 653 pages.

Senate Appropriations Subcommittee opened hearings on October 18, 1963. Printed record in "Independent Offices Appropriations, 1964," Part II, 121 pages.

Legislative History, Authorization:

House Reports: No. 591, Committee on Science and Astronautics
No. 706, Committee of Conference
Senate Report: No. 385, Committee on Aeronautical and Space Sciences

Congressional Record, Vol. 109 (1963):
Aug. 1 : Considered and passed House.
Aug. 7,8: Considered in Senate.
Aug. 9 : Considered and passed Senate, amended.
Aug. 26 : Conference report submitted in House.
Aug. 28 : Conference report agreed to by House and Senate.

Legislative History, Appropriation:

House Reports: No. 824, Committe on Appropriations
No. 1004, Committee of Conference
Senate Report: No. 641, Committee on Appropriations

Congressional Record, Vol. 109 (1963):
Oct. 10: Considered and passed House.
Nov. 19: Considered in Senate.
Nov. 20: Considered and passed Senate, amended.
Dec. 10: House agreed to conference report and concurred in certain Senate amendments.
Dec. 10: Senate adopted conference report, agreed to certain House amendments and receded from Senate amendment 92.

Amendments to Authorization Bill:

House:
Pelly (R-Wash.) amendment to reduce from $25 million to $15 million funds for facility planning and desing, accepted by voice vote.

Weaver (R-Pa.) amendment to eliminate $4,640,000 authorized for establishment of a NASA life sciences research unit at Ames Laboratory, Moffett Field, California, and instead to authorize appropriation of $2 million for expansion of either of two existing facilities -- at Wright-Patterson Field, Ohio, or Brooks Medical Center, Texas, defeated, standing vote 63-67 and subsequently by teller vote 102-107.

Roudebush (R-Ind.) amendment to reduce the $55 million recommended for facility, training, and research grants to $30.6 million, accepted, teller vote 140-129.

Wydler (R-N.Y.) amendment to prohibit use of funds for an electronic research center until NASA administrator submitted a study of the location of, need for, and nature of the center, defeated, standing vote 64-111.

Senate:

Anderson (D-N.M.) amendment to prohibit use of funds authorized by the bill to provide services for the exclusive benefit of anyone providing communications satellite services, other than a Government agency, except at that person's request and on a reimbursable basis, accepted, roll call vote, 60-11.

Kefauver (D-Tenn.) amendment to require that any person, other than a Government agency, providing communications satellite services, for whom the Government provides advice, information, or research and development, be obligated by a contract approved by the Comptroller General to reimburse the Government for a proportionate share of those services. Accepted by voice vote as amended by Anderson substitute (above).

Miller (R-Iowa) amendment to require written approval of the location of an electronics research center by the House Science and Astronautics Committee and Senate Aeronautical and Space Sciences Committee before funds could be expended for the center, accepted, voice vote.

Gruening (D-Alaska) amendment to permit use of funds authorized in the bill to pay the costs of technical assistance or research and development in behalf of a person, other than a Government agency, engaged in providing communications satellite services, only with the stipulation that the person had signed a contract to reimburse the Government for a proportionate share of such costs, defeated, voice vote.

Lausche (D-Ohio) amendment to reduce all funds to the level authorized by the House, defeated, roll call, 32-37.

Curtis (R-Neb.) amendment to prohibit use of any funds for an electronics research center, pending NASA's transmission and Congressional approval of results of a study of the need for, the nature of, and plans for such a center, defeated, roll call vote

Amendments to Appropriations Bill:

House:

Pelly (R-Wash.) amendment to prohibit the use of funds appropriated to NASA for promoting or financing a manned lunar landing to be carried out jointly by the United States and any Communist country. Standing vote, 99-93; teller vote, 125-110; accepted.

Wyman (R-N.H.) amendment to reduce by $700 million -- $550 million from Project Apollo and $150 million from lunar and planetary exploration programs -- National Aeronautics and Space Administration funds appropriated for research and development, defeated, standing vote, 47-132.

Wydler (R-N.Y.) amendment to reduce by $3,900,000 NASA funds appropriated for construction of facilities and provide that no part of the remaining funds be used for construction of an Electronic Research Center. (Its proposed location in Boston caused controversy in consideration of the NASA authorization bill.), defeated, voice vote.

Senate:

Proxmire (D-Wis.) amendment to reduce NASA funds by $90 million -- $80 million from research and development and $10 million from facilities construction, accepted, roll call vote, 40-39.

Anderson (D-N.M.) amendment to prevent use of NASA funds for construction of any facility costing more than $250,000 until the House and Senate space committees have had a full report on the facility before them for 30 days, accepted, voice vote.

Fulbright (D-Ark.) amendment to reduce NASA funds by 10 percent across-the-board, or $519 million -- $400,600,000 from research and development; $69 million from facilities construction; and $49,400,000 from administrative operations, defeated, roll call vote, 36-46.

SUMMARY OF ACTIONS OF THE NASA BUDGET -- FY 1965

NASA's Original Request to Bureau of the Budget was $5.9 billion. (See NASA Budget Briefing transcript, page 12.)

NASA Budget Briefing was held January 15, 1964. Transcript and background material available.

President's Budget for 1965 requested $5,304,000,000 for NASA, plus a supplemental appropriation of $141,000,000 under the FY 1964 authorization.

Congress authorized $5,227,506,000. Public Law 88-369 signed by President Johnson July 11, 1964.

House Committee approved $5,193,810,500; House voted $5,193,810,500. Roll call vote, 283-73.
Senate Committee approved $5,246,293,250; Senate voted $5,246,293,250. Roll call vote, 78-3.

Congress appropriated $5,250,000,000 including a $72.5 million supplemental appropriation under the FY 1964 authorization. Public Law 88-507 signed by President Johnson August 30, 1964.

House Committee approved $5,200,000,000; NASA appropriation not in bill as passed by House.
Senate Committee approved $5,300,000,000; Senate voted $5,300,000,000. Voice vote.

NASA Operating Plan submitted to Congress on March 1, 1965. (Webb letters to Speaker of the House and President of the Senate)

Authorization Hearings:

House Committee on Science and Astronautics opened authorization hearings on February 4, 1964. Printed record in "1965 NASA Authorization." In 4 parts, 2840 pages. Separate Index.

Senate Committee on Aeronautical and Space Sciences opened authorization hearings on March 4, 1964. Printed record in "1965 NASA Authorization." Two parts, 800 pages.

Appropriations Hearings:

House Appropriations Subcommittee opened hearings on April 7, 1964. Printed record in "Independent Offices Appropriations for 1965," Part 2, 402 pages.

Senate Appropriations Subcommittee opened hearings on July 9, 1964. Printed record in "Independent Offices Appropriations, 1965," Part 2, 181 pages.

Legislative History, Authorization:

House Reports: No. 1240, Committee on Science and Astronautics
No. 1529, Committee of Conference
Senate Report: No. 1054, Committee on Aeronautical and Space Science

Congressional Record, Vol. 110 (1964):
- March 25: Considered and passed House.
- June 22: Considered and passed Senate, amended.
- June 23: Senate requested House to return H.R. 10456 in order to reconsider vote.
- June 24: Reconsidered and passed Senate, amended.
- July 2: House and Senate agreed to conference report.

Legislative History, Appropriation:

House Reports: No. 1413, Committee on Appropriations
No. 1781, Committee of Conference
Senate Report: No. 1269, Committee on Appropriations

Congressional Record, Vol. 110 (1964):
- May 20, 21: Considered in House
- May 21 : Passed House
- Aug. 5 : Considered and passed Senate, amended.
- Aug. 13 : House agreed to conference report with certain amendments.
- Aug. 14 : Senate agreed to conference report; concurred in House amendments.

NASA Statement on Appropriations Bill issued on September 3, 1964. News Release No. 64-221.

Amendments to Authorization Bill:

House:

Fulton (R-Pa.) motion to recommit with instructions to add provision establishing NASA Inspector of Programs and Operations, defeated by voice vote.

Rumsfeld (R-Ill.) on behalf of John W. Wydler (R-N.Y.) amendment to delete $10 million earmarked for initial construction work on an Electronics Research Center in the Boston area, defeated, standing vote, 66-116.

Reuss (D-Wis.) amendment to eliminate $24.7 million earmarked for research on a supersonic transport plane, defeated, standing vote, 26-109.

Senate:

Fulbright (D-Ark.) amendment to reduce Project Apollo funds by $267,750,000 (10 percent) to $2,409,750,000, defeated roll call vote, 38-42.

Amendments to Appropriations:

House:

The House never voted on the NASA portion of the appropriation as such, since the authorization bill was then pending. For purposes of discussion in conference, the House Space Committee figure was used.

Senate:

Proxmire (D-Wis.) amendment to reduce National Aeronautics and Space Administration funds by $100 million, to $5.2 billion, defeated, roll call vote, 20-69.

SUMMARY OF ACTIONS ON THE NASA BUDGET -- FY 1966

NASA Budget Briefing was held January 22, 1965. Transcript and background material available.

President's Budget for 1966 requested $5,260,000,000 for NASA.

Congress authorized $5,190,396,200. Public Law 89-53 (H.R. 7717) signed by President Johnson June 28, 1965.

House Committee approved $5,183,844,850; House voted $5,183,844,850. Roll call vote, 389-11.
Senate Committee approved $5,196,826,350; Senate voted $5,196,826,350. Roll call vote, 79-4.

Congress appropriated $5,175,000,000. Public Law 89-128 (H.R. 7997) signed by President Johnson August 16, 1965.

House Committee approved $5,160,000,000; House voted $5,160,000,000. Voice vote.
Senate Committee approved $5,190,305,200; Senate voted $5,190,305,200. Roll call vote, 84-2.

NASA Operating Plan submitted to Congress and February 1, 1966. (Webb letters to Speaker of the House and President of the Senate.)

Authorization Hearings:

House Committee on Science and Astronautics opened authorization hearings on February 17, 1965. Printed record in "1966 NASA Authorization, 4 parts, 3,344 pages.

Senate Committee on Aeronautical and Space Sciences opened authorization hearings on March 8, 1965. Printed record in "NASA Authorization for Fiscal Year 1966," 3 parts, 1,117 pages. Part 3 contains "Post Apollo Planning Documents."

Appropriations Hearings:

House Appropriations Subcommittee opened hearings on April 5, 1965. Printed record in "Independent Offices Appropriations for 1966," part 2, 423 pages.

Senate Appropriations Subcommittee opened hearings on June 16, 1965. Printed record in "Independent Offices Appropriations, 1966," 101 pages.

Legislative History, Authorization:

House Reports: No. 273, Committee on Science and Astronautics
No. 514, Committee of Conference
Senate Report: No. 188, Committee on Aeronautical and Space Sciences

Congressional Record, Vol. 111 (1965):
May 6: Considered and passed House.
June 1: Considered in Senate.
June 2: Considered and passed Senate, amended.
June 16: House and Senate agreed to conference report.

Legislative History, Appropriation:

House Reports: No. 320, Committee on Appropriations
No. 727, Committee of Conference
Senate Report: No. 384, Committee on Appropriations

Congressional Record, Vol. 111 (1965):
May 11: Considered and passed House.
July 12: Considered in Senate.
July 13: Considered and passed Senate, amended.
Aug. 5: House and Senate agreed to conference report.

Amendments to Authorization Bill:

House:
There were no amendments.

Senate:
Long (D-La.) amendment to permit the NASA Administrator to waive U.S. property rights in inventions made under NASA contracts if he determines that an inventor has sufficient equity in an invention not financed by the Government, and that the waiver would "promote substantially" the use of the invention in the national interest, tabled, roll call vote, 59-26.

Amendments to Appropriations Bill:

House:
There was no NASA-related amendment.

Senate:
Proxmire (D-Wis.) amendment to reduce NASA appropriations by 5 percent, defeated, roll call vote, 16-61.

SUMMARY OF ACTIONS ON THE NASA BUDGET -- FY 1967

NASA's Original Recommendation to the Bureau of the Budget was $5.58 billion. NASA reviewed with the BOB programs ranging from $4.8 to $5.58. (See NASA Budget Briefing transcript, page 20.)

NASA Budget Briefing was held January 22, 1966. Transcript and background material available.

President's Budget for 1967 requested $5,012,000,000 for NASA.

Congress authorized $5,000,419,000. Public Law 89-528 (H.R. 14324) signed by President Johnson August 5, 1966.

House Committee approved $4,986,864,150; House voted $4,986,864,150. Roll call vote, 349-10.
Senate Committee approved $5,008,000,000; Senate voted $5,008,000,000. Voice vote.

Congress appropriated $4,968,000,000. Public Law 89-555 (H.R. 14921) signed by President Johnson September 6, 1966.

House Committee approved $4,950,000,000; House voted $4,950,000,000. Roll call vote, 297-82.
Senate Committee approved $4,991,600,000; Senate voted $4,991,600,000. Roll call vote, 82-2.

NASA Operating Plan submitted to Congress on January 23, 1967. (Webb letters to Speaker of House and President of Senate)

Authorization Hearings:

House Committee on Science and Astronautics opened authorization hearings on March 10, 1966. Printed record in "1967 NASA Authorization," 4 parts, 3,241 pages, separate index.

Senate Committee on Aeronautical and Space Sciences opened authorization hearings on February 23, 1966. Printed record in "NASA Authorization for Fiscal Year 1967," 1 part, 717 pages.

Appropriations Hearings:

House Appropriations Subcommittee opened hearings on April 4, 1966. Printed record in "Independent Offices Appropriations for 1967," part 2, 362 pages.

Senate Appropriations Subcommittee opened hearings on May 19, 1966. Printed record in "Independent Offices Appropriations, 1964," part 1, 118 pages.

Legislative History, Authorization:

House Reports: No. 1441, Committee on Science and Astronautics
No. 1748, Committee of Conference
Senate Report: No. 1184, Committee on Aeronautical and Space Science

Congressional Record, Vol. 112 (1966):
May 3: Considered and passed House.
May 23: Considered in Senate.
May 24: Considered and passed Senate, amended.
July 21: House agreed to conference report.
July 22: Senate agreed to conference report.

Legislative History, Appropriation:

House Reports: No. 1477, Committee on Appropriations
No. 1859, Committee of Conference
Senate Report: No. 1433, Committee on Appropriations

Congressional Record, Vol. 112 (1966):
May 10: Considered and passed House.
Aug. 8,9: Considered in Senate.
Aug. 10: Considered and passed Senate, amended.
Aug. 18: House agreed to conference report, concurred certain Senate amendments with amendments, and insisted on its disagreement with one other Senate amendment.
Aug. 24: Senate agreed to conference report, concurred in House amendments, and receded from its amendment with which House was in disagreement.

Amendments to Authorization Bill:

House:

Fulton (R-Pa.) amendment to reduce the authorization for Apollo by $41.9 million to eliminate "Apollo applications programs," defeated, voice vote.

Fulton (R-Pa.) amendment to reduce the $8 million authorization for "advanced missions programs" to $3 million, defeated, voice vote.

Fulton (R-Pa.) amendment to reduce funds for the Manned Spacecraft Center, Houston, by $9.1 million to eliminate authorization for a "Lunar Receiving Laboratory," defeated, standing vote, 21-33.

Fulton (R-Pa.) amendment to reduce to $1.9 million the existing $11.9 million authorized in previous years but not appropriated for NASA Facility Planning and Design, defeated, standing vote, 23-34.

Wydler (R-N.Y.) amendment to earmark $20 million in NASA research and development funds for research into the reduction of aircraft noise, defeated, standing vote, 27-64.

Senate:

There were no amendments.

Amendments to Appropriations Bill:

House:

Gross (R-Iowa) amendment to provide that none of NASA's design and construction funds be used to construct a lunar-sample laboratory, defeated by voice vote.

Senate:

Proxmire (D-Wis.) amendment to reduce by 10 percent the $4,991,600,000 appropriation for the National Aeronautics and Space Administration, to be allocated among specific items by the Treasury Secretary and the Budget Director, defeated, roll call vote, 18-65.

Proxmire (D-Wis.) amendment to reduce appropriations for NASA by $156,600,000 as follows: $116.6 million, research and development; $20 million, construction of facilities; $20 million, administrative operations, defeated, roll call vote, 31-52.

SUMMARY OF ACTIONS ON THE NASA BUDGET -- FY 1968

NASA Budget Briefing was held January 21, 1967. Transcript and background material available.

President's Budget for 1968 requested $5,050,000,000 for NASA. An additional $50 million was later requested for Nerva II.

Congress authorized $4,865,751,000. Public Law 90-67 (S. 1296 signed by President Johnson August 21, 1967.

House Committee approved $4,992,182,000; House voted $4,927,182,000. Roll call vote, 342-53.
Senate Committee approved $4,851,006,000; Senate voted $4,851,006,000. Voice vote.

Congress appropriated $4,588,900,000. Public Law 90-131 (H.R. 12474) signed by President Johnson November 8, 1967.

House Committee approved $4,583,400,000; House voted $4,583,400,000. Roll call vote, 312-92.
Senate Committee approved $4,678,900,000; Senate voted $4,678,900,000. Roll call vote, 60-5.

NASA Operating Plan submitted to Congress on February 1, 1968. (Webb letters to Speaker of House and President of Senate.)

Authorization Hearings:

House Committee on Science and Astronautics opened authorization hearings on February 28, 1967. Printed record in "1968 NASA Authorization," 4 parts, 4,273 pages, separate index.

Senate Committee on Aeronautical and Space Sciences opened authorization hearings on April 18, 1967. Printed record in "NASA Authorization for Fiscal Year 1968," 2 parts, 1,031 pages. (Hearing also held on November 8, 1967. Printed record in "NASA's Proposed Operating Plan for Fiscal Year 1968." 40 pages.)

Appropriations Hearings:

House Appropriations Subcommittee opened hearings on April 12, 1967. Printed record in "Independent Offices Appropriations for 1968," part 3, 420 pages. (Additional hearings held August 15, 1967. Printed record in "NASA Appropriations for 1968," 59 pages.)

Senate Appropriations Subcommittee opened hearings on July 26, 1967. Printed record in "NASA Appropriation for Fiscal Year 1968," 209 pages.

Legislative History, Authorization:

House Reports: No. 338, Committee on Science and Astronautics
No. 535, Committee of Conference
Senate Report: No. 353, Committee on Aeronautical and Space Sciences

Congressional Record, Vol. 113 (1967):
June 22, 27, 28: Considered and passed House, amended, in lieu of H.R. 10340.
June 27, 28 : Considered and passed Senate.
Aug. 2 : Senate agreed to conference report.
Aug. 8 : House agreed to conference report.

Legislative History, Appropriations:

House Reports: No. 569, Committee on Appropriations
No. 804, and 823, Committee of Conference
Senate Report: No. 579, Committee on Appropriations

Congressional Record, Vol. 113 (1967):
Aug. 22 : Considered and passed House.
Oct. 6 : Considered and passed Senate, amended.
Oct. 23, 26: House and Senate considered and agreed to conference report.

Amendments to Authorization Bill:

House:

Roudebush (R-Ind.) amendment was offered as a substitute for pending Fulton amendment. Amendment to reduce Apollo Applications program by $65 million and make a corresponding reduction in the bill's grand total, accepted, teller vote, 110-83.

Fulton (R-Pa.) amendment, as amended by Roudebush amendment above, to cut the Apollo Applications program by $65 million, accepted, voice vote.

Hardy (D-Va.) amendment providing that after January 1, 1968, NASA could not renew, extend, or award a support service contract in excess of $100,000 unless the cost of service contract was not greater than cost of hiring employees directly, or unless the NASA Administrator determined that program success required contract employees, accepted, standing vote, 47-41.

Gross (R-Iowa) amendment to reduce total authorization by $1 billion, rejected, voice vote.

Roudebush (R-Ind.) amendment to reduce funds for University Training Grants program by $10 million, rejected, voice vote.

Ryan (D-N.Y.) amendment to reduce funds for the NERVA program from $70 million to $44,220,000 and delete the $16.5 million for construction of the Nuclear Rocket Development Station, Nevada, rejected, teller vote, 91-121.

Rumsfeld (R-Ill.) amendment to establish an Aerospace Safety Advisory Panel, rejected, teller vote, 101-106.

Ryan (D-N.Y.) amendment to reduce funds for a number of NASA programs with a combined total cut of $75,327,000, rejected, voice vote.

Senate:

Percy (R-Ill.) amendment to require NASA Administrator to keep Congress "fully and currently informed" regarding all NASA activities, rejected, roll call vote, 32-51.

Proxmire (D-Wis.) amendment to reduce total authorization by $316,811,000, rejected, roll call vote, 35-50.

Proxmire (D-Wis.) amendment to reduce total authorization by $98,284,000, rejected, roll call vote, 38-46.

Amendments to Appropriations Bill:

House:

Ryan (D-N.Y.) amendment to reduce the Research and Development appropriation by $100 million, rejected, voice vote.

Ryan (D-N.Y.) amendment to reduce the Administrative Operations appropriation by $37 million, rejected, voice vote.

Senate:

Proxmire (D-Wis.) amendment to reduce the Research and Development appropriation by $81 million and the Construction of Facilities appropriation by $19.5 million, rejected, roll call vote, 30-36.

Williams (R-Del.) amendment to reduce the Research and Development appropriation by $26 million, rejected,roll call vote, 31-34.

SUMMARY OF ACTIONS ON THE NASA BUDGET -- FY 1969

NASA Budget Briefing was held January 27, 1968. Transcript and background material available.

President's Budget for 1969 requested $4,370,400,000 for NASA.

Congress authorized $4,013,073,000. Public Law 90-373 (H.R. 15856) signed by President Johnson July 3, 1968.

House Committee approved $4,217,323,000; House voted $4,031,423,000. Roll call vote, 262-105.
Senate Committee approved $4,150,560,000; Senate voted $4,013,073,000. Roll call vote, 66-4.

Congress appropriated $3,995,273,000. Public Law 90-550 (H.R. 17023) signed by President Johnson October 4, 1968.

House Committee approved $4,008,223,000; House voted $4,008,223,000. Roll call vote, 353-37.
Senate Committee approved $4,008,223,000; Senate voted $4,008,223,000. Roll call vote, 74-0.

Authorization Hearings:

House Committee on Science and Astronautics opened authorization hearings on February 7, 1968. Printed record in "1969 NASA Authorization," 4 parts, 2,327 pages, separate index.

Appropriations Hearings:

House Appropriations Subcommittee opened hearings on March 11, 1968. Printed record in "Independent Offices and Department of Housing and Urban Development Appropriations for 1969," part 2, 401 pages.

Senate Appropriations Subcommittee opened hearings on May 17, 1968. Printed record in "Independent Offices and HUD Appropriations, 1969," Part 1, Pages 166.

Legislative History, Authorization:

House Report: No. 1181, Committee on Science and Astronautics

Senate Report: No. 1136, Committee on Aeronautical and Space Sciences

Congressional Record, Volume 114 (1968):
May 2: Considered and passed House.
June 6, 10: Considered and passed Senate, amended.
June 18: House concurred in Senate amendements.

Legislative History, Appropriations:

House Report: No. 1348, Committee on Appropriations

Senate Report: No. 1375, Committee on Appropriations

Congressional Record, Vol. 114 (1968):
May 8: Considered and passed House.
July 18: Considered and passed Senate.
September 19: Agreed to Conference Report
September 25: Agreed to Conference Report

Amendments to Authorization Bill:

House:

Fulton (R-Pa.) amendment to reduce Apollo Applications program authorization from $395.6 million to $253.2 million, accepted, voice vote.

Roudebush (R-Ind.) amendment to reduce Administrative Operations from $646,673,000 to $603,173,000, accepted, voice vote.

Wolff (D-N.Y.) amendment to require the contractor or subcontractor on all non-competitive contracts for less than $25,000 to certify that the prices charged were no higher on a per-unit basis than the prices charged other customers, accepted, voice vote.

Pelly (R-Wash.) amendment to prohibit funds appropriated under the authorization bill from being used to pay NASA employees convicted of inciting, promoting, or carrying on a riot, accepted, voice vote.

Ryan (D-N.Y.) amendment to reduce Apollo Applications program from $395.1 million to $253.1 million, rejected, standing vote, 5-27.

Ryan (D-N.Y.) amendment to restrict the use of funds under Apollo Applications to 50 percent of the amount authorized, unless the NASA Administrator provided Congress with two alternative post-Apollo programs, one emphasizing manned and the other unmanned missions, rejected, voice vote.

Ryan (D-N.Y.) amendment to require NASA to keep Congress "fully and currently informed" regarding any contract for over $10 million in which costs exceed projected costs by over 15 percent, any program with an annual funding level of $25 million or more in which schedule slippage exceeds three months, and any instance in which a high level management review of a program is undertaken, rejected, voice vote.

Ryan (D-N.Y.) amendment to require NASA to submit budget requests reflecting total program costs (including all relevant costs reflected in the budget of a program office other than the one administering the program) beginning in FY 1969, rejected, voice vote.

Curtis (R-Nebr.) amendment to prohibit use of Research and Development funds for grants to universities and colleges which bar U. S. armed forces recruiters from their campuses, accepted, voice vote.

Cannon (D-Nev.) amendment to strike the provision of the pending Proxmire-Williams amendment (see below) which would have cut funds for NERVA I, accepted, voice vote.

Proxmire (D-Wis.) and Williams (R-Del.) amendment to reduce each item (except NERVA, above) to the lower of the House-passed or Senate-reported figures, thereby cutting the bill by $137,187,000 below the Senate Committee recommendation, accepted, roll call vote, 44-25.

Proxmire (D-Wis.) and Williams (R-Del.) amendment to limit NASA expenditures in FY 1969 to $3,370,400,000, rejected, roll call vote, 33-38.

Amendments to Appropriations Bill:

House:

Wyman (R-N.H.) amendment to prohibit payment of NSF fellowships or other benefits to any person willfully refusing to obey a lawful regulation of his college or employee, accepted, voice vote.

Broyhill (R-Va.) amendment to prohibit use of funds appropriated by the bill for payment of salary to a Federal employee convicted of rioting or any illegal group activity resulting in personal or property injury, accepted, voice vote.

Senate:

Williams (R-Del.) amendment to reduce the NASA Research and Development appropriation from $3,370,300,000 to $3,070,300,000, rejected, roll call vote, 34-52.

NEWS NASA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

TELS. WO 2-4155
WO 3-6925

FOR RELEASE: UPON DELIVERY
Monday
September 30, 1968

Address
by
James E. Webb, Administrator
National Aeronautics and Space Administration

John Diebold Lecture on
Technological Change and Management
Harvard University Graduate School of Business Administration
Boston, Massachusetts
September 30, 1968

NASA AS AN ADAPTIVE ORGANIZATION

These are uncertain and unusual times. The war in Vietnam, the peace talks in Paris, the problems that face our cities, new alarms as to Soviet intentions, the problems of inflation, of the balance of payments, and the uncertainties of an election year -- taken together and interacting -- place us all in a position from which it is most difficult to chart a clear and certain course for the future. Almost every important national and regional enterprise is proceeding through a series of adjustments and readjustments as our economic, political and social systems move to resolve the problems with which we are faced. And most local enterprises cannot go forward independent of national and regional conditions.

The National Aeronautics and Space Administration is no exception. In its research and development activities in aeronautics and space, adjustments to the needs of these times have taken the form of sharp reductions in our budget and programs and the initiation of a series or organizational and personnel changes designed to provide both continuity and vigorous leadership during this period of transition.

In this fiscal year NASA is conducting important tests and flying out a number of vitally important missions started during the buildup period since 1961. With very few exceptions we are not initiating work on new ones. Work on the Apollo program is now nearing the home stretch. We are in the countdown stage for a series of Saturn V flights that will culminate in the first manned moon landing and exploration. Activities in other areas have had to be curtailed, and many projects reduced in scope. Other work has been deferred to future years. I believe NASA will prove that its organizational pattern is an adaptive one.

The development of programs to use the Apollo equipment after the lunar landing for practical uses is funded at less than one-third the amount we had anticipated in our 1969 budget of last January. Therefore, the Apollo applications flight program will be delayed and limited to one Saturn I workshop and one Apollo telescope system, with a backup for each. Work toward post-Apollo lunar exploration and toward an earth orbiting Saturn V workshop will be severely limited. Production of Saturn IB launch vehicles will be terminated, and -- as things now stand -- the production of Saturn V's will be stopped after completion of 15 vehicles.

The plan submitted last January for a Mars mission in 1973 is being revised to conform to our reduced funding levels. The payload to be landed on Mars and the scientific return will be substantially less than was included in our budget request.

In the nuclear propulsion field, development of a flight qualified rocket engine will not begin this year. To preserve an option to initiate this development in fiscal year 1970, a cadre of design and development personnel will be retained. Work in advanced nuclear technology will be continued and one experimental engine will be tested.

In aeronautics, the X-15 and B-70 program of experimental test flights will be terminated. A number of development projects in short and vertical takeoff and in supersonic and hypersonic fields will be phased down.

An overall measure of the burden of adapting the NASA organization to the drastic reductions that are being effected is the fact that by the end of this fiscal year the work force will be down to just over 200,000, a level of about one-half that of three years ago. The 200,000 people who are being extruded from the program are for the most part not government employees -- over 90% of them are in industrial plants and laboratories. This spreads the burden of adaptation quite broadly throughout the aerospace industry.

These reductions in the level of research and development work in the fields of aeronautics and space will have many serious effects on the U. S. position in science and technology, and in time on our status and prospects as a great power. But the ones to which we are adapting this year are only the most recent in a series of cutbacks that constitute in total what may be called a national decision. This decision has been in the making since 1964. It is that the United States will not at this time take the steps necessary to use the trained manpower and capital plant which we have built up to continue the advances of recent years in the scientific and engineering fields essential for success in space and aeronautics.

Looked at in another way, the decision means that the United States is not pursuing, for the time being at least, its goal of "preeminence in space." The USSR is quite evidently stepping up its efforts at the same time that we are curtailing our own. At the time that our production of the large Saturn boosters grinds to a halt, the Soviets will be bringing on stream their large new booster. While our plans for a Saturn V orbiting workshop remain on ice, the Soviets will be able to proceed with their long-heralded, multi-manned and multi-purpose space station. At present levels, the launching of planetary probes and deep space exploration in the early 1970s will be left to the almost exclusive domain of the USSR. The US is accepting for a long time, perhaps for the indefinite future, both the advantage of expenditure reduction and the disadvantages of a second-rate position in space. In aeronautical research and development the situation is not the same, but is still a cause for serious concern.

While I would be remiss if I did not thus emphasize the consequences that will flow from recent decisions, I recognize that the totality of the problems our nation faces reaches far beyond NASA. As responsible government officials, we in NASA accept the result of our nation's decision-making process. We know that our immediate job is to achieve success in the mission started in past years and now nearing completion. We accept the necessity of adjusting our organization, programs, contracts, university grants, and facilities to meet the reductions that have been decided on. In the process, we will do all we can to maintain a firm foundation on which we can build in the future.

As I say this, let me make very clear that NASA is still in business; and it will stay in business. We view what is happening not as a defeat but as a challenge of the times and we are moving to meet this challenge by assuring continuity in our senior management group and continuing a hard-hitting, technically sound program aimed at keeping open a wide range of options for use when the nation decides to resume its advance as a spacefaring nation. We are making the necessary adjustments now and we are also preparing a base for the nation's longer term requirements.

In connection with conditions essential to continuity, I should stress that the events of the past few months, while they have led to reduced levels of support, have nevertheless shown that there exists throughout the country a strong continuing core of support for research and development in both space and aeronautics. When one considers the whole array of problems now facing the Congress and the nation, and the fact that all national programs, needs, and priorities are being adjusted, it must be taken as significant that both the legislative and executive branches are standing firm at a four billion dollar level for the 1969 NASA budget. I think this shows a recognition of the need to continue a major effort in aeronautics and space.

Also, among thoughtful people in the country at large, I do not find a decline in public support for the space program. Rather, many feel we are in a period in which attention has been focused on other serious needs and problems. The problems of how we stand in the world, including our position in Southeast Asia, and the problems faced by the cities have been with us for many years. But it was not until these approached major points of crisis that demands were made for major commitments of resources extending over a long period of years. We in NASA saw much the same thing happen with Sputnik and with Gagarin. This phenomenon has been called "decision by crisis." The result is that many people who in the years following 1961 ascribed to space needs a special, top priority status are now realizing, as the national leadership in the space program has understood all along, that the space program must be regarded as only one of a number of essential activities of high priority to which the country must devote substantial resources. In my opinion, what may appear to some to be a decline in public support is not a changed attitude toward space, but a reflection of a new awareness of other high priority problems and requirements. This may well lead to the recognition that many of the other newly seen problems can best be approached and actions to solve them taken within the framework of NASA's experience with the organization of large scale scientific and engineering efforts. The investments made in NASA may well add greatly to the value of investments we will have to make in these other fields.

Whatever differences there may be among us as to the wisdom of our efforts in space, no one can deny that these have produced results that few would have thought possible a decade ago. In June of 1957 in a commencement address at Colorado College I thought to stimulate the graduates by repeating a speculative timetable for space exploration that Mr. J. S. McDonnell of St.Louis had laid out two weeks before at the Missouri School of Mines. I quoted Mr. McDonnell in these terms:

> "In about a dozen years or so, we will launch a satellite that will circle the earth and moon.
>
> "By about 1980, we will have made sufficient advances to permit the launching of a satellite that will circle the earth and Mars.
>
> "By about 1990, we can go forward to the point of launching a space ship carrying human beings which will circle the earth for an extended period as a satellite and return safely."

Today we all know that in quoting Mr. McDonnell on that June day in 1957, I underestimated what both the USSR and the US could do. Four months later Sputnik flew and in four years Gagarin had circled the earth and returned -- not in the year 1990 but in 1961.

It was just seven years four months and five days ago that President Kennedy summoned this nation to an expanded and accelerated effort to achieve for the United States the status of a spacefaring nation second to none. What has been done in these seven years?

We could spend many hours on the answer to this question. And it would be a pleasant exercise, for I am immensely proud of the record of NASA's performance.

We could review the Mercury program from Alan Shepard through John Glenn to Gordon Cooper. We could show that this involved a tremendous and successful effort to take a military booster and man-rate it, to utilize the capability of the Atlas for astronauts instead of warheads. It would be easy to follow and dwell on Gemini, in which we flew 20 men in 20 months. In Gemini, we learned that men could live and work in space for 14 days, that they could walk in space, that they could join two space vehicles together, and that they could return to earth so accurately that the opening of their parachutes could be seen from a waiting ship.

We could spend much time on advances in space science. It would be easy to point to new findings about our earth and its relationship to the sun, to what we have learned of the moon and of Mars and Venus. In the area of space applications we could list many accomplishments and exciting prospects for bringing truly marvelous new tools to the service of man.

My purpose today precludes this detailed cataloging of space accomplishments. But it is important to get across an understanding of the <u>capabilities</u> we have built up, capabilities that are now in place, are serving our Nation's present needs and will have a long, useful life. A good way to do this is, I believe, to recall with you our launch activities during just one week of last year.

This week was the second in November 1967. Admittedly it was a full week. But what was done can be repeated and on an ever grander scale. The capabilities that made that week possible are lasting capabilities. We may never use those capabilities to the fullest, or even in large part, but they do exist and can be put to use if they are not permitted to deteriorate below the minimum for reactivation.

On Monday, November 6, we launched an Applications Technology Satellite -- the ATS III. This was put into an earth synchronous orbit over the South Atlantic, which means that the satellite hovers twenty-four hours a day over the same spot. It has over the intervening months been sending back color pictures of the earth and its atmosphere and serving as an experimental communications relay station. This machine will stay in position for a long time. It is continuously adding to our knowledge of the earth, its weather, the effects of the sun's energy on nature's processes here on earth, and how to increase efficiency in long distance communications.

The ATS III is the third member of the third generation of experimental weather observation satellites which have been launched within a five-year period. It ia also a member of the fifth generation of communications satellites, all launched since 1961.

In understanding and predicting weather, the measurements made by the ATS and other NASA experimental spacecraft, added to the twenty-four hours per day regular operations now performed by ESSA's space systems, are even at this early time in space development providing a handsome return on the time and money invested. Some continually transmit cloud-cover pictures as they circle the earth and any weather station in any nation or on any ship has only to use an inexpensive receiver to get this up-to-the-minute and on location weather information. This is one way our country says to every other country, every day, that we as a people want to use our new power over the forces of nature in a joint effort with them, with benefits to both of us, and not to threaten or to coerce them to follow some pattern laid down by us. It is our way of saying that we want to develop power together with them, not power over them.

Well, let's leave Monday and go to Tuesday, when our second launch of the week was Surveyor VI. Two days after launch this second generation lunar spacecraft made a soft landing on the moon and promptly began to transmit detailed pictures of a very rugged stretch of the lunar surface. This launch was one of a series of unmanned launches of automated systems that included Ranger and Lunar Orbiter, as well as Surveyor. You will remember the Rangers came directly in for a crash landing, taking large numbers of pictures of a limited area right up to the point of contact. Many of you, I suspect, saw the broadcast of the first Ranger coming in and heard that dramatic announcement, "live from the moon." The Ranger pictures provide astronomers with the equivalent detail of a telescope a thousand times more powerful than any previously available. As to Lunar Orbiters, there have been five, all of which were outstandingly successful. They circled the moon at about 27 miles, with the result that we now have a complete map of the moon, both front and back, with excellent resolution. We can now study any particular place for landing astronauts or to advance scientific knowledge.

The Surveyors are the soft-landers. They round out the work of the Lunar Orbiter and the Ranger. You have seen them on your television digging holes on the moon, making chemical analysis of the soil, blasting small craters with their jet engines. Surveyor VI that we launched on Tuesday, the 7th of November, 1967, was moved from one place to another -- in the first, very short but significant rocket flight on the surface of the moon, moving eight feet. Just as the Ranger pictures provide details 1,000 times more precise than earth-based telescopes, Surveyor pictures provide astronomers with a further improvement in resolution, by another factor of 1,000 times. So, with Ranger and Surveyor, the improvement in magnification is a thousand times a thousand, or a million. With this kind of new capability, the way is open for lunar and planetary investigations of a type and scope undreamed of before we learned to use the rocket technology. With this new capability, man will undoubtedly reach in close to the sun and out to the most distant regions of the solar system. In much the same way, rocket-launched instruments can provide data on cosmic rays, solar plasmas, the magnetic fields in space, and the relationships of these to the earth's magnetosphere.

Let us go on to Thursday, November 9, for the truly big shot of the week: the first test-launch of the Saturn V. This test was to make sure that this powerful booster could develop the full 7.5 million pounds of thrust which we will need when our Apollo astronauts start their round-trip journey to the moon or when we decide to send a 10,000 pound payload to Mars. A second objective was to make sure that the heat shield on the Apollo spacecraft could withstand the temperature, deceleration, and pressures of reentry into the earth's atmosphere at 25,000 m.p.h. A third was to make sure that the 500 million dollar Saturn-Apollo launch complex at Cape Kennedy and the global tracking and data acquisition network we have been building could handle the job of automatically launching this gigantic machine and remotely controlling its complex mission.

This Saturn V launch of November 9 demonstrated that we can have, when we decide to activate it, the big-booster capability and the launch rate capability in which we have been behind the U.S.S.R. It gave us assurance that the Apollo spacecraft can guide itself to a precise point of return and survive a reentry heat that is almost two times the melting point of steel, about $5,000^{\circ}$ F. It gave us assurance that the design, the construction andthe equipping of both the space and ground segments of the Saturn-Apollo System had been well done by the tens of thousands of construction and other workers put on the job by American industry.

Let us now turn to the last launch of the week--ESSA IV--on Saturday, November 11. This launch was from the Western Test Range in California. ESSA IV was launched into an orbit that passes near both the North and South Poles and is so synchronized with the rotation of the earth that it can observe and report on the entire earth's weather in daylight every 24 hours. This is known as a polar-retrograde orbit, so that as the earth turns the satellite progresses backward just enough so that it always passes over a point on the earth in maximum sunlight to take its pictures and make its measurements. This is also called a sun-synchronous orbit. The ESSA IV launch differs from the three launches described above in that it exemplifies not the pioneering we do at the frontier of technology and science, but the way in which space operations have become a routine contributor of essential services for the benefit of everyone. ESSA IV is a standard workhorse machine which the U.S. Weather Bureau uses in its day to day task of studying and forecasting the weather. It uses this satellite just as it uses weather reporting ships, planes and balloons. However, the utility of ESSA IV is far beyond any we can achieve in any other way. It works 24 hours a day, all around the world, and feeds information into something like 296 stations in the United States and about 86 in 45 other countries. It is truly a working bird.

The space capabilities demonstrated in the second week of November 1967 represent -- or can be parlayed into -- better than 90% of everything we would need to carry out almost any mission that even the most daring have placed on our space agenda for the next decade. The Saturn V-Apollo system for example, permits us to operate as far out as the moon with payloads of about 100,000 pounds. This distance requires about 98% of the energy it would take to operate out to any other place in the solar system; and it enables us to use all of the maneuvers needed anywhere in space -- the launch from earth, orbit around the earth, propulsion and guidance to reach another body in space, ability to slow down and go into orbit around another body, to land a payload on the surface of that body, and to return to earth either a part of the payload or the scientific measurements obtained.

How important are these capabilities? There are many different views on this question. Formy own part, I have no hesitancy as to my answer: I do not believe our Nation could have long continued as a great power if we had not built up the means to conduct operations in space -- if we had instead conceded a monopoly of this new dimension of man's activity to the USSR or any other country. I believe we would have sacrificed our chances to keep pace in the technological competition that is the crucial test of our times. We would have turned out backs on the opportunities space offers for large extensions of scientific knowlege. We would have denied to ourselves the tools and the knowledge necessary to bring to bear on the problems that beset us and the rest of mankind the benefits that surely will follow from the full development of space applications.

Of those who are skeptical of my view, I would simply ask: Had we not done the things necessary to develop these capabilities, how would the outside world look to us today? How would we look to the outside world? What would our people think of our leaders and of themselves? What would our future be?

I believe what we have done in space measures up in importance to any of the other great national accomplishments of our history. The space story, however, has another significance. There is, as suggested earlier, the matter of how as well as what. The way in which we have built up our space capabilities and what we have learned in the process about the requirements for success in such long-scale endeavors, and how well we adapt to the conditions of today may constitute as important a contribution to our Nation -- to its ability to move forward into the future -- as the space capabilities themselves.

In the NASA program, it has been demonstrated that a combination of hundreds of thousands of industry, university and government workers can coordinate their efforts successfully in the most complex of the large technical undertakings the human race has yet attempted. The fact that some 400,000 people with many varied skills have been brought together within the framework of our Nation's proven economic, social and political insitutions and have succeeded in accomplishing an extraordinarily complicated task is a matter of great consequence at a time when all nations are looking at us, and we are looking at ourselves, and asking how the other great and fateful tasks that loom so large before us.will be carried out.

To do what we have done in space, we have had to learn and apply new ways of organizing and administering human and material resources. Old ways were inadequate to meet the complicated problems of melding widely varying elements into a coherent, effectively functioning enterprise that could take into account the second and third order effects of its actions, as well as the primary ones. Itis also true that the old ways are inadequate for other large and increasingly complex endeavors which the nation has no choice but to undertake. The hard fact of modern organizational life is that traditional patterns and procedures cannot meet today's needs for overcoming society's pressing problems or for keeping pace in a purposeful way with accelerating technological change.

The feature that has hitherto most strongly marked large-scale organized activity in our society has been the trend toward ever larger and more ponderous bureaucracies. This is evident in both the private and public sectors. We have seen that for many lines of endeavor bureaucracies work reasonably well. When the job is routine, or repetitive, the mechanistic approach of the bureaucracy is probably the best to use since it is both safer and surer. But where the job is new and different, where it involves coping with uncertainty and rapid change, where it requires a first use of new knowledge and new technology, where it is concerned with new and shifting demands, where it is dependent for success on highly skilled and sensitive individuals with varied types of expertise, the bureaucratic approach falls down. Its structure is almost by definition inflexible. It can, as the historian William H. McNeil has pointed out, "only do what it was built to do." It cannot be readily redirected. Its effectiveness is in almost direct ratio to the degree of stability that prevails within itself and in the surrounding environment. When pressures arise for change in either its goals, its way of doing things, or its role, the bureaucracy can hardly respond lest it destroy itself. Instead it brings to bear built-in mechanisms to neutralize the pressures whether they come from within or from without. To quote McNeil again:

> "Scientific personnel classification allows, nay, requires, interchangeability of parts in the bureaucracy; hence individual appointments and dismissals make remarkable little difference... The administrative totality, its over-all structure and functioning, and even the general lines of policy remain almost unaffected by changes of elected officials. Even energetic reformers, placed in high office and nominally put in charge of such vast bureaucratic hierarchies, find it all but impossible to do more than slightly deflect the line of march.
>
> "A really massive bureaucracy...becomes a vested interest greater and more strategically located than any 'private' vested interest in the past. Such groupings are characterized by a lively sense of corporate self-interest, expressed through

elaborate rules and precedents, and procedures rising toward the semi-sacredness of holy ritual. These buttress a safe conservatism of routine and make modern bureaucracy potentially capable of throttling back even the riotous up-thrust of social and technical change nurtured by modern science."

The type of job with which NASA was charged in the National Aeronautics and Space Act of 1958 is clearly beyond the capability of a traditional bureaucratic establishment. It requires above everything flexibility. It cannot be accomplished by an organization that is rigid either in structure or methods. It can be done only by an organization that is truly adaptive, that has the capability to deal with the unknown, to operate under conditions of rapid change in a turbulent environment, to secure and act upon instantaneous feedback from both its own performance and its environment, to use and where necessary generate new knowledge and new technology, to combine and recombine highly trained experts of differing backgrounds and disciplines, to adjust to varying levels of support, to speed up and slow down, to change directions in mid-course, to constantly improvise, invent, and innovate.

Other of the great jobs with which we as a Nation are now faced -- those related to re-making our cities, checking the deterioration of our natural environment, solving our transportation problems, ending the ravages of poverty, safeguarding our national security, and reaping for ourselves and for mankind the benefits to be gained from that continuum both within and without our national boundaries which extends from beneath the ocean floor upward and outward through the atmosphere and into space -- all of these jobs are sure to open new opportunities. They will require, just as the opening of the space age required NASA, a new and different organizational approach.

Dr. Warren G. Bennis describes this need, in terms of "adaptive, problem-solving, temporary systems of diverse specialists, linked together by coordinating executives in organic flux."

Mr. Harvey Sherman describes it in much the same way: "... the problem we now face in organization may well have changed in nature from one of adjusting organizations to meet present conditions; that is, maintaining equilibrium to one of adjusting organizations to meet future unknown conditions; that is, maintaining desired dis-equilibrium."

Some have the view that the experiences we have gained in organizing and administering the Nation's aeronautics and space programs have littled applicability to the other large, complex and difficult tasks we face. For instance, Forbes, in its space issue of July 1, voiced such skepticism:

> "Can these systems /that NASA has employed/ be applied to problems other than those of space and of the military? A good deal has been said and written on the subject. Much of it is sheer propaganda, intended to justify space exploration and to try to gain a beachhead for aerospace

companies in non-aerospace businesses. Only this January, for example, an article in Fortune expounded: 'The systematic planning that built missiles and spacecraft can be used with telling effect to attack urban complexities.' The argument ran that the systems approach can be applied to earthly problems: transportation, bottlenecks, hardcore unemployment, the pollution of water and air.

"But can it? This is open to serious doubt. Space exploration deals chiefly with nature and technology -- non-human forces. The more earthly problems basically involve interrelations among people: We already know, technologically speaking, what the problems are and how to solve them. We do not know how to get people to accept the solutions or how to allocate the costs...

"... systems engineering is simply the planned, organized undertaking of unusually big, unusually complex engineering projects. A great deal can be learned from it. To oversell it, however; to promise some kind of alchemy from it -- like so much of the other overselling involved in the space program -- is a real disservice to the basic values of space exploration."

These comments, it seems to me, represent an important element in the debate now underway as to how our Nation should approach the demands of the future. I would say that they rest upon an over-simplification of the process NASA has used in organizing and administering the space program. As to the "systems approach" and its various sub-elements, such as "systems analysis," "systems engineering," and "systems management", I agree and have repeatedly emphasized that much of what is said represents myth rather than reality. These are all useful tools. They greatly increase our ability to get things done. But, as I pointed out recently in the McKinsey lectures at Columbia University, they also have their limitations and pitfalls. Any idea that they can give us an assured way to lead and manage large and complex enterprises is fanciful in the extreme.

The NASA programs have made very effective use of the systems approach. I would say that without employment of that approach, our programs could not have succeeded. But our effort has involved much more than the systems approach. Much that has contributed to the success of the space program is beyond the capability of any computer yet dreamed of. The NASA program has been an adventure into the unknown and it has had to proceed through a turbulent and unpredictable, multi-faceted environment. While it has been peculiarly dependent on computer science, it has been even more dependent on the subtleties and flexibilities brought into play by those responsible for leadership and by pressures exerted on these leaders. NASA has had to develop an ability to adapt to reality and to recognize new and emerging concepts of reality.

It is incorrect to say, as Forbes does, that space exploration deals chiefly with "nature and technology" and hence contrasts with "more earthly problems" that "basically involve interrelationships among people." Space exploration is indeed concerned with natural forces and with the technology needed to measure and use these forces. But is has required the coordinated work of 20,000 industrial enterprises, 200 universities, 400,000 highly skilled men and women, and hundreds of leading scientists, engineers, and managers. It has involved welding together many pre-existing organizations, all established under differing circumstances and for different purposes and all with their own separate practices and methods. It has involved learning to work within the framework of our representative governmental system of decision-making and under the constant glare of the TV cameras. It has involved keeping the people of the Nation and their elected representatives informed of what we were doing, and how, and to what ends. It has involved safeguarding basic values in our society and respecting its preferred ways of doing things. It has involved keeping a close weather eye out for unexpected impacts. And it has involved meeting the unending need to insure the financial support necessary to keep the whole enterprise going.

The essence of the job NASA has done is not that a new body of knowledge and technology has been brought into being. Most of the basic knowledge and basic technology was already at hand. The essence of our job has been that of organizing and managing the use of available knowledge and technology in a purposeful and effective way. This, fundamentally, has been a job of organizing and managing people and simultaneously making sure citizens and their legislative representatives were in position to understand, to accept, and to support what was being done and the purposes for which it was being done.

Here, I believe, also lies the essence of the other great undertakings that our society will have to face up to. I doubt that we will need to discover new knowledge or to invent new technology to meet urban and other pressing problems. We already have most of the knowledge and technology necessary and where deficiencies exist, they can be overcome as work programs progress. Our real need is to better organize the use of the knowledge and technology we have and to apply the increased power thus attained to those purposes we decide to pursue. The experience we have gained in NASA can surely provide more than a little guidance to those entrusted with this process.

In saying these things, I am not seeking, as some may contend, new assignments for NASA or added work for the aerospace industry. I am not suggesting that those of us who have engaged in the aeronautics and space programs should be entrusted with other great tasks. My thought instead is that NASA's experiences -- its failures as well as its successes -- can help in the critically needed development of a proven way to organize and administer large and complex enterprises. These enterprises by their very nature require enormous investments of human and material resources; they also require the concentration of great power in the hands of a few individuals. The costs of failures and abuses can be immense. Society needs as much assurance of success as it can have when it commits its resources in large amounts to large undertakings. And it needs assurances that the leaders involved will use the resources and the accompanying powers to strengthen, and not to weaken, valuable existing institutions and groupings in the Nation's economic, social and political structure.

A great difficulty that complicates organizing and carrying out large enterprises under present conditions is that the issues involved are often so complex that the average citizen cannot understand them. Out moderator today, Dean Don Price, in his recent book entitled <u>The Scientific Estate</u> underscores the seriousness of this situation. In his words:

> "The industrial revolution brought its complexities, and relied heavily on new forms of expertise, but it did not challenge the assumption thatthe owner or manager, even without scientific knowledge, was able to control the policies of a business. And the same general belief was fundamental to our governmental system: the key ideas, if not the lesser details, could be understood by the legislature and debated before the public, and thus controlled by a chain of public responsibility. In one sense this was

never true. But it is much less apparently true today than it was, and a great many more people doubt it. The great issues of life and death, many people fear, are now so technically abstruse that they must be decided in secret by the few who have the ability to understand scientific complexities. We were already worrying about the alleged predominance of the executive over the legislature; now we worry lest even our elected executives cannot really understand what they are doing, lest they are only a facade that conceals the power of the scientists -- many of whom are not even fulltime officials, but have a primary loyalty to some university or corporation -- who really control the decisions... Science has thus given our political evolution a reverse twist. It has brought us back to a set of political problems that we thought we had disposed of forever by simple Constitutional principles."

These are sobering considerations. Some might say that they logically lead to the conclusion that our democratic system must be modified, that it must give way to some kind of absolutist set-up, perhaps some sort of technocracy. In my view the answer is quite different. I see as the answer the experimental development of a proven or low-risk way to carry forward large and complex and technologically advanced enterprises; a way that will engender trust and confidence on the part of citizens even when they cannot fully comprehend all the nuances of the enterprises or see clearly what all their consequences will be. Such a proven and trusted way, it seems to me, requires a willingness and ability of those responsible for the enterprises to keep constantly in view the relationship between their undertakings and the totality of the needs and interests of the Nation at any given moment; to adjust readily to changing conditions and changing requirements; to accept and work effectively within the restraints imposed by our representative system; to utilize wherever possible existing institutions and establishments in a manner to strengthen rather than weaken the values they represent; to take into account the second and third order effects of their decisions and actions; to operate to the fullest extent possible in the open and subject to public scrutiny; and to report in understandable terms whether or not an enterprise is accomplishing what it was set up to do. Further, they should evaluate and report as to whether or not the accomplishments are worth what they are costing. They should do this when the public wants to know and not just when the leadership itself wishes to report.

No single endeavor in which this Nation has so far engaged has equalled the NASA aeronautical and space programs in complexity. Few have involved so many unknowns and uncertainties, or have been so dependent for success on the "mysteries" of science and advanced technology. Few have presented as wide a range of problems in organization and management. And fewer still have held such popular interest; been subject to such public examination; and required such a unique degree of faith and trust on the part of the public.

Let me review for a moment in more specific terms some of the characteristics that have distinguished these programs. Seven immediately stand out.

First, the program has had multiple objectives. On the one side, and as we must acknowledge in all frankness, was the matter of speed in restoring the technological-strategic balance that had been upset by the USSR with its *Sputnik*. The initial issue here, as you may well recall, was "to do something now" to offset the advanatage the Soviets had gained. Related to this was the more far-reaching and fundamental objective of developing the basic capabilities necessary for us to reach up through the earth's atmosphere and to become "a spacefaring nation second to none," to attain "preeminence in space." Then there were a variety of particular assignments, all inter-related but each of importance in itself: (a) to study the space environment by scientific instruments involving the use of sounding rockets, earth satellites, and deep space probes; (b) to begin the exploration of space by man himself; (c) to search for extraterrestrial life and thus find out whether we are alone in this vast universe; (d) to apply space science and technology for peaceful purposes to promote human welfare; and (e) to expand space science and technology as a basis for assuring national defense and welfare.

Second, <u>the program has required working at the frontiers of knowledge and technology and has involved the construction of facilities and equipment, much of it without precedent</u>. For much of the ten years of its life, NASA has found itself facing problems for which no solution was available. It has had to rely upon men and women with special, often unique skills, with high intelligence and creativity, individuals who by their very nature raise difficult problems of organization and management. Experts from the whole range of disciplines from astronomy through zoology have been required. Most tasks have needed more than a multi-disciplinary effort -- in effect, a fusing of disciplines. New kinds of facilities had to be provided, running all the way from the two million square foot Michoud booster assembly facility to vacuum chambers, centrifuges and other machines to simulate the hard vacuum and other extreme conditions of outer space. These varying, unique, and interrelated requirements for personnel and new kinds of facilities have greatly complicated the tasks of organization and management.

A third distinguishing characteristic of NASA's assignment is <u>the long lead times required</u>. This factor of long lead times, coupled with uncertainties and rapidly evolving technologies has added many complexities to the task of organizing the effort. A span of years is often required from the conception of a new space mission until the launch vehicle, the payload and attendant facilities are designed, built, tested, launched, and the resulting data returned. Meanwhile, some early assumptions have been revised or new knowledge or technology has generated substantial alteration. This characteristic of space missions places a major premium on realism in planning and replanning and on grouping and regrouping of resources. Experience must reflect back into what is going on and what is planned for the future. The long lead times also mean that a substantial period will always exist between public investments and visible major payoffs. This factor compounds and complicates the difficulties of securing continuing support.

Fourth, <u>a high order of reliability is an absolute necessity</u>. Cost, public concern over each mission, and the risks to human life have combined to create a demand for a degree of reliability seldom required in other fields. The imaginative concepts of scientists and engineers, and the unique equipment which they have developed have necessitated a wide use of simulation techniques. The ability to simulate complex environments and their interrelationships to complex machines and instruments has been developed almost to the level of a science. The use of simulation and testing now assures a high degree of reliability, but this must be obtained within much tighter time schedules than has historically been the case in complex research and development undertakings. There is little room for trial and error. In space, a system of utmost complexity must work at near perfection the first time it is put into operation if a serious setback is to be avoided. There are few "second chances" in space.

A fifth distinguishing characteristic is that under the provisions we have established, space missions are carried on under the persistent and exacting scrutiny of the mass media, the public, the Congress, the scientific community, and friends and foes at home and abroad. Space missions, which are the final test of much of our work, have been and will almost certainly continue to be front page news. Those engaged in these tasks work in a goldfish bowl and are expected to interpret, explain, and defend in detail what they are doing and why they are doing it.

Sixth, aeronautical and space programs are peculiarly and intricately interrelated with the state of public sentiment or concern -- the political environment or mood. A significant change in this environment -- the Soviet breakthrough with Sputnik -- sparked the initiation of the program. Such developments as the new political situation of 1961, the ups and downs in international activities, shifting views as to Soviet intentions and purposes, Congressional and popular reaction to the Apollo fire of January 1967, popular concern over the outbreak of a riot or a seemingly bad turn in the situation in Viet-Nam place on NASA a critically important need for flexibility in organizational structure and management processes in order to adjust to new situations and demands. NASA's programs have always been peculiarly dependent on confidence that a continuing "critical mass" of support will exist. As with an airplane, these programs must have initial support adequate to attain the equivalent of "flying speed," and sufficient support must continue to maintain the airplane's equivalent of an efficient flight pattern. NASA's space programs, in turn, have had and will continue to have an important impact on public sentiment. Some effects have been direct and immediate, as when measurements made by spacecraft reach the scientific community, or contracts modify the economic and employment situation in a city or state, or the stimulation of technological innovation changes practices in industry, medicine, communications, weather services, transportation, etc. Other effects are secondary and tertiary in nature and tend to alter attitudes, as when millions of people acquire new concepts of motion, or time, or the place of man in the vastness of space.

The seventh and final distinguishing characteristic of NASA's program on which I would place special emphasis follows from those I have already noted. It is the <u>crucial role that feedback and quick response to feedback signals must play in every phase of planning and operation</u>. For NASA, as for other complex endeavors which are contained in a turbulent environment, a high degree of disequilibrium is essential if the maneuverability necessary to maintain control is to be maintained. Yet the forces of disequilibrium must at all times be within the power to control and thus maneuver. Therefore, sufficient real-time feedback from substantive and administrative activities must be available to signal unexpected difficulties, or incipient failure, or emerging opportunities. This feedback, these signals must be in a form that those responsible for control can respond and make quick changes of course. Enormous amounts of information have to be generated, but information alone is not enough. Means have to be devised and employed to sift from a mass of disparate data that which is needed at any given moment and to deliver it at that moment to the critical point of decision. A further requirement is speed in decisions and in the implementation of decisions. Such a feedback and response system, it should be emphasized, is necessary not only for operations within the NASA program itself. The need extends to the relevant features of the outside environment in which those operations take place.

While these, and other, special characteristics have distinguished the NASA programs from routine endeavors, they can hardly be considered unique. Similar characteristics have to be faced up to and dealt with whenever the nation undertakes a task of unusual complexity requiring concentration of large and diverse human and material resources and which involves the use of new knowledge and advanced technology. Moreover, until we bring ourselves to anticipate and act upon difficult problems in advance of a crisis situation, performance of these tasks will require working under conditions of great stress and strain.

In the case of NASA, during the first years, work had to proceed under conditions where the agency (a) was being organized from components of government agencies already in existence, (b) was instituting large new programs to increase our national capability in both aeronautics and space and at the same time was carrying forward those that had been started in constituent units, and (c) was undertaking the large buildup of manned space flight capability called for by President Kennedy's message to the Congress in May 1961. All this had to go forward against the background of great impatience on the part of many people and their elected representatives.

The easiest course that we could have followed would have been to put the program on a crash basis. There was ample precedent for such an approach, and the spirit of the country was certainly tolerant -- one might even say demanding -- of this. We could have aggregated personnel and other resources in a giant monolithic organization, scoured the country for scientists and engineers to incorporate into the organization, built massive new government installations, created our own construction units to build the test and launch facilities, and so on. We could have demanded that the entire program be put on the highest priority basis and commandeered elements of key industries. We could have focused our energies and resources on the achievement in the shortest possible time of a number of space spectaculars that would "take the heat off" ourselves and the nation.

NASA, however, did not adopt this course. We wanted to get moving toward space preeminence as quickly as feasible. But we also wanted to build soundly and for the long term as well as the short. We wanted not simply to get into space, but to achieve a well-rounded and lasting capability that would enable us to do the wide variety of things that we knew would soon become possible. Above all, we wanted the country and its institutions to be the stronger and not the weaker in consequence of our engagement in the space endeavor.

It was against this background, and not against the background of winning a race at any cost, that we charted our course in the early days. And it has been against this background that we have proceeded since. And this includes our most recent decisions and actions in response to budgetary constraints and my own retirement under circumstances calculated to insure continuity and strength in the agency's senior management group.

It may be of value to leaders in other endeavors, and to scholars, to note some of the more key actions taken by NASA to adapt to all the conditions it has faced. NASA has had the benefit of a farsighted legislative base. The National Aeronautics and Space Act of 1958 is in many ways an outstanding legislative achievement. It followed intensive studies and consultations within and outside the government on all aspects of the space question, as well as of what we had done in the past to meet similar situations. It recognized that technology would have to precede science for success in many space endeavors. It also recognized that both general and security needs could be served by developments in space and it provided for a division of labor between civilian agencies and the Department of Defense. It carried forward the concepts of the atoms for peace program, but did not require that work go forward through an international organization. It called for operations in the open and the inclusion of the scientific ommunity in the planning, conduct, and reporting of work. It brought the continuum of the atmosphere and the continuum of space together in a single research and development program. On the administrative side, the Act returned to the principle established in the Constitution of reliance on a single executive rather than on a board, commission, or council. At the same time, it freed the agency of some of the restraints of existing Civil Service regulations. And it avoided any hard and fast provisions regarding choice of missions, organizational structure and operational procedures, thus leaving the way open for NASA and its executives to be as adaptive as the requirements of the space job and the rapidly changing circumstances might require.

I should also point out that within the Congress many of the ablest and most experienced and influential of its members were deeply concerned with the space program and its success. In my years of government experience I have learned that no factor can contribute more to the success of an undertaking than for its elements to have the trust, confidence, and support of wise and strong leaders in Congress. That NASA enjoyed such support also greatly contributed to its ability to follow an adaptive course.

It is hard to judge which of NASA's particular experiences should have special emphasis as we look to the challenges of the future.

I obviously cannot go into full details. Moreover, a great deal of research and study by trained specialists will be required to form reliable judgments. I would like to indicate, however, some of the things I feel merit special attention.

One matter that is little understood is the importance of the choice of the lunar landing mission as a means of unifying and integrating into a single workable system the varied goals and the widely separated problems that marked the early years of the space program.

I have already mentioned the multiplicity of objectives that were set and the range of disparate tasks that were assigned to NASA in early 1961. I have also noted the diversity of organizational elements that went to make up NASA. No new agency in the history of the Executive Branch of the Federal Government was created through the transfer of so many units from other departments and agencies as was the case with NASA. These agencies were already engaged in a large number of ongoing developmental programs and projects, each with its special purposes and its special supporting theories and concepts, as well as its special vested interests. There were, also, many differing schools of thought as to what would best serve our nation's needs in space, and there were strong-willed and influential champions of each of those schools.

Under these conditions, our decision was to set for ourselves a number of missions, including, of course, the Apollo lunar mission, that were sufficiently challenging, and sufficiently complex and difficult in scientific, technological and administrative requirements, as to furnish in total a balanced science and technology development program. In effect, we established a focal point around which could be organized in a purposeful and coordinated way a range of activities that would collectively give us both the general and specific capabilities needed for the attainment of national preeminence.

Dr. Hugh Dryden, who served as Deputy Administrator of NASA from its establishment in 1958 until his death in December 1965, summarized in June 1961 the considerations that underlay our Apollo decision. He wrote:

> "The setting of the difficult goal of landing a man on the moon and return to Earth has the highly important role of accelerating the development of space science and technology, motivating the scientists and engineers who are engaged in this effort to move forward with urgency, and integrating their efforts in a way that cannot be accomplished by a disconnected series of research investigations in the several fields. It is important to realize, however, that the real values and purposes are not in the mere accomplishment of man setting foot on the moon, but rather in the great cooperative national effort in the development of science and technology which is stimulated by this goal. ... The national enterprise involved in the goal of manned lunar landing and return within the decade is an activity

of critical impact on the future of this nation as an industrial and military power, and as a leader of a free world."

In singling out the lunar decision for emphasis here, I do not mean to suggest that something similar to a "moon goal" is needed or will work for other large and complex undertakings. I do believe, however, that for success in such undertakings the same sort of approach that we followed and which resulted in selection of the moon goal is necessary. I believe, more specifically, that it is necessary to make the most careful analysis of all known needs at the start, to fix on a goal or set of goals that will encompass all of these needs and at the same time make adequate allowances for unknown factors and unexpected developments. It is necessary to establish an organizational and operational plan that will, on the one hand, enable the carrying out of diverse activities directed to purposefully correlated ends. It is also necessary to insure that adjustments to reality can be made when conditions turn out differently from those anticipated.

Can this kind of experience help us face the problems of our urban centers? To save our cities we at least need to meet transportation needs, housing needs, human relations needs, health needs, education and employability needs, and waste disposal needs, of air and water pollution, of crime control, and on down the well-known list. To attack each of these problems individually, as we seem intent on doing is not likely to meet the total need. To view them and their possible solutions as interdependent elements in a single whole and adopt an integrated approach in organizing ourselves to deal with them presents stupendous difficulties. I believe that for our cities, as for the space exploration, such an integrated approach will prove vastly more effective than any "individual components" approach.

A second area of NASA experience that I feel worthy of note has to do with organizational arrangements. Prior to NASA's establishment, activities related to space research and development were carried on in a number of government departments and agencies. These activities were quite productive, surprisingly so in a number of instances. Nevertheless, and understandably, once the full impact of Sputnik was felt, the Nation became impatient of the results of these uncoordinated efforts. And, as seems to be more or less customary under such circumstances, an entirely new agency -- NASA -- was brought into being to get a critical job done.

Under its legislative charter, and particularly after the 1961 decision for a greatly expanded and accelerated space effort, NASA could have proceeded with the buildup of a large and highly centralized department-like structure. This would have been the more or less normal thing to do, and as noted earlier, it would have been the easiest from the strictly administrative standpoint. But the NASA program was too complex -- its requirements extended over too wide a range of the nation's competence -- to draw into the confines of a single organization all or even most of the expertise needed. We could have tried this, but instead we adopted the policy in the performance of our work of utilizing to the maximum feasible existing organizations and institutions. This operated to spread our problems over the largest number of able minds and to draw upon the range of the nation's scientific and industrial competence in the locations where it existed.

This policy was applied in the first instance to the laboratories, research and development centers, and other installations transferred to NASA from other government agencies. These establishments were left in place and allowed a large degree of operational and administrative autonomy. They were delegated contractual authority up to $5 million, subject to central review. Where we have found it necessary to add to our in-house capabilities, we have done so not through expanding NASA's central headquarters in Washington, but through strengthening and adding to regional centers. Employment in Washington has never exceeded 2500. This contrasts with a peak of some 33,000 in the regional establishments and a total work force of 420,000.

We have also made extensive use of the manpower and facilities available in other government agencies. We have, for example, turned to the U.S. Army Corps of Engineers to manage our construction programs, which required, at its peak, a work force of 40,000 men and women, and represents a capital investment of $3 billion. We have similarly relied on other specialized units of the Department of Defense, the

Bureau of Standards, the Weather Bureau, and many others for much of our research and development. We have been assisted on many problems by the National Science Foundation. And we have borrowed from other agencies, and particularly from the Armed Services, many of those who have manned and directed our various projects.

A major NASA policy has been to rely on contracts with non-governmental establishments and institutions for the work they were qualified to do. Over ninety percent of all funds invested in the NASA program have been spent outside the government. In some years this has reached 95%. Principal reliance has, of course, been placed on industry, but we have also drawn heavily on universities and such private organizations as the National Academy of Sciences, the National Academy of Engineering, the National Academy of Public Administration, and a long list of others.

Seldom in history has a large and complex undertaking been so widely spread over existing organizations and institutions as has been the case with NASA. I might repeat here some figures I mentioned earlier: The NASA program has involved about 20,000 industrial prime and sub-contractors and suppliers, 200 universities, and almost 400,000 non-governmental workers.

The spreading of NASA's work load over such a large number of elements has forced us to extend into new dimensions the art and practice of administration and mangement. The NASA program has been not only large; it has been extremely complex. While it could not have been carried forward successfully without the resources represented by our nation's industrial establishments and universities, it also could not have been carried forward without strong in-house capabilities within NASA and within the cooperating government agencies.

This brings me to an essential corollary of our policy of maximum utilization of outside resources. For a complex, large scale undertaking, it is necessary to have within the responsible organization itself enough capability -- scientific, managerial, and engineering -- to plan and administer, to watch over and assist the research and development work being done by others. It is not possible to rely upon even the most complex contracting system where accountants and lawyers are the prime reliance for performance. In NASA we have found that we must be able to speak and understand the language of those on whom we rely, to know as much about the problems they are dealing with as they do, to check and supplement their work in our own laboratories, to step in when required with the necessary specialists and, in some cases, help untangle snarled situations. In other words, we have to learn to be active participants in all phases of the projects that we entrust to others without undermining their own discipline and control.

What is the significance of such organizational arrangements? I would say simply this: Our society cannot afford the creation of one massive organization after another to cope with every new, complex situation that arises. We cannot continue the practice of "government by crisis." We must equip ourselves to deal with the large and the difficult and the complex in a regularized way. We must develop and systematize methods and procedures whereby we can combine, dismantle and recombine elements of existing establishments in and outside of government to get big and increasingly complex jobs done. We must learn how to marshall and focus the great resources available in our established organizations and institutions to shifting "points of main impact." This must be accomplished without disruption of those organizations and institutions or dimunition of their ability to perform the other tasks with which they are concerned. And we must accustom ourselves to the regular use of such an approach.

There are numerous other aspects of our NASA experiences that merit attention but on which I can only touch today. A particularly important one is that as we have used industry and universities and other institutions to carry the main burden of the NASA work program, we have as a matter of deliberate policy done so in a way to strengthen rather than weaken these basic elements of our society. With respect to industry, we have been willing to pay a fair price, including a fair profit, for work done, including research and development that would not lead to follow-up production work. We have employed incentive contracts. We have encouraged and stimulated the utilization by industry of the latest technology. We have assisted in development of new capabilities within existing enterprises.

For universities, we have taken many steps that encourage research on the campus, rather than encouragement for the researcher to leave the campus. This has aided teaching and graduate training. We have provided doctoral training support for several thousand scientists and engineers. We have assisted in the construction on the campus of new laboratories and other research and training facilities. We have done all we could to encourage improvement in both curriculum and program and to stimulate the melding of disciplinees so as to increase the capabilities of universities and their graduates to deal with modern day problems. We have endeavored to help universities become "trusted sources of knowledge" in our society. And we have not limited ourselves to a few great universities. We have also worked closely with less well known universities when these could demonstrate merit or promise of merit. We have done this in order to get all of the help we could in the performance of our difficult tasks and at the same time to stimulate the further development and extension of the higher educational resources of the country in areas related to our missions.

Our overall aim has been to effect a mutually beneficial working partnership between the universities, industry and the government. We have operated on the principle that there is no inherent quarrel between public and private purposes but that there is instead a coincidence of interest which offers a sound basis for genuine teamwork to the benefit of both sides and indeed of our society as a whole.

NASA has also concerned itself with other impacts that its program and activities have had or may have on society. We have been concerned not alone with prime effects, but with second and third order effects as well. I must acknowledge that our understanding of this matter of second and third order effects and how to control them to desired ends is as yet rudimentary. But we have learned enough to appreciate that closest attention must be paid to them, and particularly as they relate to society's basic institutions and values.

In NASA we have had a great deal of experience with such things as management information systems, the multiple executive, the concept of a strong executive secretariat, decentralized management, functional management, project management, program management, institutional management, new methods in contracting, self-policing systems, and so on. These experiences are too numerous to cover today. I can only express my view that they are deserving of investigation and study, both the successes and failures. This year, we have started to experiment with the computer storage and retrieval of all information in our central files, with remote access units. In time, this should make the work of scholars wishing to use our records for research somewhat easier.

A last matter that I would touch upon with you today is our experiences with regard to the changing tempo and scale of the NASA operation.

At the inception of the enlarged space effort in 1961, it was clear that the NASA assignment would be an evolving one. We saw the probability of four major stages: First, a period of rapid buildup of capabilities and facilities, during which maximal inputs of resources and manpower would be required; <u>second</u>, a period of leveling off, or maturing, during which emphasis would shift from the development of capabilities to the use of capabilities already created and during which there would be a decline of new inputs of resources and manpower; <u>third</u>, a period of transition preparatory to putting the space endeavor on a long haul or regularized basis; and <u>fourth</u>, a period, extending over the indefinite future, during which space explorations and activities would be carried on as a normal and more or less routine part of our national life.

We recognized that each of these stages would require essentially different organizational and administrative systems and procedures, and that it was important that we avoid freezing ourselves into any set pattern during any one stage, short at least of the final one of regularized activity. We have consequently not only kept the NASA administrative structure flexible, we have made a practice of regularly structuring it in whole and in its several parts. We have, as a matter of fact, used structural reorganization as an important administrative device. We have sought, in other words, "desired disequilibrium" as necessary to meet both the complex requirements of today and the unknown requirements of the future.

We have also recognized that in the project-type endeavor, acceleration would have to be followed by deceleration and that many operations involving both governmental and non-governmental manpower and facilities would have only a limited usefulness. We have accepted the need to end these after their purposes had been met. In other words, we foresaw that the NASA program would involve areas of declining activity as well as areas where newly-approved projects were building up.

We have already, as I have said, reduced the scale of our total activities to about one-half the peak level, which was attained three years ago. The construction program is largely completed, which means that our research and development programs are now at about two-thirds of the peak. We are in position to operate at this level or to increase or decrease as decisions generate either trend. We have made corresponding organizational and administrative changes. These adjustments have been carried out in a forward-looking way, and they leave both NASA and the space program in as good order as is possible under the circumstances.

We have been able to adapt to a series of drastic reductions in NASA's activities.

No one thing, it seems to me, is as important in gaining acceptance for the use of large and complex endeavors to get big and special jobs done as the demonstration of a capacity for the orderly phasing down of activities if the early momentum cannot continue. Organizations, private as well as public, have a way of generating dynamics to keep themselves going or even to increase the scope of their activities. This is perhaps one reason why citizens generally resist the initiation of special efforts to meet difficult problems until there is a fullblown crisis. And here, I believe the instincts of our citizens are in part sound. We cannot afford to continuously add self-perpetuating organizations to our governmental structure. But there is another side to the story: We also cannot afford to dismantle and scrap effective organizations that have been built up at great cost each time a special job is finished. We particularly cannot afford this when the organizations in question are capable of initiating and leading the new technological developments essential for the continued advancement of our society.

How is our Nation to deal with this dilemma? We all need to give it much attention and study. As a possible contribution, I would offer in closing the thought that progress can be encouraged through a better understanding of what is needed for governmental elements to effectively adapt to changing conditions, to be able to reorganize and regroup.components and units as problems and situations and opportunities change. Such an ability to adapt, to restructure, will require important legislative changes as well as strong leadership in the Executive Branch. For both, a better base of knowledge as to what produces success or failure is needed.

* * * * *

B-III

B-II-3 item 9
goes here

APPENDIX TO CHAPTER III

MANNED SPACE FLIGHT:

GEMINI & APOLLO

TABLE OF CONTENTS

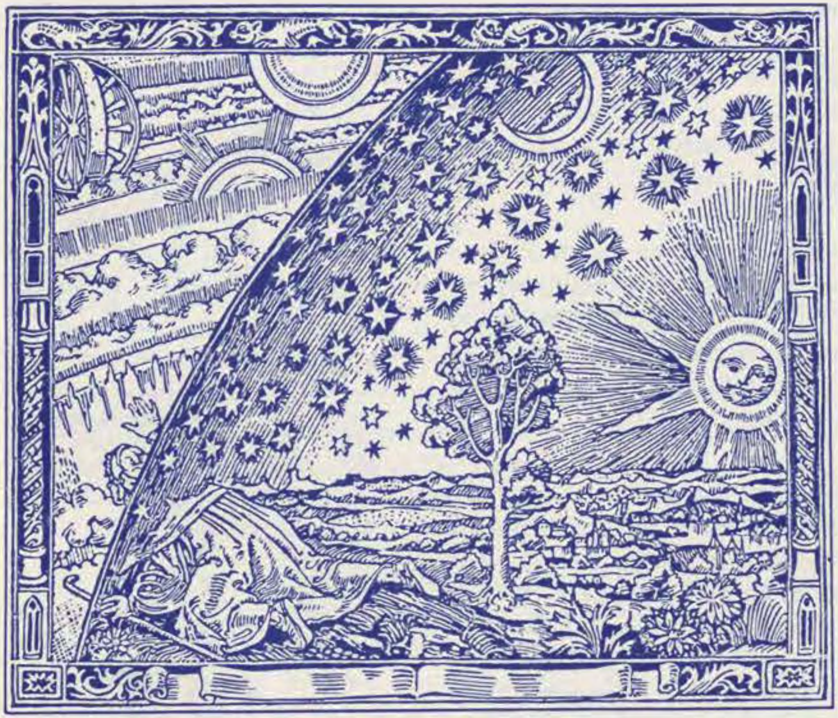
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER

SATURN I SUMMARY

The fifth Saturn I vehicle rises from its launch pad.

PUBLICATION DATE FEBRUARY 15, 1966

A PROLOGUE TO SATURN....



A medieval notion of the structure of the cosmos led to this concept of space exploration.

Nobody knows precisely when the dream of space travel first started. By A.D. 160, at least one fictional account concerning a voyage to the Moon had been written, demonstrating that the concept of traveling from one heavenly body to another is over 1800 years old. For centuries thereafter, the only recorded ideas of journeys into space were fanciful tales, wherein voyagers traversed the skies on muscle-powered, flapping wings attached to their bodies, drove flying chariots with unspecified or supernatural means of lift and propulsion, or inveigled rides with angels, demons, or birds.

Except for a lucky guess by Cyrano de Bergerac, a Seventeenth Century poet and writer, who suggested the use of a box with large numbers of black-powder rockets attached as a vehicle for reaching the Moon, no authors came close to guessing how one could truly travel in space. Not until the end of the Nineteenth Century did technology advance far enough for serious thought to be directed toward space travel. Even then, the work of pioneer rocketeers in the United States, Russia, and Germany on space flight was generally considered to be crackpot or harebrained by the average man, to whom the space rocket remained a science-fiction or comic-book concept until the advent of the V-2 rocket in the closing phases of World War II.

Under the impression that the sun "draws up" dewdrops, Cyrano de Bergerac suggested fancifully that one might fly by trapping dew in bottles, strapping the bottles to oneself, and standing in the sunlight.

After the war, there was accelerated rocket research in several countries, much of it built upon the firings of captured V-2s. This led to more talk about space flight. During this stage, rocket research for space flight was no longer considered so much harebrained as possible, but impractical.

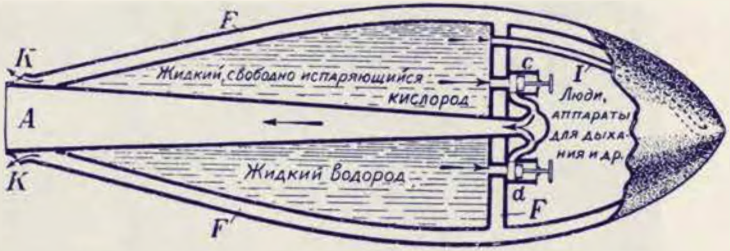
Although more and more engineers and scientists were computing and planning various possible space projects, it was not until July 29, 1955, that the United States had an official space program--the launching of an artificial earth satellite within and as a part of the International Geophysical Year (IGY).

By April of 1957, the Development Operations Division of the Army Ballistic Missile Agency (ABMA), headed by Dr. Wernher von Braun, began studies that would lead to the Saturn program. Months before the launching of Sputnik I, it was already clear to many leading space scientists that the space program of the United States had to have large vehicles designed purely for space applications. In December of 1957, before the first American satellite was launched successfully, a proposal for a program for the creation of a rocket booster having a thrust of 1,500,000 pounds was forwarded to the Department of Defense. The Department of Defense approved the project on August 15, 1958, and named it Juno V. The rocket later was renamed Saturn, in February of 1959. It was named Saturn because Saturn is the next planet farther from the sun than Jupiter, and the name was in keeping with the tradition of naming rockets after Greek and Roman gods.

During the early introduction of rockets to Europe, they were used only as weapons.

火
箭

The origin of the rocket is told simply in these Chinese characters. They stand for both "rocket" and "fire arrow."

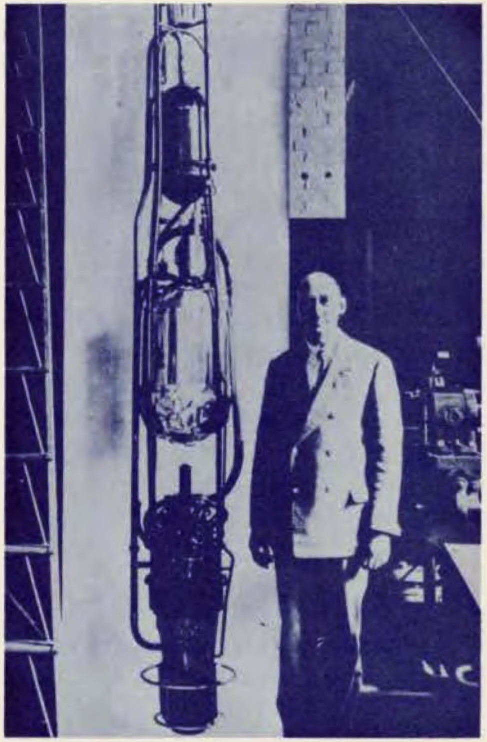


At the beginning of the 20th Century, the Russian rocket pioneer Konstantin E. Tsiolkovski published scientific papers on rocketry and space travel. His earliest dealt with liquid-fuel rockets. Curiously, the Russian scientists of this time neither ridiculed nor praised him. They greeted his papers with total indifference.

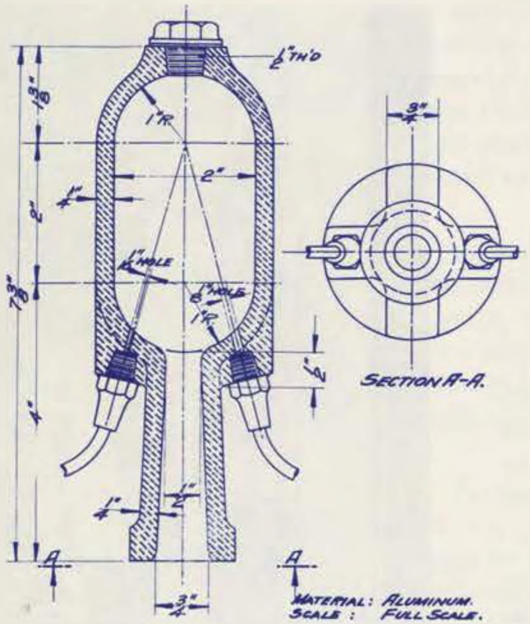
There were two schools of thought on the development of rocket programs at that time. One school suggested that a completely new design be made for each space vehicle type. The other school suggested the more evolutionary approach of modifying existing design to produce new vehicles that would be based upon proven engineering principles.

In the Saturn program, it was decided to use components modified from already-available equipment. This off-the-shelf hardware concept had paid dividends in our early Explorer and Pioneer launches, and its application to the Saturn program was natural. For example, the engines for what became the Saturn booster were to be improved and uprated versions of an engine that was used in the Jupiter and Thor missiles, and the propellant containers would be modified from existing types of tankage used in the Redstone and Jupiter boosters.

What was to become the Saturn I rocket evolved from earlier rockets. Its phenomenal success rate can be attributed in large part to this design concept.

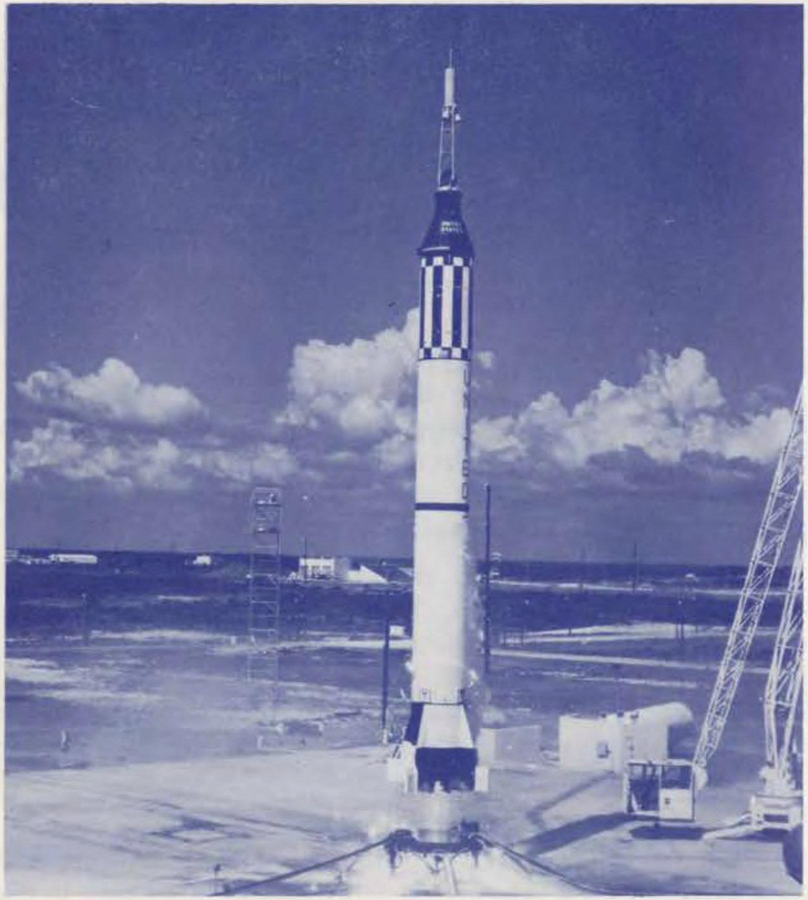


Dr. Robert H. Goddard, the father of modern rocketry. Dr. Goddard invented the first liquid-propellant rocket to fly; he launched it in 1926 at Auburn, Massachusetts. Pictured here is one of his later rockets, developed in his laboratory at Roswell, New Mexico.



In addition to Dr. Goddard's pioneer work, American experimentation in rocketry prior to World War II grew, primarily in technical societies. This is an early rocket motor designed and developed by the American Rocket Society in 1932.

An "ancestor" of the Saturn, the Redstone rocket was called "Old Reliable" because of its outstanding performance record. Used to launch the first U.S. artificial satellite, and as the vehicle for the early Mercury spacecraft, the engineering design philosophy and some modified components of this vehicle were incorporated into the Saturn design.



THE SATURN PROGRAM....

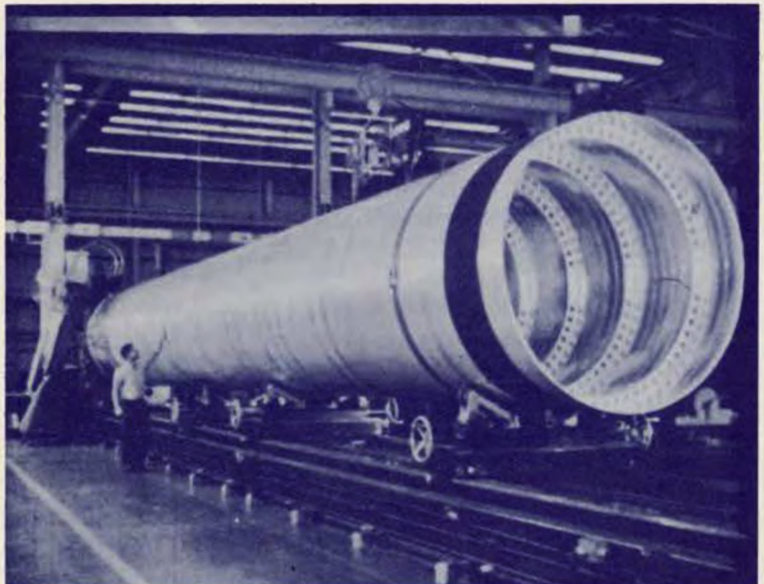
The first Saturn S-I stage being installed in the static test tower at MSFC. Here the rocket underwent captive firing tests to insure reliable performance.

Finished ideas grow from simple concepts. Originally, the Saturn booster program was initiated just to develop the technology of large-thrust vehicles. It was reasoned that by utilizing hardware from existing systems, and modifying it as necessary, a new rocket of the desired thrust could be developed that would be both reliable and relatively inexpensive.

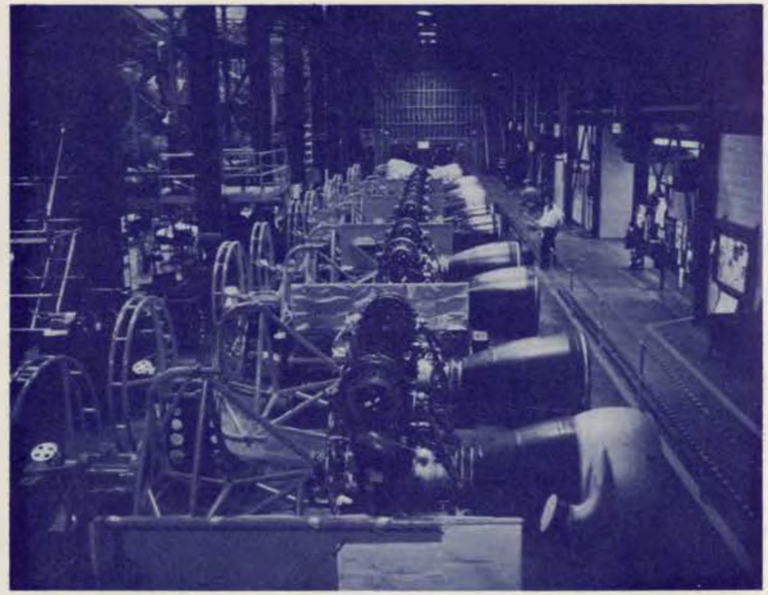
However, it was realized even then that building a booster stage alone to prove a principle would not be enough. The personnel on the program were therefore requested by the Advanced Research Projects Agency (ARPA) to study a complete vehicle system, so that upper stages could be selected and developed for use with the booster stage. At the same time, studies on launching facilities for such vehicles were initiated.

The results of the initial studies indicated that existing rockets, such as the Atlas or the Titan, would be adaptable for use on the booster; however, these studies, while complete in themselves, were still but a beginning.

By 1959, the space goals of the United States were becoming firmer. And as design and development of the Saturn booster progressed, it was becoming more evident that a large-thrust stage of this sort would be



An engineer inspects a modified Redstone tank, used in the S-I stage. The completed stage had eight such tanks clustered around a larger central tank.



The H-1 engines, manufactured by Rocketdyne for the first stage of the Saturn I rocket, dwarf the engineers at the assembly area in MSFC.

most useful as part of a vehicle for the National Aeronautics and Space Administration (NASA). Dr. Abe Silverstein of NASA, with both NASA and Department of Defense approval, recommended a long-range development plan for Saturn. It was agreed that all upper stages of the early family of Saturn vehicles should use liquid hydrogen and liquid oxygen as propellants because of the high energy available with this combination.

Working under direction from ARPA, ABMA completed by the end of the year a study design for the overall Saturn vehicle configurations. This design, based on the concept of using flight-proven hardware to the maximum, also included the capability of carrying NASA payloads.

The static test of an early S-I stage as seen from an observation plane. The flame of the exhaust is deflected by a water-cooled scoop at the base of the tower.

Also by the end of 1959, a ten-vehicle research and development program was established as a part of the overall program, with the tenth vehicle scheduled to be the prototype for the operational vehicle. Anticipating a formal transfer announced by President Eisenhower, NASA assumed technical direction of the Saturn program in November. It was now clear that Saturn was to play an extensive part in our civilian space program.

The original concept of the Saturn vehicle, called C-1, was a three-stage rocket. The first stage was to be the 1,500,000-pound-thrust stage already under development. This stage, designated as the S-I, would use the already-proven combination of kerosene and liquid oxygen for fuel. The second stage, named the S-IV, was planned to use a propellant combination of liquid hydrogen and liquid oxygen, one of the most powerful combinations of propellants possible in liquid-fuel rocket technology. The initial plans called for this stage to have four engines producing a total combined thrust of 80,000 pounds. The third stage, designated the S-V, was also to use liquid hydrogen and liquid oxygen as propellants, and was to have two engines of the same kind as used in the S-IV stage. The S-V stage was planned to have a thrust of 40,000 pounds.

A completed early Saturn, "horizontally mated," seen next to a Redstone and a Jupiter vehicle.

While the booster design was being tested, a contract had been awarded to Douglas Aircraft Company for the design and development of a second stage for the rocket, the S-IV stage.

The official dedication of the George C. Marshall Space Flight Center (MSFC), the NASA facility at Huntsville, Alabama, took place on September 8, 1960. In an executive order, President Eisenhower named the facility after General Marshall, noting that the Center was expected to play a major part in the space programs of the United States.

Studies had been initiated for the proposed third stage, the S-V, and also for the possible use of the rocket as a part of the project to land astronauts on the Moon. As a result of these studies and other considerations, NASA approved use of the Saturn C-1 vehicle, in a two-stage configuration, for launching multi-ton earth-orbital Apollo payloads.

The Saturn concept was evolving. A requirement to demonstrate large-thrust capability had grown into a program for a vehicle with a specific mission, as a part of a great overall program of United States space exploration. But, though the mission and the vehicle type were now defined, much work remained to be done.

Studies therefore continued. Research work on the proposed liquid hydrogen engine determined that an engine already being developed for another rocket program (Centaur) would meet Saturn requirements. NASA headquarters approved the use of six RL-10 first-generation Centaur engines, built by Pratt & Whitney, in a cluster instead of the four engines originally scheduled for development for the S-IV stage.

In April of 1961, the first static firing test for flight qualification of an S-I stage took place. The results of this test were successful. And even as the first of the stages was being tested, the second one was being constructed.

GROWTH AND DEVELOPMENT

In May of 1961, NASA Headquarters approved the design changes of the S-I stage of the C-1 vehicle to include a greater propellant capacity and the addition of fins. Special emphasis was placed upon the safety requirements for manned missions: in performance, the rocket had to be absolutely reliable. And, while the new changes still allowed the possible use of a third (S-V) stage for special missions, the immediate need for a third stage was eliminated.

The test sequence for the vehicles was also evolving. The design philosophy of an evolutionary development of the Saturn rockets carried over into the test flights. Each flight was designed to gain new knowledge for the overall design problems of the rocket.

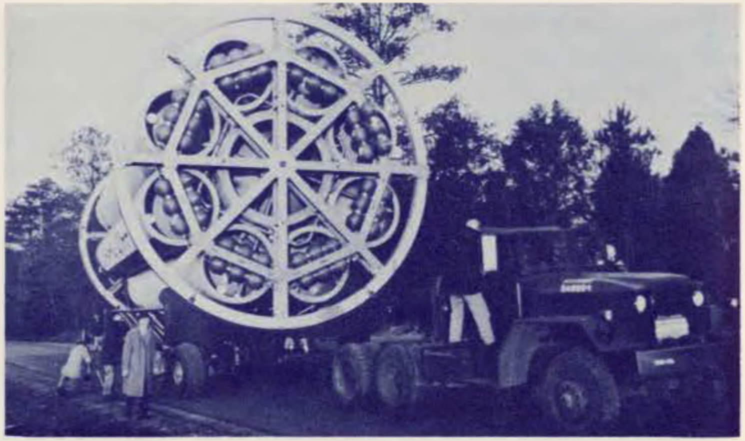
The first four vehicles scheduled for flight were designed specifically to develop the first stage only. The upper stages

President Eisenhower talks with Dr. von Braun at the dedication of the George C. Marshall Space Flight Center.

of these vehicles were inert or dummy stages. Such stages duplicated the overall external characteristics of the later live stages, and each had the same approximate center of gravity and weight as its live counterpart.

Some of the upper stages to be used with these first four vehicles were already in the process of being manufactured before it was decided to use the C-1 vehicle in the Apollo program; therefore, the dummy stages duplicated the three-stage C-1 configuration--the S-IV and S-V stages atop the S-I stage.

The first four vehicles were designated as the Block I phase. In addition to the three-stage configuration,



The completed and tested S-I stage is transported to the river and its barge for shipment to the Cape.

The Saturn SA-1 vehicle components aboard the barge Compromise during the trip to the Cape.

Block I vehicles were easy to distinguish from the later vehicles in that they had no fins. There were other differences between the earlier and later vehicles, but these two basic ones were instantly evident to the casual observer.

The remaining six vehicles in the ten-vehicle developmental series of the C-1 vehicle were designated as the Block II phase. All Block II vehicles would have live second stages, and all but one had payloads in Apollo configurations. These payloads, called boilerplate configurations, would duplicate the mass, center of gravity, and external characteristics of the operational Apollo spacecraft.

Pictured here are NASA management officials for Apollo/Saturn. From top left: James E. Webb, NASA Administrator; Dr. Robert C. Seamans, Jr., Associate Administrator; Dr. George E. Mueller, Associate Administrator for Manned Space Flight; Dr. Wernher von Braun, Director, Marshall Space Flight Center; Dr. Kurt H. Debus, Director, Kennedy Space Center; Dr. Robert R. Gilruth, Director, Manned Spacecraft Center.

The Saturn program was not to be limited to what was then known as the C-1 vehicle. As the rocket was being developed for the Apollo program, the need was seen for additional, more powerful Saturn vehicles. However, the results of the studies that led to later vehicles are not properly a part of this summary of the Saturn I vehicle, and will be mentioned only in those matters relating to the mission of the Saturn I rocket. It is interesting to note, however, that the expanded Saturn program adheres rigidly to the evolutionary concept that was an intrinsic element of the Saturn I program.

By the time the first S-I stage began its long journey from MSFC to what was then known as Cape Canaveral (Cape Kennedy), a second S-I stage had already undergone a successful static firing test, lasting for 124 seconds, and construction had already begun on a third S-I stage. The stages for the first Saturn had to be transported to the Cape by barge, as they were too large for the normal highway transportation used for earlier rockets.

While the first Saturn was being readied for launch, a conference was held at New Orleans to secure bids for the industrial production of S-I stages. Design had reached the point at which industrial production of the vehicle could be considered.

Then, on October 27, 1961, slightly over four years from the beginning of the Space Age, the first Saturn rocket was launched. The vehicle, weighing 460 tons at liftoff, rose to a height of 85 miles during its journey. It impacted 214 miles downrange, and close to its predicted impact point. The launch was considered to be almost flawless, the only delays being two weather holds during the countdown.

When launched, the first Saturn rocket was the most powerful rocket known in the world. It proved the principle of building new systems with off-the-shelf hardware, and demonstrated the validity of the clustered-engine concept. For the space program, these accomplishments were secondary to the fact that it performed as predicted in an actual shot: the Saturn rocket was in business as a flight vehicle.

The Saturn I program was due for changes as it continued to evolve. Much of the initial planning had already changed, but the program had established itself as workable. In November 1961, NASA selected Chrysler Corporation as the prime contractor for the first stage, joining Douglas Aircraft Company as the prime contractor for the second stage.

THE SATURN I VEHICLE...

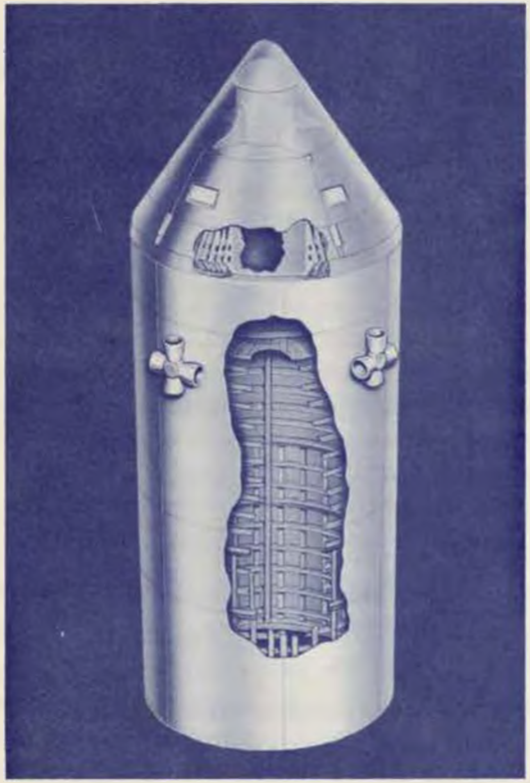
The Saturn I rockets can be divided into two major types or blocks, and the second block can be further subdivided. Primarily, each rocket reflects the evolution of the program, but certain features are basic to all rockets in each block. Before discussing the results of the Saturn program, therefore, an outline of the main features of each block is presented.

Saturn I, Block I - This rocket had only one live stage, the S-I stage. It consisted of eight tanks, each 70 inches in diameter, clustered around a central tank 105 inches in diameter. Four of the external tanks were fuel tanks, for the RP-1 (kerosene) fuel; the other four, which were spaced alternately with the fuel tanks, were liquid oxygen tanks, as was the larger center tank. The fuel tanks were interconnected, as were the liquid oxygen tanks; thus, any engine could obtain propellant from any tank. All fuel tanks and all liquid oxygen tanks drained at the same rates respectively.

The thrust for the stage came from eight H-1 engines, each producing a thrust of 165,000 pounds, for a total thrust of over 1,300,000 pounds. The engines were arranged in a double pattern: four engines, located inboard, were fixed in a square pattern around the stage axis, canted outward slightly, while the remaining four engines were located outboard in a larger square pattern offset 45° from the inner pattern. Unlike the inner engines, each outer engine was gimbaled. That is, each could be swung through an arc, in this case an arc of 14°, in two directions. The capability was termed a "±7° square gimbal pattern." The outboard engines were gimbaled as a means of steering the rocket, by letting the instrumentation of the rocket correct any deviations of the rocket's powered trajectory. Since the Block I rocket had no fins, engine gimbaling was also the only method of guiding and stabilizing the rocket through the lower atmosphere.

The upper stages of the Block I rocket reflected the three-stage configuration of the Saturn I vehicle. The ballast of the dummy upper stages was primarily water. It was determined that water could not survive reentry, thus giving an added safety factor to the tests. Typical height of a Block I vehicle was approximately 163 feet.

Saturn I, Block II - This vehicle had two live stages, and was basically in the two-stage configuration of the Saturn I vehicle (that is, it did not loft any dummy third stages). The first stage was an improved version of the Block I S-I stage. While the tank arrangement and the engine patterns were the same, there were marked changes between the Block I and II versions. The Block II S-I stage had eight fins added for greater aerodynamic stability in the lower atmosphere. Four of these fins were larger than the other four, and the two sets were arranged alternately; they were known as the large fins and the stub fins respectively. The engines were still arranged in the two-square pattern with both squares centered on



The inert, or Boilerplate, configuration used on the later Saturn I vehicles. This dummy construction faithfully duplicated the mass and the external characteristics of the Apollo spacecraft.

the vehicle axis, but the outboard engines of the Block II phase had a ±8° gimbal pattern. All Block II H-1 engines had a thrust of 188,000 pounds each, for a combined thrust of over 1,500,000 pounds.

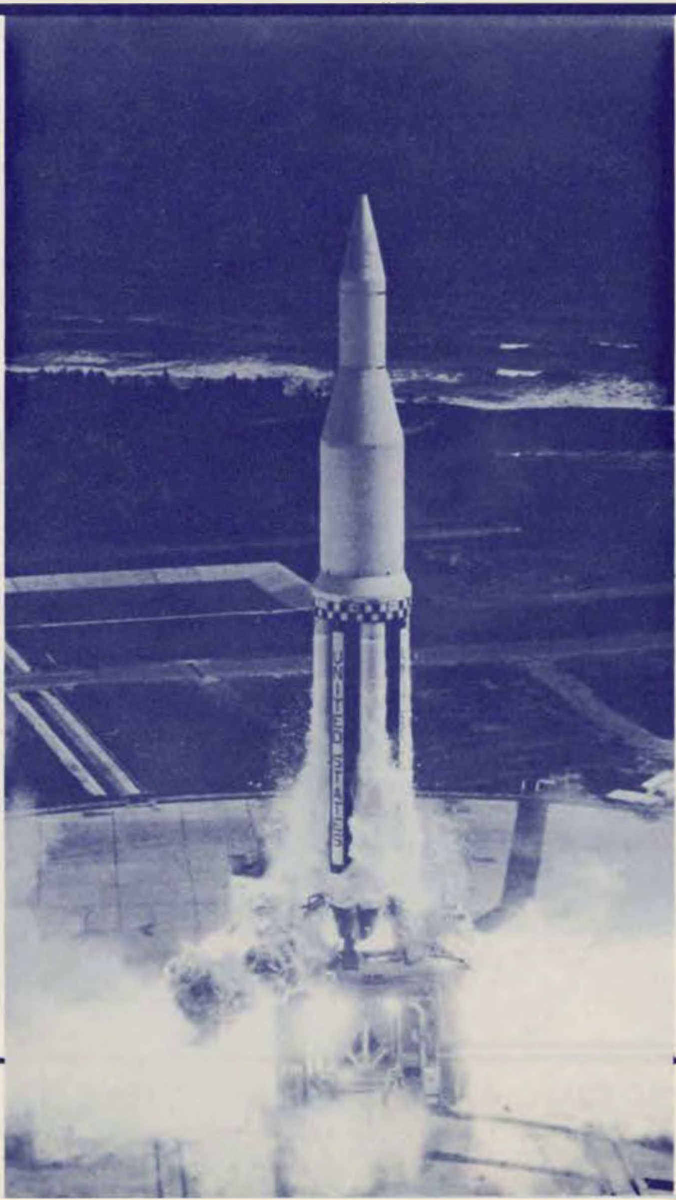
The Block II second stage (S-IV) used liquid hydrogen and liquid oxygen as its propellants. Unlike other propellant tank systems, the liquid hydrogen and liquid oxygen tanks shared a common bulkhead made of two sheets of aluminum bonded to a fiberglass honeycomb core. The stage had six RL-10 hydrogen-oxygen engines arranged in a circle. Each of these engines produced a thrust of 15,000 pounds for a total combined thrust of 90,000 pounds. Each engine was gimbaled for a ±4° square.

As a two-stage vehicle, the Saturn I had full orbital capability for a variety of payloads. A Jupiter nose cone, a boilerplate (dummy) Apollo spacecraft, and meteoroid detection satellites were orbited as payloads by this two-stage configuration.

The later Block II vehicles differed from the earlier vehicles by having an improved Instrument Unit. The Instrument Unit, a joint project of MSFC, the Bendix Corp., and IBM, was the device that acted as the brain of the rocket. Since the later Instrument Units were lighter and physically smaller than the earlier version, the later Block II vehicles were a few feet shorter and somewhat lighter than the earlier Block II vehicles, with improvement in the characteristics of the vehicles.

The height of the vehicle varied with the mission; a typical height for a later Block II vehicle was approximately 188 feet.

THE FLIGHTS AND THE MISSIONS....

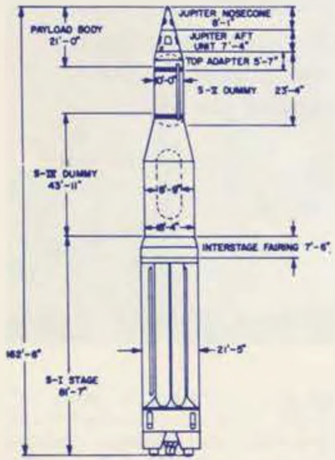


Each Saturn I vehicle had a mission that helped in the evolution of future space rockets. Even in the final launch of the series, on what was an operational vehicle, improvements and performance evaluations of the instrumentation and guidance systems were being undertaken. The evolutionary trend of the rocket design is reflected in the achievements of the individual flights.

Saturn SA-1 in the process of being launched. It was the most powerful rocket known at the time of its flight.

SA-1

With SA-1, the Saturn clustered-engine concept was demonstrated to be valid. The eight engines of this rocket produced a thrust of 1,300,000 pounds; this was true of all Block I vehicles. The dummy upper stages of this rocket were not intended to be separated after cutoff of the live stage.



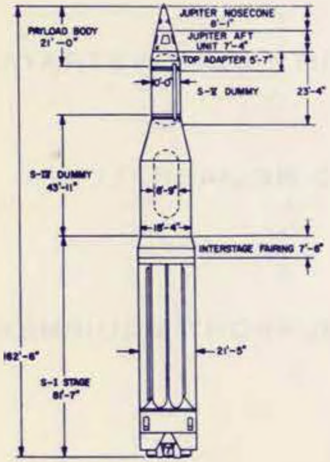
SA-1 being readied before launch.

MISSION HIGHLIGHTS

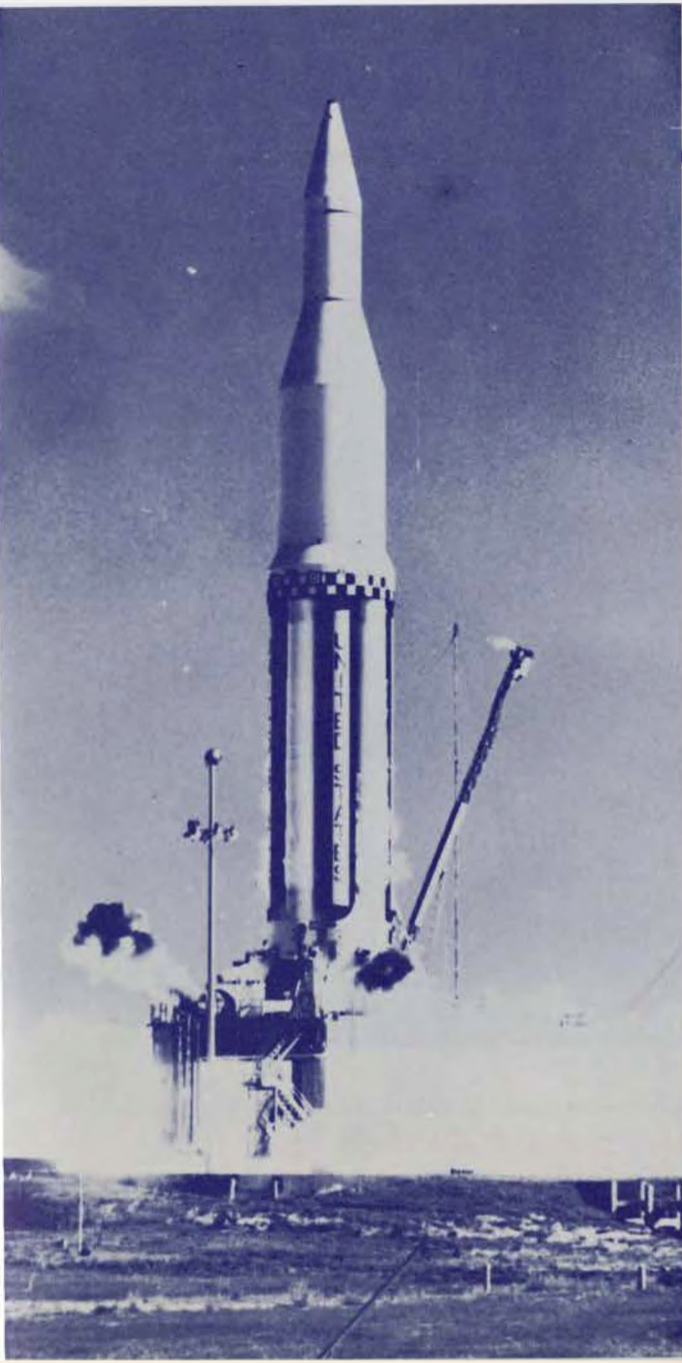
- LAUNCHED WITH NO TECHNICAL HOLDS
- MAXIMUM ALTITUDE -- 85 NAUTICAL MILES
- MAXIMUM RANGE -- 214 NAUTICAL MILES
- AIRFRAME STRUCTURAL RIGIDITY DEMONSTRATED
- CONTROL PERFORMANCE AND RELIABILITY DEMONSTRATED
- COMPATIBILITY TO GROUND SUPPORT EQUIPMENT DEMONSTRATED

OCTOBER 27,1961

PROJECT HIGHWATER



The SA-2 continued the experiments of the SA-1 flight. In addition, a special experiment with widespread scientific interest, "Project Highwater," authorized by the NASA Office of Space Sciences, was conducted. The experiment released nearly 30,000 gallons of ballast water in the upper atmosphere. Release of this vast quantity of water in a near-space environment marked the first purely scientific large-scale experiment concerned with space environments that was ever conducted. The water was released at an altitude of 65 miles, where, within only 5 seconds, it expanded into a massive ice cloud 4.6 miles in diameter. This cloud continued to climb to a height of 90 miles.

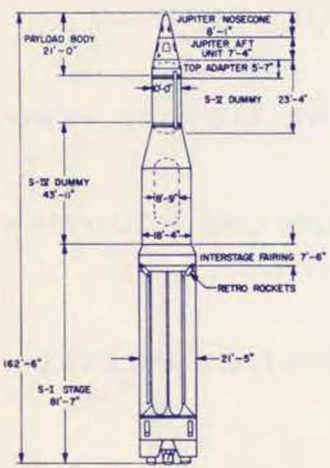


MISSION HIGHLIGHTS

- LAUNCHED WITH NO VEHICLE TECHNICAL HOLDS
- MAXIMUM ALTITUDE -- 65 NAUTICAL MILES
- MAXIMUM RANGE -- 50 NAUTICAL MILES
- AIRFRAME STRUCTURAL INTEGRITY VERIFIED
- CONTROL PERFORMANCE AND RELIABILITY VERIFIED
- COMPATABILITY TO GROUND SUPPORT EQUIPMENT VERIFIED
- PROJECT HIGHWATER EXPERIMENT COMPLETED SUCCESSFULLY

APRIL 25, 1962

The SA-3 carried on the experiments of the SA-2 flight, including the Highwater project. In addition, one of the first experiments necessary for the development of the Block II vehicle phase was conducted: the firing of four solid-fuel retro-rockets identical to those to be used in the Block II phase stage separation sequence, although the upper stages were not intended to separate in the Block I rockets. Other experiments related to the Block II vehicles were performed successfully, as was an experiment related to the Centaur program.



Typical scene at the Launch Control Center of Launch Complex 34 during a Saturn launch.

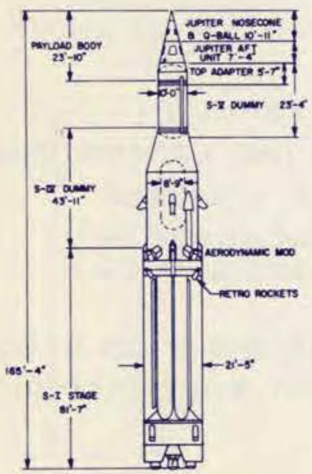
MISSION HIGHLIGHTS

- MAXIMUM ALTITUDE -- 104 NAUTICAL MILES
- MAXIMUM RANGE -- 131 NAUTICAL MILES
- AIRFRAME STRUCTURAL INTEGRITY VERIFIED
- CONTROL PERFORMANCE AND RELIABILITY VERIFIED
- COMPATIBILITY TO GROUND SUPPORT EQUIPMENT VERIFIED
- TEST OF BLOCK II SWING ARMS
- TEST OF PROTOTYPE HORIZON SENSOR
- FLIGHT TEST OF PASSENGER STABILIZED PLATFORM
- TEST OF PULSE CODE MODULATION (PCM) AND UHF TELEMETRY
- TEST OF BLOCK II HEAT SHIELD PANEL
- TEST FIRING OF RETROROCKETS (NO SEPARATION)
- SIMULATION OF BLOCK II ULLAGE VOLUMES
- ACHIEVEMENT OF SIGNIFICANT INCREASE IN PROPELLANT UTILIZATION THROUGH NEW CUTOFF METHOD
- CENTAUR ROCKET PRESSURE DISTRIBUTION STUDY
- PROJECT HIGHWATER EXPERIMENT SUCCESSFULLY COMPLETED

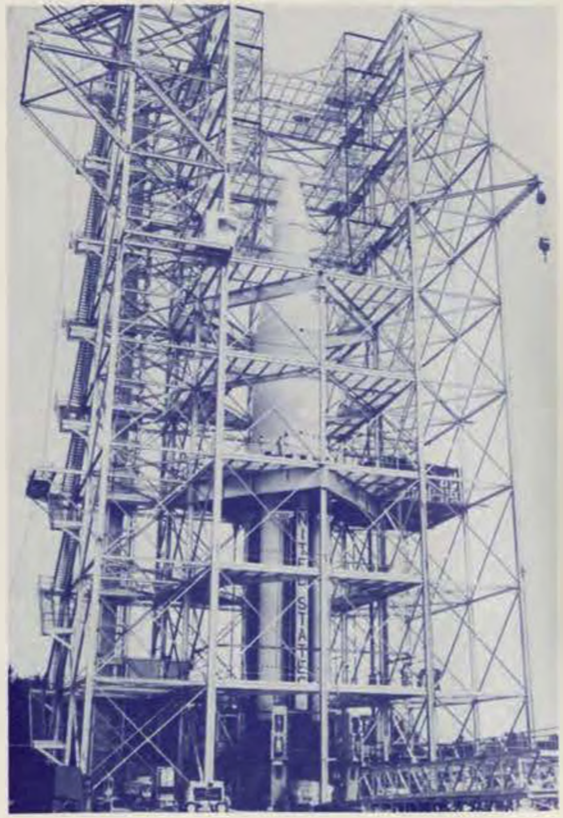
NOVEMBER 16, 1962

The SA-4 was the final vehicle of the Block I phase. Besides carrying on the experiments of the first three Saturns, the SA-4 carried considerable amounts of equipment to be used in the Block II phase. The external characteristics of the SA-4 vehicle reflected more closely the Block II design than any previous vehicle. In addition to the retro-rockets added to the design on SA-3, dummy camera pods were attached to the S-I stage to simulate the actual camera pods that would be used on some of the Block II vehicles. Also, and far more obvious, dummy aerodynamic protuberances were added to the inert S-IV stage to simulate the ullage rockets that would be used on the live rocket stage.

A special feature of the clustered engine concept is that, if an engine fails past a critical point on a flight path, it may be possible to carry out the mission by utilizing the remaining operating engines. If a vehicle is specifically designed to do this, as was the Saturn I, the vehicle is said to have an "engine-out capability."



Since the Saturn engine-out capability had not been demonstrated, it was decided to program a premature cutoff of one engine as an experiment on the SA-4 flight to demonstrate the validity of the design calculations. One of the engines was cut off deliberately after 100 seconds of flight time, and the remaining portion of the flight was made using only seven engines. The flight performed as calculated, and the engine-out principle was proven to be a valid engineering approach.



Full-scale model mockup of Block I vehicle undergoes vibration analysis in this dynamic test tower at MSFC to insure perfect engineering in the flight models.

MISSION HIGHLIGHTS

- MAXIMUM ALTITUDE -- 81 NAUTICAL MILES
- MAXIMUM RANGE -- 219 NAUTICAL MILES
- AIRFRAME STRUCTURAL INTEGRITY WAS VERIFIED FOR USE OF SOME BLOCK II AERODYNAMIC PROTRUSIONS
- CONTROL PERFORMANCE AND RELIABILITY VERIFIED
- TEST OF PROTOTYPE HORIZON SENSOR
- THERMAL FLIGHT TEST OF SELECTED SENSING DEVICES
- TEST OF BLOCK II ANTENNA PANELS
- USE OF ONBOARD PLAYBACK RECORDER FOR DATA GATHERING
- PASSENGER TEST OF Q-BALL ANGLE-OF-ATTACK DEVICE
- PASSENGER TEST OF RADAR ALTIMETER
- PASSENGER TEST OF MISTRAM DEVICE
- SUCCESSFUL ENGINE-OUT TEST
- VERIFICATION OF PROPELLANT UTILIZATION IMPROVEMENT BY CUTOFF METHOD
- TEST OF PCM AND UHF TELEMETRY
- TEST OF BLOCK II HEAT SHIELD PANELS CONTINUED
- RETROROCKET FIRING (NO SEPARATION)
- FLIGHT TEST OF PASSENGER STABILIZED PLATFORM

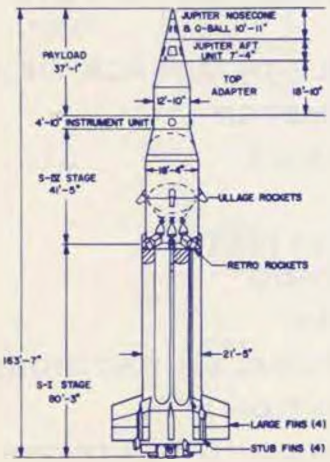
MARCH 28, 1963

SA-5

The SA-5 was the first of the Block II vehicles. While a part of the orderly evolution of the Saturn I design, it was a definite milestone. Although it still retained a Jupiter nose cone and had a payload compartment only slightly different from the dummy S-V stages of the Block I vehicles, it had a live second stage that gave the Saturn I orbital capabilities for the first time.

SA-5 in flight, shortly before first stage cutoff.

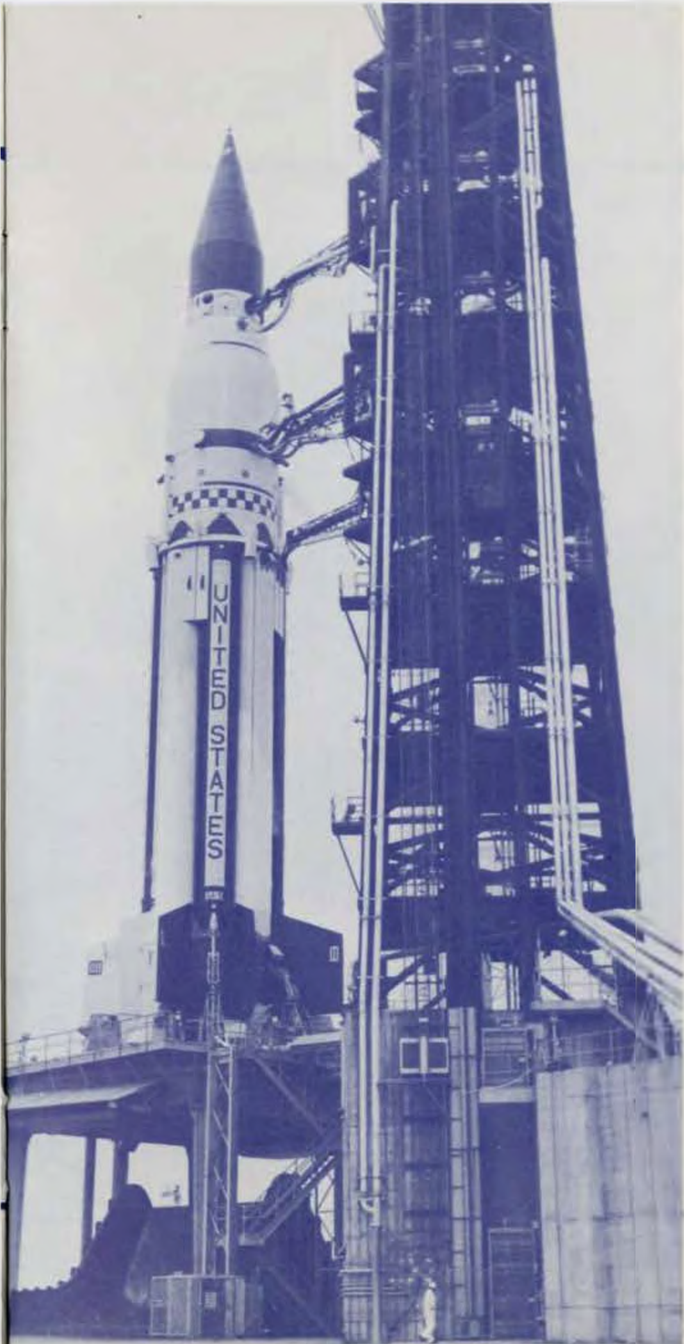
The S-IV stage itself was a major developmental milestone, being powered by a propellant combination of liquid hydrogen and liquid oxygen. Liquid hydrogen in combination with an oxidizer produces considerably more thrust than the more conventional fuels, but until recently the technology of liquid hydrogen rocketry was new. And in performance, the clustered engine concept again proved valid. Cameras recovered from the SA-5 flight recorded the S-IV stage separation and the ignition of the second stage engines.



There were many firsts on the SA-5 flight. A new Instrument Unit, prototype of the Instrument Units to be flown on later vehicles, was used. The Instrument Unit, located immediately above the S-IV stage, acted as the overall brain of the vehicle. The path of the powered portion of the flight was directed from the Instrument Unit, and many sensing and evaluating instruments were controlled through this central point.

Beginning with the SA-5, the S-I stage used the uprated H-1 engines, each of which had a thrust of 188,000 pounds. Thus, with SA-5, the first rocket with a first-stage thrust of 1,500,000 pounds was launched.

The flight was an unqualified success, injecting the largest payload then recorded into an earth orbit.



MISSION HIGHLIGHTS

- FIRST LAUNCH OF BLOCK II VEHICLE
- FIRST FLIGHT TEST OF S-IV STAGE
- FIRST FLIGHT TEST OF INSTRUMENT UNIT
- FLIGHT CONTROL UTILIZATION OF S-I STAGE FINS DEMONSTRATED
- SUCCESSFUL PASSENGER FLIGHT OF ST-124 GUIDANCE SYSTEM
- SUCCESSFUL STAGE SEPARATION
- FIRST ORBITAL SATURN VEHICLE
- FIRST SATURN VEHICLE USING UPRATED H-1 ENGINES
- SUCCESSFUL RECOVERY OF MOTION PICTURE CAMERA CAPSULES FROM S-I STAGE
- INJECTION OF 38.000-POUND SATELLITE INTO ORBIT

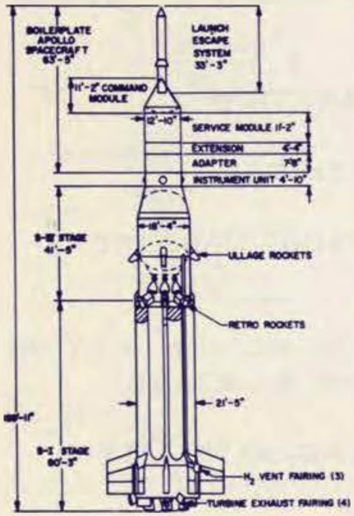
JANUARY 29, 1964

SA-6

SA-6 was the second of the developmental Block II vehicles, and the first to loft a dummy Apollo capsule. While continuing the developmental experimentation of the previous missions, SA-6 was the next step in the development of the rocket for its basic purpose--the development of a two-stage launch vehicle that would be used in support of the Apollo manned program.

The S-IV stage blasts away from the S-I stage as separation is completed.

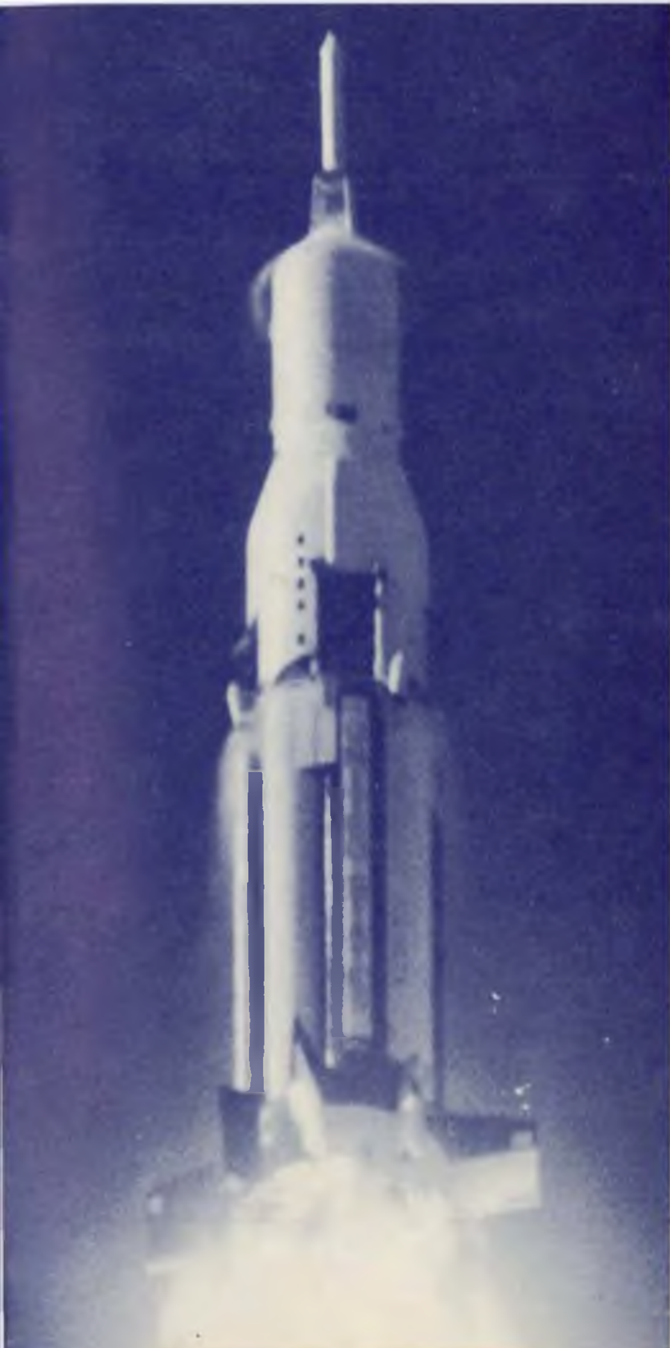
The mission objectives were extensions of those of the SA-5 vehicle. In addition to the basic mission objectives of SA-5, the sixth Saturn vehicle was to demonstrate capabilities, such as the in-flight environmental parameters of the spacecraft and the normal jettisoning of the Launch Escape System tower, that would assist in designing the manned Apollo vehicles.



Like the SA-5 vehicle, the SA-6 had motion picture cameras on board that recorded the propellant consumption of the S-I stage and the separation of the S-I and S-IV stages. These cameras were attached to the vehicle in special recoverable camera pods. After the separation of the stages, the camera pods were ejected from the S-I stage and, with it, continued in a ballistic trajectory. Unlike the stage, however, the camera pods were equipped with special recovery parachute devices that enabled the camera pods to land relatively intact in the ocean downrange where they were recovered by ship.

The SA-6 vehicle demonstrated the validity of the clustered engine concept and the value of the engineering planning of an "engine-out" capability. One of the engines aboard the vehicle cut off prematurely. Although this was not part of the programmed flight, the performance of the remaining seven engines ensured the successful completion of the mission.

The SA-6 injected the spent S-IV stage, the Instrument Unit, and the Apollo Spacecraft assembly into orbit, having a total weight substantially in excess of 18 tons.



MISSION HIGHLIGHTS

- DEMONSTRATION OF PHYSICAL COMPATIBILITY OF THE LAUNCH VEHICLE AND THE FIRST APOLLO BOILERPLATE
- PARTIAL ACTIVE TEST OF THE ST-124 SYSTEM
- FIRST TEST OF GUIDANCE VELOCITY AT CUTOFF
- SUCCESSFUL MISSION WITH PLANNED LARGE ANGLE OF ATTACK
- RECOVERY OF MOTION PICTURE CAPSULES FROM S-I STAGE
- DEMONSTRATION OF LAUNCH ESCAPE SYSTEM UNDER FLIGHT CONDITIONS
- ENGINE-OUT CAPABILITY SHOWN IN ACTUAL ENGINE CASUALTY
- INJECTION OF 37.000-POUND SATELLITE INTO ORBIT

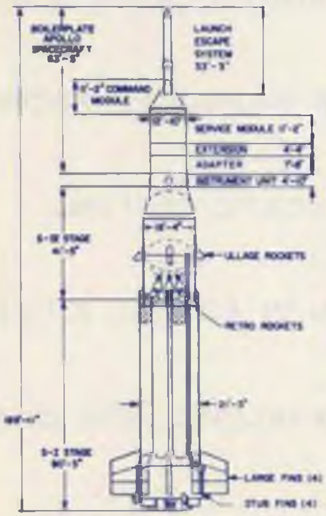
MAY 28. 1964

SA-7

The SA-7 was the first of the Block II vehicles that was considered operational. The unparalleled success of the Saturn I program allowed the research and development phase of the Saturn I program to be completed earlier than had been expected.

An important mission of SA-7 was to demonstrate a different method of jettisoning the Launch Escape System tower from the one used aboard SA-6. It is necessary to jettison these towers once the rocket reaches a point where they would no longer be useful, and the successful demonstration of two different methods of this operation shows flexibility that can prove useful for eventual design situations.

Two SA-7 camera pods, which were recovered after seven weeks--the delay caused by Hurricane Gladys.



Many of the remaining missions were similar to those of SA-6, with some being extensions of the missions of the earlier vehicle. The movie camera setup was the same, although the results were a little different than had been anticipated, due to the intervention of a hurricane. When the camera pods had been ejected, they re-entered flawlessly, but landed in a region of the sea close to Hurricane Gladys, and the hurricane closed in before the capsules could be recovered. Though given up for lost, two of the capsules washed ashore after seven weeks, none the worse for wear, save for the acquisition of a few barnacles.

The overall mission of SA-7, however, was the same--the injection into orbit of a dummy Apollo spacecraft, an S-IV stage, and the Instrument Unit--a total weight of 19 1/2 tons.

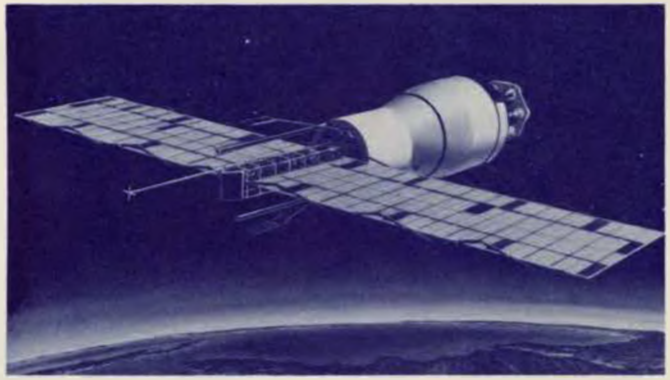
MISSION HIGHLIGHTS

- FIRST COMPLETE FLIGHT TEST OF ST-124 SYSTEM USING CLOSED LOOP
- FIRST FLIGHT DEMONSTRATION OF THE SPACECRAFT ALTERNATE L.E.S. TOWER JETTISON MODE
- FIRST TEST OF S-IV STAGE NON-PROPULSIVE VENTING SYSTEM
- PASSENGER TEST OF S-I AREA FIRE DETECTION SYSTEM
- FIRST TEST NOT USING S-IV STAGE LOX BACKUP PRESSURIZATION SYSTEM
- THIRD FLIGHT TEST OF INSTRUMENT UNIT
- FIRST FLIGHT OF ACTIVE ASC TIME TILT POLYNOMIAL SYSTEM FOR THE S-I STAGE
- THIRD ORBITAL FLIGHT; SECOND ORBITAL FLIGHT OF EXPENDED S-IV STAGE, INSTRUMENT UNIT, AND APOLLO BOILERPLATE, HAVING AN APPROXIMATE WEIGHT OF 39,100 POUNDS

SEPTEMBER 18, 1964

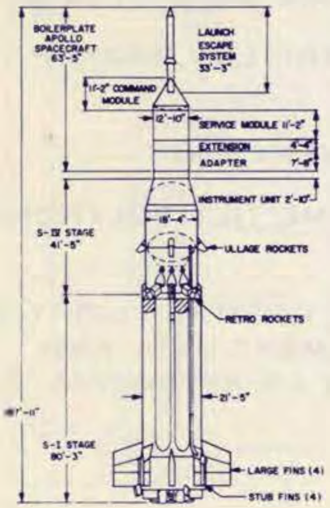
SA-9

The vehicle designated SA-9 was the next vehicle launched after SA-7. The reason for the mismatch between vehicle numbers and flights is that two of the Saturn I rockets were scheduled to have first stages that were manufactured by private industry, the Chrysler Corporation Space Division; these rockets were designated SA-8 and SA-10. Although the last rocket with an MSFC-manufactured first stage was to be launched before the first one using Chrysler-built stages, it was numbered SA-9, since it was launched after SA-7 and the SA-8 designation had already been assigned.

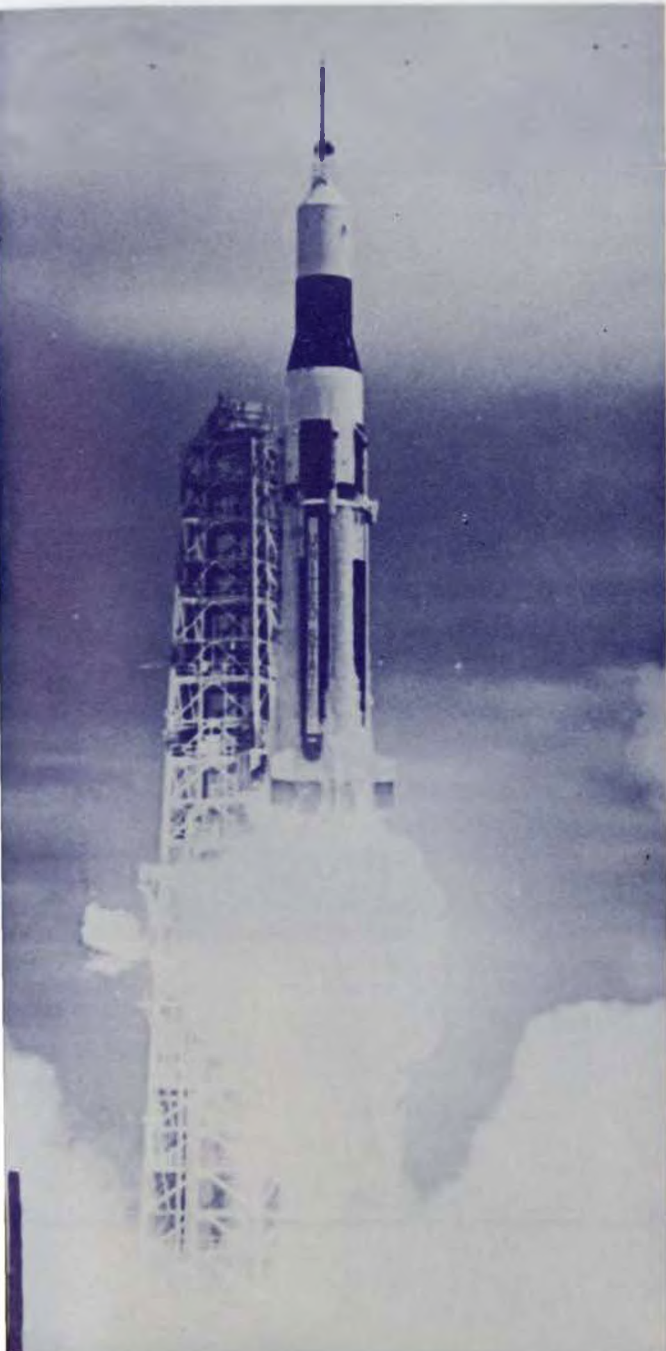


An artist's concept of the Pegasus satellite, with the wings fully deployed.

This was the first of the later Block II vehicles. One of the major differences between the earlier and later Block II vehicles was in the design of the Instrument Unit. The earlier Instrument Unit was divided into "conditioned" tubular sections. Each section was pressurized and the components were enclosed within the sections, surrounded by an inert gas for environmental control. The later Instrument Unit was not pressurized; the components had no external temperature control. The components were mounted to the wall of the IU, which was merely a wall cylinder, and some of them had individual prelaunch heating elements incorporated into their design.



The SA-9 launched the Meteoroid Technology Satellite (MTS), sponsored by the NASA office of Advanced Research and Technology, and built by the Fairchild-Hiller Corporation. This satellite was nicknamed "Pegasus" after the winged horse of Greek mythology because it had two vast "wings," which consisted of panels to detect meteoroid impacts. Impact information was transmitted to the ground. In addition to the fundamental scientific value of such data, the information of meteoroid density is of extreme importance for our manned space program, since it gives us an idea of the penetration hazards of meteoroids to be encountered in an earth orbit environment.



MISSION HIGHLIGHTS

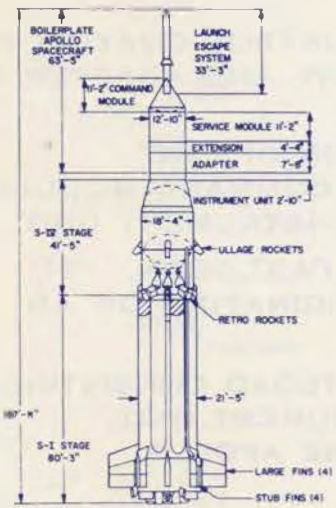
- FIRST SATURN ROCKET WITH AN OPERATIONAL PAYLOAD
- PEGASUS SATELLITE DEMONSTRATES FUNCTIONAL OPERATIONS
- EVALUATION OF CLOSED-LOOP GUIDANCE ACCURACY
- FIRST FLIGHT UTILIZATION OF ITERATIVE GUIDANCE SCHEME
- FIRST FLIGHT OF AN IMPROVED, NONPRESSURIZED INSTRUMENT UNIT
- EVALUATION OF A THERMAL CONTROL COATING FOR S-IV STAGE, INSTRUMENT UNIT, AND ADAPTER OF SERVICE MODULE
- DEMONSTRATION OF SEPARATION OF THE BOILERPLATE SERVICE AND COMMAND MODULES FROM THE S-IV STAGE AND INSTRUMENT UNIT
- FIRST LIVE, HIGH-RESOLUTION, FAST-SCAN, TELEVISION BROADCAST ORIGINATING ON AN ORBITING SATELLITE
- ORBITING OF 33,900-POUND PAYLOAD CONSISTING OF SPENT S-IV STAGE, INSTRUMENT UNIT, PEGASUS SATELLITE, AND THE APOLLO COMMAND MODULE

FEBRUARY 16, 1965

The SA-8 flight was a milestone in the Saturn program. For the first time, both powered stages of the rocket were manufactured by private industry--the S-I stage by Chrysler Corporation, and the S-IV stage by Douglas Aircraft. As an operational vehicle, the SA-8 carried a Pegasus satellite.

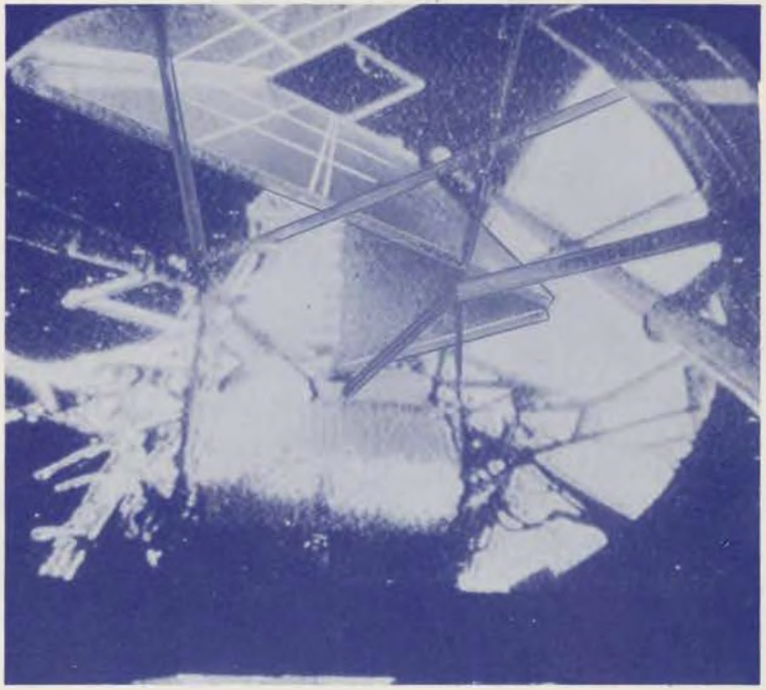
In addition to being the first industry-built Saturn, SA-8 was the first Saturn rocket to be launched at night.

Like SA-9 and SA-10, SA-8 carried an on-board live television system to observe the deployment of the Pegasus wings. Television was used for this purpose of observing the operation as it happened.



In addition to its basic mission, SA-8 continued the studies of SA-9.

The SA-8 lofted the Pegasus satellite, the spent stage, and the Instrument Unit into an orbit with a minimum altitude (perigee) of 273 nautical miles, and a maximum altitude (apogee) of 420 nautical miles.



Television from orbit. Onboard cameras transmit the unfolding of the Pegasus satellite wings.

MISSION HIGHLIGHTS

- FIRST SATURN LAUNCHED WITH BOTH STAGES BUILT BY PRIVATE INDUSTRY
- FIRST NIGHT LAUNCH OF A SATURN ROCKET
- EVALUATION OF METEOROID DATA SAMPLING IN NEAR-EARTH ORBIT
- CONTINUATION OF DEMONSTRATION OF FUNCTIONAL OPERATIONS OF THE MECHANICAL, STRUCTURAL, AND ELECTRICAL SUBSYSTEMS OF THE PEGASUS METEOROID SATELLITE
- CONTINUATION OF THE EVALUATION OF THE THERMAL COATING FOR THE EXTERIOR OF THE S-IV STAGE, INSTRUMENT UNIT, AND SERVICE MODULE ADAPTER EXTENSION
- TELEVISION COVERAGE OF THE SEPARATION OF THE BOILERPLATE COMMAND MODULE AND SERVICE MODULE FROM THE PEGASUS SATELLITE AREA
- ORBITING OF 34,100-POUND SATELLITE CONSISTING OF SPENT S-IV STAGE, INSTRUMENT UNIT, PEGASUS SATELLITE, AND THE APOLLO COMMAND MODULE

MAY 25, 1965

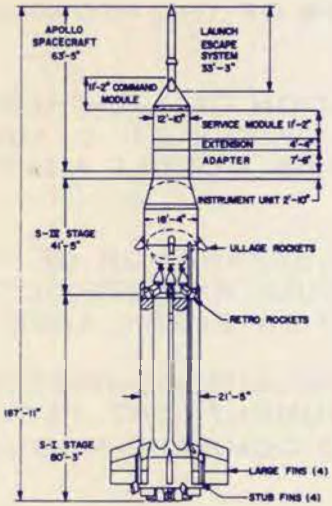
SA-10

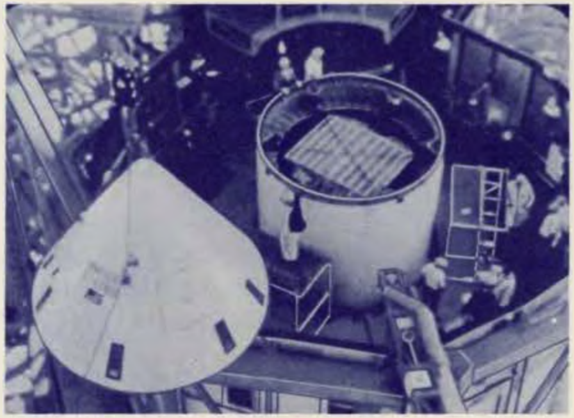
The SA-10 vehicle marked the close of the most phenomenally successful of the United States' space programs. It also carried a Pegasus satellite into orbit.

Like the two previous vehicles, SA-10 carried a Meteroid Technology Satellite. Its mission was more complex as it not only measures meteroid hazards, but also checks out the validity of its own data and those of SA-8 and SA-9. In addition, removable panels were attached to the satellite for possible later recovery by space-manuvering astronauts.

The recovery of these panels would be of great scientific value, allowing us to examine material that has been exposed to space conditions for prolonged periods of time. Indeed, the information extracted from the recovered panels could contribute materially to our future space station and lunar base design specifications.

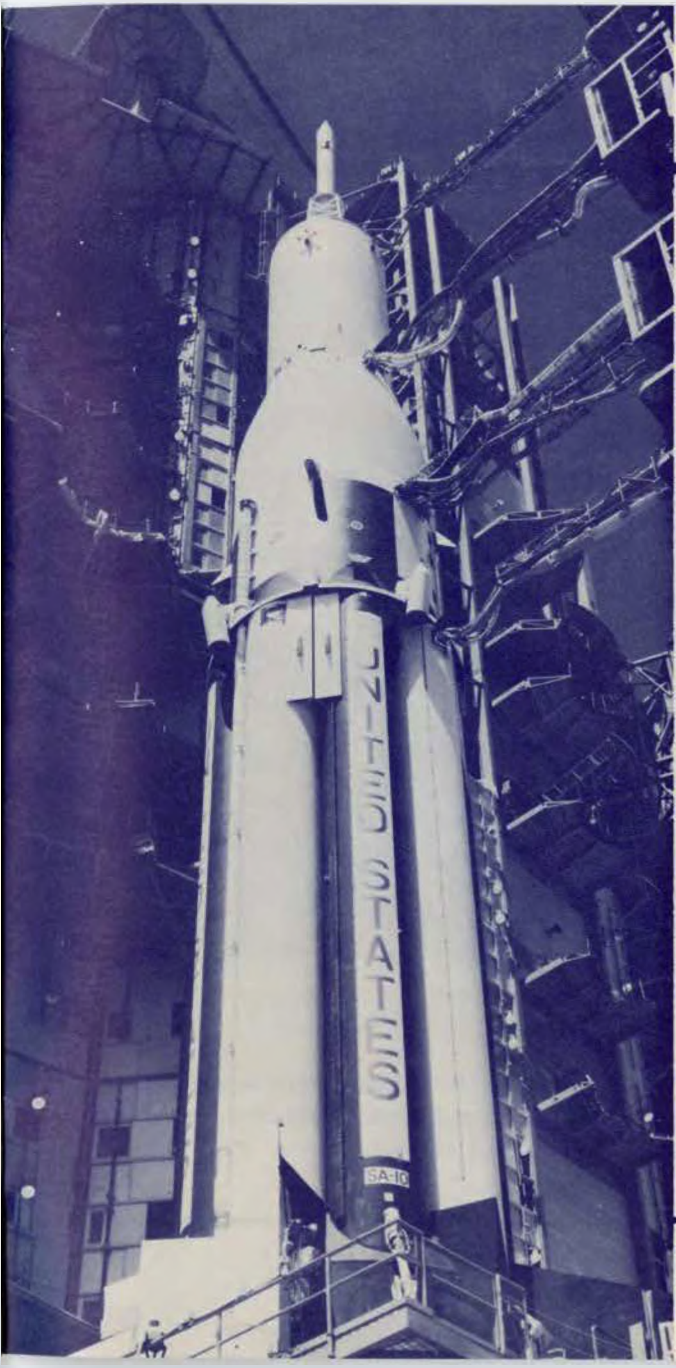
The SA-10 lofted its payload into an almost perfectly circular orbit, with a perigee of just under 286 nautical miles, and an apogee of slightly more than 287 nautical miles.





The Apollo capsule is installed on the rocket above the folded Pegasus wings. The capsule was jettisoned before the wings deployed.

Block II Instrument Units. The simplification of systems reduced weight markedly in the later version.

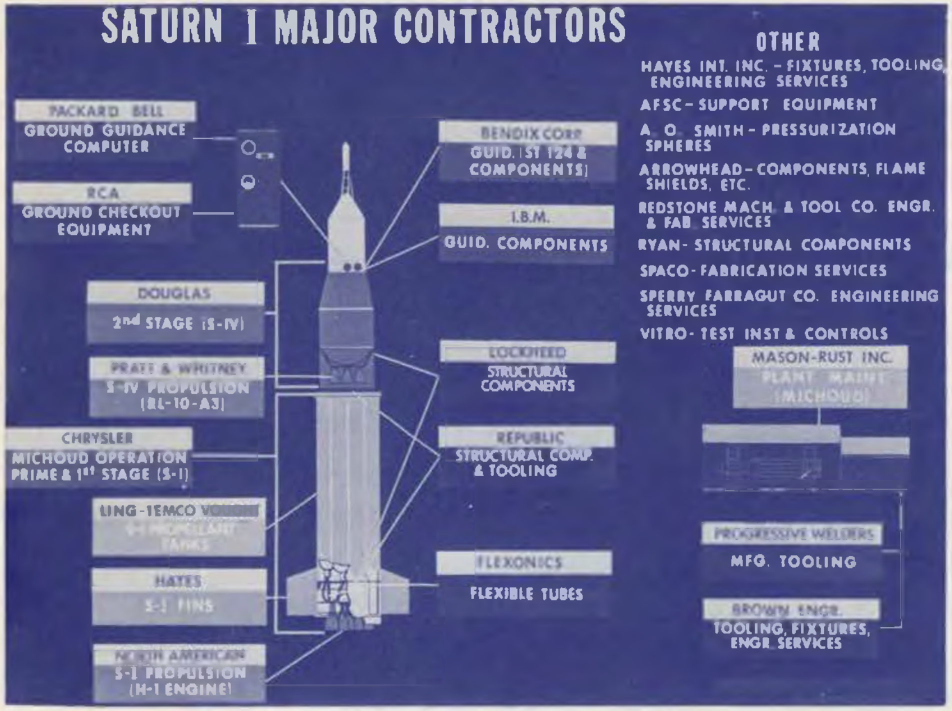


MISSION HIGHLIGHTS

- FINAL LAUNCH OF THE SATURN I SERIES
- DETERMINATION OF METEOROID PENETRATION FOR THREE DIFFERENT THICKNESSES OF ALUMINUM
- MEASUREMENT OF SATELLITE RADIATION ENVIRONMENT AND PANEL TEMPERATURE TO EVALUATE THE VALIDITY OF HIT DATA
- DETERMINATION OF THE POSITION AND ORIENTATION OF THE SATELLITE RELATIVE TO THE TIME OF HIT
- CONTINUED DEMONSTRATION OF THE ITERATIVE GUIDANCE MODE AND EVALUATION OF SYSTEM ACCURACY
- CONTINUATION OF THE EVALUATION OF THE THERMAL COATING FOR THE EXTERIOR OF THE S-IV STAGE, INSTRUMENT UNIT, AND SERVICE MODULE ADAPTER EXTENSION
- ORBITING OF 34,000-POUND PEGASUS SATELLITE, INCLUDING S-IV STAGE AND INSTRUMENT UNIT, INTO NEARLY PERFECT CIRCULAR ORBIT

JULY 30, 1965

THE NASA

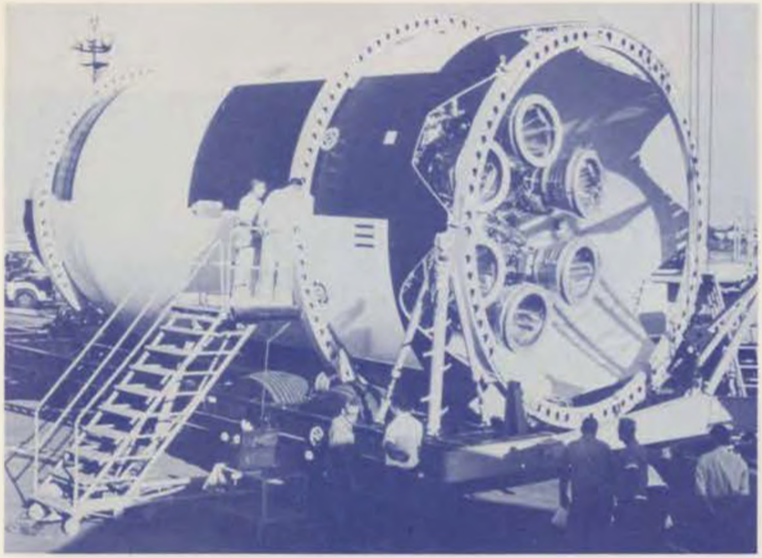


The NASA-Industry Team. These major contractors are but a fraction of the total Saturn I effort. In addition, hundreds of subcontractor companies assisted by manufacturing parts, or by supplying technical support.

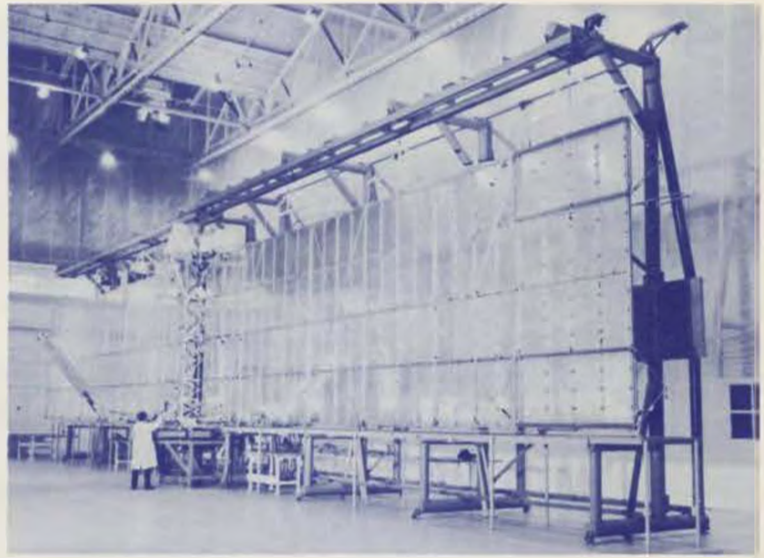
The first industry-built S-I stage is presented to NASA by Chrysler President Lynn Townsend in special ceremonies at the Michoud assembly plant.

Success, demonstrated in missions, crowns the efforts of skilled, dedicated people. Reliability was designed and built into the ten Saturn I launch vehicles, and was ensured by the active participation of the personnel of major industrial contractors under the management of MSFC, as well as by the work of NASA personnel.

INDUSTRY TEAM....



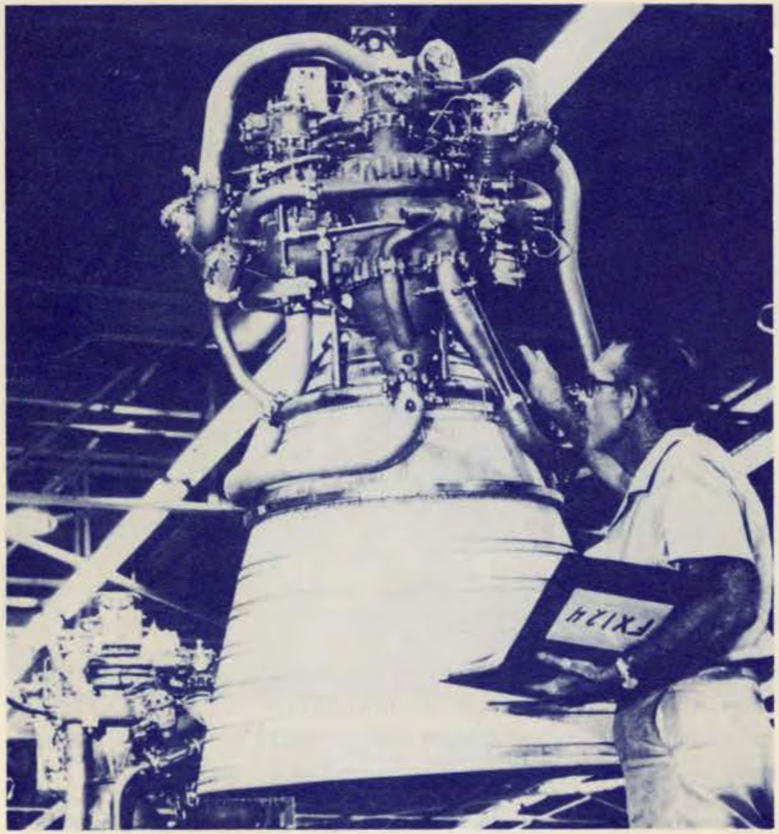
Douglas Aircraft Company engineers check out S-IV stage at their Santa Monica plant.



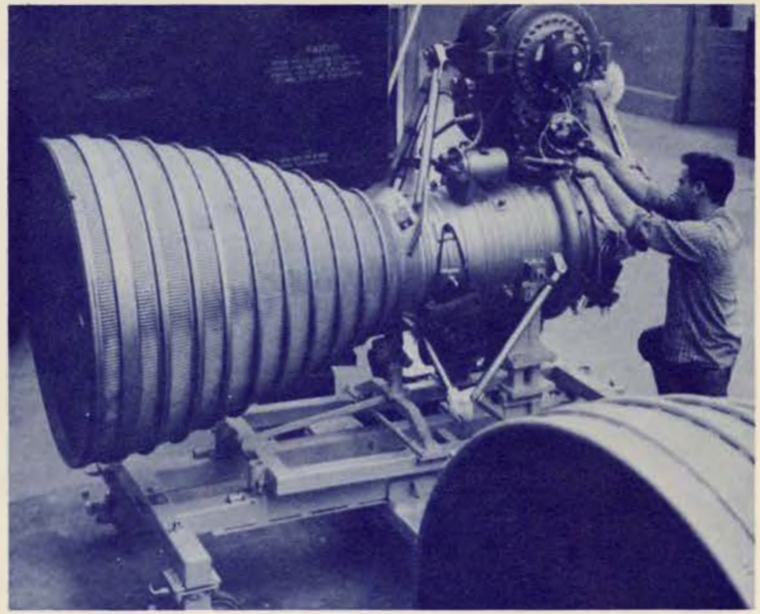
A Fairchild-Hiller engineer checks the deployment of the Pegasus satellite wings.

In this great effort to make America foremost in space, the job is too big for one group or one company or one governmental agency. The overall program management was directed by the Associate Administrator for Manned Space Flight through the NASA Centers for launch vehicle development by Marshall Space Flight Center (MSFC), payload development by Manned Spacecraft Center (MSC) and MSFC, and launch operations by Kennedy Space Center (KSC).

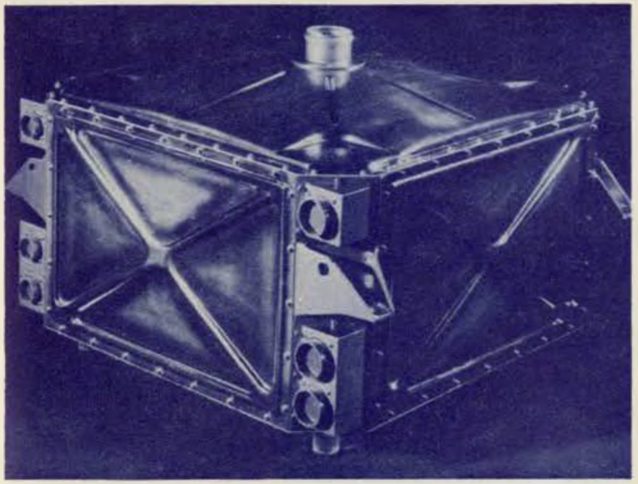
Shown on these pages are examples of the contribution the major contractors made to the Saturn I program. The companies represented are but a sampling of the hundreds of companies that have contributed to the success of the Saturn I, and that are working for the success of all future Saturn vehicles.



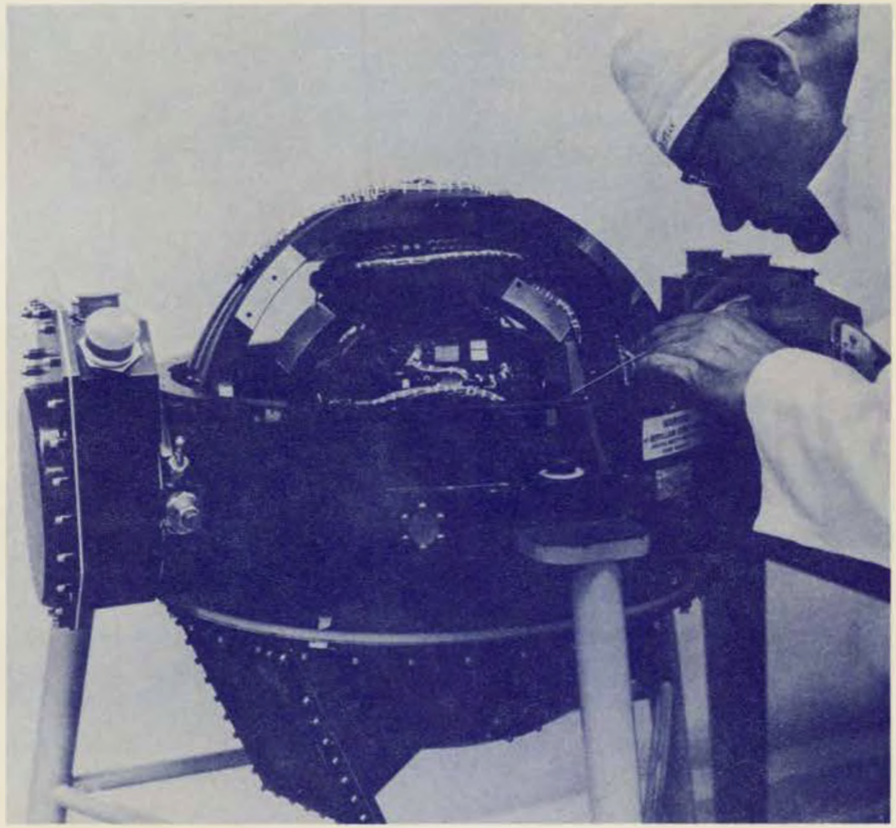
A Pratt & Whitney technician checks out an RL-10 engine at the manufacturing plant. This engine was used in a six-engine cluster on an S-IV stage.



An H-1 engine, manufactured by Rocketdyne, is given a final inspection. An uprated version of this engine is scheduled for use on later Saturn vehicles.



Guidance computers, manufactured by IBM, were used aboard the Saturn I vehicles to signal the engines to keep the rockets on course.



A Bendix stabilized platform (inertial guidance) unit is examined by a technician. These units were part of the guidance system within the Saturn I vehicles.

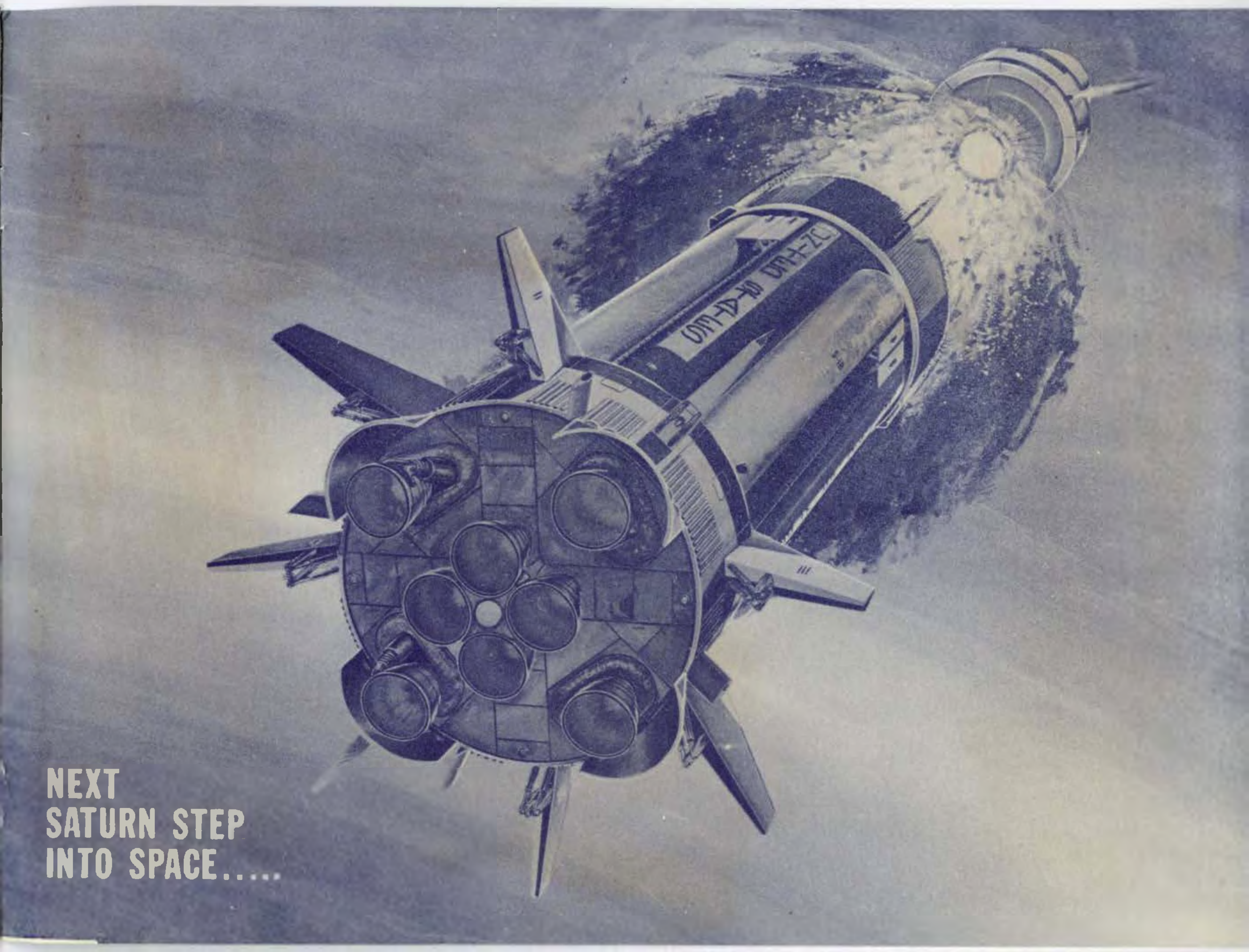
THE SUMMING UP....

The Saturn I was not only a successful program, but a very productive one. Having evolved from established design concepts, the rocket was not plagued with some of the failures normally associated with a rocket development program. We have seen the rapid course of its development, from an idea concerned only with producing a hitherto-fantastic amount of thrust to an operational vehicle capable of significant scientific research. And always within the developmental frame was the spirit of evolution and progress.

Within the frame, we have seen the necessity for the vehicles--for testing again and again, analyzing the endless minutiae whose functionings must be understood and, if necessary, corrected, so that the later vehicles to be developed in the Saturn program will be absolutely safe for the priceless human cargo that they will loft into orbit.

For, while the Saturn I program is now completed, its influence is felt strongly throughout the United States space program. The lessons learned in the Saturn I program are of inestimable value for the design of future space rockets. And the design philosophy so carefully developed throughout the ten Saturn I vehicles will perhaps preserve the lives of our astronauts as they embark on ever greater ventures.

Mighty as the Saturn I was, it was but the first step on the stairway that leads ultimately to the stars. Gigantic and massive as it loomed, already it is being dwarfed by other, more ambitious rockets. And yet, as these successors to the Saturn I lift off, Saturn I will ride with them, in a way; for, from the knowledge gained from Saturn I, the later rockets grow. And as these sons of Saturn I probe outward, and in turn are replaced by later generations, it can truly be said that the Saturn I, an early pioneer in space exploration, lives within them still.


NEXT
SATURN STEP
INTO SPACE.....

APOLLO

NASA

GEMINI FLIGHT SUMMARY

LAUNCH DATE	DESIGNATION	CREW	REMARKS
4/8/64	GEMINI I	Unmanned	Gemini spacecraft launched into orbit by modified Titan II booster. Spacecraft decayed during 69th orbit over South Atlantic Ocean, with all test objective achieved. Purpose of flight was to test the Titan launch vehicle system; Gemini spacecraft structural integrity; spacecraft launch vehicle compatibility; and to demonstrate the launch vehicle and guidance systems.
1/19/65	GEMINI II	Unmanned	Gemini spacecraft launched into suborbital flight, splashing down approximately 1,848 nautical miles southeast of Cape Kennedy, Florida. Major mission objectives, all successfully accomplished, were to demonstrate basic structural integrity of spacecraft throughout the flight environment; and to verify the adequacy of reentry heat protection. In addition, satisfactory performance was demonstrated by flight control, life support, retrograde rocket, recovery and landing, and other systems critical to flight safety and mission success. Duration--22 minutes.

LAUNCH DATE	DESIGNATION	CREW	REMARKS
3/23/65	GEMINI III	Virgil I. Grissom John W. Young	Gemini spacecraft launched into 3-revolution orbital flight by modified Titan II booster (Gemini-Titan 3). First U.S. two-man spaceflight, Grissom first man in space for 2nd time. One orbital maneuver was conducted in each of the three orbits. During 1st orbit the apogee was lowered from 139 mi. to 105 mi. and the perigee from 100 mi. to 98 mi.; in 2nd orbit a series of maneuvers produced a translational movement changing inclination by 1/50 of a degree; in 3rd orbit the perigee was lowered to 52 mi. Manual control was exercised throughout the reentry phase, using the limited lifting characteristics of the spacecraft to steer toward touchdown. Two of three experiments were performed; experiment on effect of weightlessness on sea-urchin eggs during fertilization and cell division failed; successful experiments were effect of weightlessness in interaction with radiation on white blood cells and injection of fluid into the reentry plasma sheath in attempt to attenuate communication blackout. Duration -- 4 hours, 53 minutes.

LAUNCH DATE	DESIGNATION	CREW	REMARKS
6/3/65	GEMINI IV	James A. McDivitt Edward H. White II	Gemini spacecraft launched into orbit by modified Titan II booster (Gemini-Titan 4). Four-day, 62-revolution endurance mission to test crew and spacecraft in buildup to longer missions. Eleven scientific and engineering experiments, in addition to basic medical checks on four days of exposure to the space environment, measured radiation, electrostatic charge, proton-electron flow, and geomagnetic fields. Synoptic weather and terrain photography was accomplished, as well as two-color photographs of the earth's limb. Navigation measurements were conducted, inflight phono-cardiograms taken, and bone demineralization measurements made. Attempt to rendezvous with spent 2nd stage was abandoned when spacecraft fuel consumption became excessive. White spent 22 min. outside the spacecraft in extravehicular activity, propelling himself with an oxygen-jet gun. During spacewalk he was attached to the spacecraft with a 25-ft. tether-and-oxygen line; he carried emergency oxygen and camera. Spacecraft computer malfunction necessitated a ballistic reentry sequence. First mission controlled from new Mission Control Center at Manned Spacecraft Center, Houston, Texas. Duration -- 97 hours, 56 minutes.

LAUNCH DATE	DESIGNATION	CREW	REMARKS
8/21/65	GEMINI V	L. Gordon Cooper, Jr. Charles Conrad, Jr.	Gemini spacecraft launched into orbit by modified Titan II booster (Gemini-Titan 5). Eight-day, 120-revolution endurance mission confirmed the physiological feasibility of Apollo lunar landing mission. Several major records set by U.S.: longest manned spaceflight in time and distance, total man hours in space, and most manned flights. First flight of fuel cell electrical power system. During first orbit, perigee was raised to 106 mi. from initial 100 mi. At beginning of 2nd orbit a Radar Evaluation Pod was ejected; the GEMINI V rendezvous radar furnished range and range rate data on this target for 40 mins. On 8/23 a simulated rendezvous was conducted with a series of 4 maneuvers through 2 orbits which raised the perigee to 124 mi. and lowered the apogee to 192.6 mi. Sixteen of 17 experiments were successfully conducted: 5 medical experiments measured physiological effects; extensive weather and terrain photography was conducted; visual observations of missile launches and ground patterns were made; and zodiacal light was photographed. Only experiment canceled was photography of the Radar Evaluation Pod. Voice communication was conducted with Sea Lab II under the Pacific Ocean. Duration -- 190 hours, 55 minutes.

LAUNCH DATE	DESIGNATION	CREW	REMARKS
12/4/65	GEMINI VII	Frank Borman James A. Lovell, Jr.	Gemini spacecraft boosted into orbit by modified Titan II booster (Gemini-Titan 7). Fourteen-day, 206-revolution endurance mission, longest scheduled flight in Gemini program. Station-keeping conducted with booster 2nd stage after separation; spacecraft maneuvered to raise apogee from original 100 mi. to 138 mi. to serve as rendezvous target for Gemini 6. On 12/7 orbit was adjusted to 197 mi. apogee 145 mi. perigee, then on 12/9 perigee was raised to 185.8 mi. and apogee lowered to 188.3 mi. Missile reentry was observed over Pacific on 12/14. Accurate controlled reentry was made, landing 7.6 mi. from target. One astronaut at a time doffed his pressure suit to enhance comfort. No adverse physiological effects from 2 weeks in the space environment. Twenty experiments were incorporated into the mission, ranging from detailed medical measurements and sleep analysis to earth photography and radiometry measurements. Duration -- 330 hours, 35 minutes.

LAUNCH DATE	DESIGNATION	CREW	REMARKS
12/15/65	GEMINI VI-A	Walter M. Schirra, Jr. Thomas P. Stafford	Gemini spacecraft launched into 16 revolution orbital flight by modified Titan II booster (Gemini-Titan 6). This spacecraft-booster combination was originally ready for launch on 10/25 but held when Agena target vehicle failed to orbit. Rescheduled to rendezvous with GEMINI VII as target, launch attempted on 12/12 but aborted when the 1st stage engine shut down immediately after ignition. Initial orbit was: apogee, 161 mi., perigee 100 mi.; a series of posigrade maneuvers began the rendezvous chase and shortened the initial 1,200 mi. separation distance to 730 mi. During 2nd revolution the distance was reduced to 300 mi. with another thruster firing, followed by a plane change to match GEMINI VII's orbit. Orbit was adjusted to near circular at beginning of 3rd revolution; as 4th revolution began, the terminal phase of rendezvous was initiated, resulting in approach to within 1 ft. of GEMINI VII. Station keeping and fly-around maneuvers were conducted for 5 hrs. 19 min. Controlled reentry to landing within 13 mi. of prime recovery ship. Duration--25 hours, 51 minutes.

LAUNCH DATE	DESIGNATION	CREW	REMARKS
3/16/66	GEMINI VIII	Neil A. Armstrong David R. Scott	Gemini spacecraft launched into orbit by modified Titan II booster, 1 hr. 41 min. after Gemini Agena Target Vehicle (GATV) · Atlas booster combination. Rendevzous with the GATV was accomplished in fourth orbit, 6 hours after launch, and first docking of two vehicles in space achieved 33 minutes later. After 28 minutes of flight in the docked configuration a thruster in the orbital attitude maneuvering system stuck open and spacecraft began to spin. Gemini spacecraft was undocked from GATV and, after 25 minutes, was stabilized by use of reentry control system. Mission terminated early after 6 1/2 revolutions, landing in secondary recovery area in Western Pacific. Scheduled extra vehicular activity (EVA) was not accomplished. GATV was placed in a "storage" orbit for later use as a rendezvous target. Duration--10 hrs. 41 min.
6/3/66	GEMINI IX-A	Thomas P. Stafford Eugene A. Cernan	First mission attempt made on 5/17 when an Atlas booster engine failed at 121 seconds after lift off, and the GATV failed to reach orbit. A back-up mission utilizing Augmented Target Docking Adapter (ATDA) as the target, scheduled for 6/1.

LAUNCH DATE	DESIGNATION	CREW	REMARKS
6/3/66			The ADTA was placed into orbit on 6/1 with an Atlas booster, but inability of Gemini spacecraft to receive final guidance information caused postponement of Gemini launch to 6/3 when spacecraft was launched into 45-revolution orbital flight by its modified Titan II booster. Rendezvous with ATDA achieved on third orbit. Crew confirmed that shroud covering the docking collar had failed to separate and docking was cancelled. Two additional rendezvous performed as planned, one using visual techniques and the last from above the ATDA. EVA delayed from 6/4 to 6/5 due to crew fatigue. After 1 hour of EVA, Cernan's visor accumulated fog and communications between Stafford and Cernan were poor as Cernan checked out the Astronaut Maneuvering Unit (AMU) in the adapter section of the spacecraft. Planned use of the self-contained life support and propulsion systems to maneuver with the AMU was cancelled. Total 2 hr. 7 min. EVA. Radio polarization and photographic experiments were conducted in addition to micrometeoroid collection. Controlled reentry to .42 miles of target. Duration--72 hours, 21 minutes.

LAUNCH DATE	DESIGNATION	CREW	REMARKS
7/18/66	GEMINI X	John W. Young Michael Collins	GATV-Atlas booster combination launched 100 minutes before Gemini spacecraft launched into orbit by modified Titan II booster. Rendezvous and docking with GATV accomplished in fourth orbit of 43-revolution flight. GATV engine used to propel the docked combination to record altitude, then proper orbit to rendezvous with GATV from Gemini VIII. After separation from GATV, Gemini IX-A effected rendezvous with the passive target. First period of stand up EVA was terminated at 50 minutes when both crewmen suffered eye irration. Second EVA period, after rendezvous with passive GATV, consisted of Collins on umbilical moving to GATV and recovering micrometeorite experiment package. Umbilical EVA terminated after 39 minutes to conserve maneuvering fuel. Of 14 scheduled experiments, data was obtained on 12. First rendezvous with two different spacecraft, first extensive test of docked spacecraft, first post-docking maneuvers using propulsion unit and fuel of target vehicle, first crewman to touch another spacecraft. New altitude and speed (17,700 st. mi. per hour) records for manned space flight. Duration--70 hours, 47 minutes.

LAUNCH DATE	DESIGNATION	CREW	REMARKS
9/12/66	GEMINI XI	Charles Conrad, Jr. Richard F. Gordon, Jr.	GATV-Atlas booster combination launched 1 hr. 37 min. before Gemini spacecraft launched into orbit by modified Titan II booster within 2-second launch window. Rendezvous accomplishes on first orbit of 44-revolution flight using onboard information exclusively. Docking at 1 hr. 34 min. after launch. Docking accomplished twice by each crewman. During umbilical EVA, Gordon removed the nuclear emulsion experiment package and attached tether between Gemini spacecraft and GATV. Excessive fatigue from these activities caused early termination of EVA at 33 minutes. After returning to, and repressurizing spacecraft, the hatch was opened for 3 minutes to jettison umbilical EVA equipment. Using GATV primary propulsion system, docked configuration was propelled to new altitude and speed (17,943 st. mi. per hour) records. Hatch opened third time for 2 hr. 10 min. standup EVA during which scheduled photography was accomplished. Two spacecraft undocked and station keeping by use of 100 feet nylon tether exercised with a slow spin rate imparted to the tethered combination. After separation of the tether, a second rendezvous with GATV was conducted from

LAUNCH DATE	DESIGNATION	CREW	REMARKS
9/12/66			25 mile separation. Reentry sequence was fully automatic for the first time with impact 2.9 miles from the aiming point. Ten of 11 scheduled experiments were conducted as planned, power tool evaluation cancelled due to shortened umbilical EVA. Duration--71 hours, 17 minutes.
11/11/66	GEMINI XII	James A. Lovell, Jr. Edwin E. Aldrin, Jr.	GATV-Atlas booster combination launched 1 hr. 38 min. before Gemini spacecraft launched into orbit by modified Titan II booster. Rendezvous accomplished in third orbit of 59-revolution flight with docking 4 hr. 14 min. after Gemini launch. Scheduled boost of docked Gemini-GATV combination into higher orbit cancelled due to pressure fluctuations in GATV primary propulsion system. The docked combination was maneuvered to obtain photographs of solar eclipse during the 10th revolution. Two standup EVA periods, on first and third days, totalled 3 hrs. 34 min. On second day, Aldrin conducted 2 hrs. 6 min. umbilical EVA, testing restraint devices to overcome body positioning problems experienced on prior flights. Resting frequently, Aldrin utilized portable hand rails, foot restraints, and various tethers. He completed 19 tasks, demonstrating useful EVA work was feasible

LAUNCH DATE	DESIGNATION	CREW	REMARKS
11/11/66			with proper planning and restraint devices. Gemini and GATV spacecraft undocked, remaining joined by 100 ft. tether for station keeping and gravity gradient stabilization experiment. Fourteen experiments conducted. Automatic reentry sequence used for second time. Duration--94 hours, 35 minutes.

NASA-S-66-11915

EXPERIMENT PROGRAM SUMMARY

SPONSORING AGENCY	NO. OF EXPERIMENTS	TOTAL EXP MISSIONS
○ SCIENTIFIC		
∘ OSSA(S)	17	47
○ TECHNOLOGICAL		
∘ OART (T)	2	2
∘ OMSF (MSC)	10	18
∘ DOD (D)	15	26
○ MEDICAL		
∘ MEDICAL (M)	8	18
TOTALS	52	111

NASA HQ MC 67-5877
2/23/67

NASA-S-66-12109

PRINCIPAL INVESTIGATORS AND AFFILIATIONS
PART I

NAME	EXPERIMENTER	AFFIL	MISSIONS
ZODIACAL PHOTOGRAPHY	NEY	U OF M	V, VIII, IX, X
SEA URCHIN EGG GROWTH	YOUNG	AMES	III
FROG EGG GROWTH	YOUNG	AMES	VIII, XII
RADIATION ON BLOOD	BENDER	AEC	III, XI
TERRAIN PHOTOGRAPHY	LOWMAN	GSFC	IV, V, VI, VII, X, XI, XII
WEATHER PHOTOGRAPHY	NAGLER, SOULES	USWB	IV, V, VI, VII, X, XI, XII
CLOUD TOP SPECTROMETER	SAIEDY	ESSA	V, VIII
VISUAL ACUITY	DUNTLEY	U OF C	V, VII
NUCLEAR EMULSION	SHAPIRO FICHTEL	NRL GSFC	VIII, XI
AGENA MICRO COLLECT	HEMENWAY	DUDLEY	VIII, IX, X, XII
AIRGLOW PHOTOGRAPHY	KOOMEN	NRL	IX, XI, XII
MICROMETEORITE COLLECT	HEMENWAY	DUDLEY	IX, X, XII
UV ASTRONOMICAL CAMERA	HENIZE	NWU	X, XI, XII
ION WAKE MEASUREMENT	MEDVED	EOS	X, XI
LIBRATION PHOTOGRAPHY	MORRIS	USGS	XII
DIM SKY ORTHICON	HEMENWAY	DUDLEY	XI
DAYTIME SODIUM CLOUD	BLAMONT	CNRS	XII

NASA HQ MC 67-5880
2/23/67

NASA-S-66-12110

PRINCIPAL INVESTIGATORS AND AFFILIATIONS

PART II

NAME	EXPERIMENTER	AFFIL	MISSIONS
REENTRY COMMUNICATIONS	SCHROEDER	LRC	III
MANUAL SPACE NAVIGATION	SMITH CREER	AMES	XII
ELECTROSTATIC CHARGE	LAFFERTY	MSC	IV, V
PROTON-ELECTRON SPECTROMETER	MARBACH	MSC	IV, VII
FLUX-GATE MAGNETOMETER	WOMACK	MSC	IV, VII, X, XII
OPTICAL COMMUNICATION	LILLY	MSC	VII
LUNAR SPECTRAL REFLECTANCE	STOKES	MSC	X
BETA SPECTROMETER	MARBACH	MSC	X, XII
BREMSSTRAHLUNG SPECTROMETER	LINDSEY	MSC	X, XII
COLOR PATCH PHOTOGRAPHY	BRINKMAN	MSC	X
EARTHS LIMB PHOTOGRAPHY	PETERSEN	MIT	IV
LANDMARK MEASUREMENTS	MANRY	MSC	VII, X

NASA HQ MC 67-5881
2/23/67

NASA-S-66-12128

PRINCIPAL INVESTIGATORS AND AFFILIATIONS

PART III

NAME	EXPERIMENTER	AFFIL	MISSIONS
BASIC OBJECT PHOTO	KOZUMA	SSD	V
NEARBY OBJECT PHOTO	KOZUMA	SSD	V
MASS DETERMINATION	HAMBORSKI	SSD	VIII, XI
SPACE OBJ RADIOMETRY	BRENTNALL	SSD	V, VII
STAR OCCULTATION NAVIG	JORRIS	AFAL	VII, X
SURFACE PHOTOGRAPHY	KOZUMA	SSD	V
CELESTIAL RADIOMETRY	LOVETT	AFCRL	V, VII
RADIATION IN SC	JANNI	AFWL	IV, VI
SIMPLE NAVIGATION	SILVA	AFAL	IV, VII
ION ATTITUDE CONTROL	SAGALYN	AFCRL	X, XII
MANEUVERING UNIT	GIVENS	SSD	IX
ASTRONAUT VISIBILITY	DUNTLEY	UOFC	V, VII
UHF-VHF POLARIZATION	ELLIS	NRL	VIII, IX
IMAGE INTENSIFICATION	SHOPPLE	NADC	VIII, XI
POWER TOOL	MAY	AFAPL	VIII, XI

NASA HQ MC 67-5882
2/23/67

NASA-S-66-11959

PRINCIPAL INVESTIGATORS AND AFFILIATIONS

PART IV

NAME	EXPERIMENTER	AFFIL	MISSIONS
CARDIOVASCULAR CONDITIONING	DIETLEIN	MSC	V, VII
EXERCISER	RAPP	MSC	IV, V, VII
PHONOCARDIOGRAM	JOHNSON	MSC	IV, V, VII
BIOASSAYS BODY FLUIDS	LIPSCOMB	MSC	VII, VIII, IX
BONE DEMINERALIZATION	MACK	TWU	IV, V, VII
CALCIUM BALANCE STUDY	WHEDON	NIH	VII
INFLIGHT SLEEP ANALYSIS	KELLOWAY	BAYLOR	VII
HUMAN OTOLITH FUNCTION	GRAYBIEL	USNSAM	V, VII

-S-66-11889

EXPERIMENT PERFORMANCE STATUS

GEMINI MISSION	LAUNCHED	ACCOMPLISHED	PROBLEMS
III	3	2	EQUIP
IV	11	11	
V	17	16	MISSION
VI-A	3	3	
VII	20	17	EQUIP
VIII	10	1	MISSION
IX-A	7	6	MISSION
X	15	12	MISSION
XI	11	10	MISSION
XII	14	12	EQUIP
TOTALS	111	90	

NASA HQ MC 67-5910
2/24/67

GPO 918-966

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
ASTRONAUT STATUS
OCTOBER, 1968

GROUP I: (7) Selected 4/9/59	Carpenter*, Cooper, Glenn*, Grissom*, Schirra, Shepard, Slayton. * Carpenter returned to U.S. Navy at Navy's request to participate in Deep Submergence Systems Project (SEALABs). Glenn resigned to enter politics, now a businessman and NASA consultant. Grissom died in Apollo 204 accident, Cape Kennedy, 1/27/67.
GROUP II: (9) Selected 9/17/62	Armstrong, Borman, Conrad, Lovell, McDivitt, See*, Stafford, White*, Young. * See died in St. Louis jet crash with Bassett 2/28/66. White died in Apollo 204 accident 1/27/67.
GROUP III: (14) Selected 10/8/63	Aldrin, Anders, Bassett*, Bean, Cernan, Chaffee*, Collins, Cunningham, Eisele, Freeman*, Gordon, Schweickart, Scott, Williams*. * Bassett died in jet crash with See 2/28/66. Chaffee died in Apollo 204 accident 1/27/67. Freeman died in jet crash near Houston 10/31/64. Williams died in jet crash near Tallahassee, Fla. 10/6/67.
GROUP IV: (6) Selected 6/28/65 Scientist/ Astronauts	Garriott, Gibson, Graveline*, Kerwin, Michel, Schmitt. * Graveline resigned.
GROUP V: (19) Selected 4/4/66	Brand, Bull*, Carr, Duke, Engle, Evans, Givens*, Haise, Irwin, Lind, Lousma, Mattingly, McCandless, Mitchell, Pogue, Roosa, Swigert, Weitz, Worden * Givens died in an automobile crash near Houston 6/6/67. Bull resigned.

GROUP VI: (11) Selected 8/4/67 Scientist/ Astronauts	Allen, Chapman, England, Henize, Holmquest, Lenoir, Llewellyn*, Musgrave, O'Leary*, Parker, Thornton. * Llewellyn resigned. O'Leary resigned.

RECAPITULATION

Total Selected.......................66
Losses...............................14
Active October 1968..................52

Manned Space Flight Management Films

This is a list of films produced by the Office of Manned Space Flight for the use of management in briefings, Congressional testimony, and internal orientation. They are not included in the film catalog published by the Office of Public Affairs, but one copy of each is on file at the Smithsonian Institution.

1. OMSF Quarterly Film Report
   Numbered 1 through 22 (April 1963 through September 1968)

2. Annual Films
   1963 - Filling the Pipeline
   1964 - Year of Development Testing
   1965 - Year of Qualification Testing
   1966 - Year of Flight Qualification
   1967 - Apollo in Perspective

3. Gemini
   Gemini Rendezvous Missions
   The Gemini Science Program
   The Twelve Gemini
   Gemini IX Quick Look
   Gemini X Quick Look
   Gemini XI Quick Look
   Gemini XII Quick Look

4. Apollo
   Ten Lives of Saturn I
   Apollo Lunar Mission Profile
   Apollo/Saturn 203 - Liquid Hydrogen Experiment
   Power for Apollo Saturn V
   Apollo Lunar Mission
   AS-203 Mission Report
   AS-202 Mission Report
   Apollo 5 Mission Report
   Apollo 6 Mission Report
   Apollo Mission Film (continuing - clips from each flight)

5. AAP
   Apollo Extended Systems
   Apollo Saturn - The Use for Science and Applications
   Apollo Saturn - A New Dimension in Science
   Apollo Applications
   AAP - The Early Missions

6. Special Films
   Power for Progress
   Manned Spacecraft Technology
   Preparing the Way
   Manned Space Flight 1966
   The Mississippi Test Facility Story

INTERNATIONAL BENEFITS OF COOPERATIVE TRACKING AND DATA ACQUISITION AGREEMENTS

Gerald M. Truszynski
Associate Administrator
for Tracking and Data Acquisition
National Aeronautics and Space Administration (USA)

1. Today's space explorers are intricate laboratories, some manned, some unmanned, sent on their missions to search the cosmos for new scientific knowledge. These modern-day explorers are filled with scientific instruments that literally extend man's senses into outer space. Whatever data the astronauts and instruments record must be returned to the earth-bound scientist. Electronic tracking and data acquisition networks link the spacecraft to earth. As a part of the overall conduct of space research, the United States, through its national space research organization, the National Aeronautics and Space Administration (NASA), has established a world-wide system of tracking and data acquisition stations to support the requirements of its space-flight missions. These stations also support, as mutually agreed, NASA international cooperative projects as well as independent projects of other countries and international organizations.

2. The great variety of space missions conducted today is reflected in the technical character and geographical distribution of the associated ground tracking and data

acquisition stations. The missions are both manned and unmanned. Near-earth orbital missions vary in inclination from equatorial through polar and range in trajectory configuration from nearly circular to highly elliptical (Figure I). Lunar and planetary missions are characterized by ranges to extreme distances -- hundreds of millions of miles in the case of planetary research vehicles.

3. The services required of the ground networks consist of tracking to determine the precise trajectory of vehicles in space, acquiring data from scientific experiments, monitoring the engineering performance of spacecraft and launch-vehicle systems, transmitting commands from ground stations to spacecraft, communicating information between various ground facilities and mission control centers, and processing the data acquired from the space vehicles to convert it into understandable scientific terms. As mentioned previously, the variety of characteristics encountered in the space missions determines characteristics of the ground equipment. This is illustrated in Figure II. The extreme distance involved in planetary missions requires large ground antennas with extremely sensitive receivers to capture the minuscule signals and the use of technical equipment and signal processing techniques which are at the very forefront of technology. The manned space flight program requires vital decisions in

flight and attention to the primary consideration of astronaut safety. This in turn requires a world-wide system of extreme reliability to assure positive voice and data contact with these complex manned spacecraft. Here, systems to rapidly manage large streams of data are required to extract and put into meaningful terms, for use by the flight director in the control center thousands of miles away, information which is received while the space vehicle is in transit over a station. On the basis of data observed, the flight director must be able to speak with the astronauts and decide a next course of action. This requires station technical equipment, computer systems, and world-wide communications systems of unparalleled reliability to assure not only the basic reception and transfer of the information received but also to verify and preserve its accuracy throughout the entire system.

4. In the course of providing effective support for the variety of flight projects, a twenty-eight station global instrumentation network responsive to the critical requirements of the missions has been established. The stations of this network are located in the United States and in fourteen other countries and territories. The countries in which stations are located abroad are shown in Figure III. They represent a capital investment of over $450 million and are operated by approximately 4,000 highly trained U.S. and host country personnel. At the present time, NASA is spending, in

direct payments, some $30 million annually for operations in cooperating countries. These stations are linked together by a network of ground communications which provide the real-time information necessary for critical decisions (Figure IV). Computer facilities also are provided both at the stations and at intermediate points in the communications system as well as at the main control center to process into useable form the large amounts of data which are collected from flight projects. Tracking and data acquisition facilities must be continually augmented and improved to meet the requirements of future missions. This necessitates planning and equipment development to assure a sound technological approach.

5. The success with which the United States has been able to establish an effective tracking and data acquisition system has been due in great measure to the wholehearted cooperation of the nations abroad in which stations are located. Such cooperation takes place at all stages of the establishment and subsequent operation of the station. The specific nature of this cooperation and the benefits derived, both by the United States and the host countries in which the stations are located, can best be understood if discussed in sequence.

Survey

6. The first step in locating a station is for the host country and the United States to assign representatives to search for suitable sites. The host country usually assigns personnel from an agency within its government which retains contact with NASA in the construction and subsequent operation and use of the station. The assistance and advice rendered by representatives of the host country in this initial effort involve land availability and acquisition, electromagnetic interference, radio frequency clearance, weather considerations, housing, roads, rights-of-way, transportation, communications, power, water, construction contractors, and the like.

7. The technical and operational criteria surrounding the selection of a location for a space tracking and data acquisition station are extremely stringent, especially in relation to minimizing electromagnetic interference. The acutely sensitive receiving systems of a tracking and data acquisition station must be isolated from radio-frequency interference such as radio, radar and television stations, airports, high-voltage power lines, and automobiles, to name a few, and from obstructions which may cause interfering reflections. Consequently, these stations are usually located away from urban centers of population, and ideally, where they are surrounded by distant hills which effectively shield the

site from unwanted radio signals and electromagnetic noise propagated along the ground. By active participation in the survey, the host country representatives obtain an insight into the requirements of such a complex station and the associated considerations which must enter into the selection of its final location to preserve its technical longevity.

Design and Construction

8. In those countries where NASA undertakes the construction of the station, we depend on the cooperating agency to serve as interface with other agencies of the host government. The cooperating agency arranges permission to use the site selected, obtains the necessary rights-of-way, other permits and licenses, and advises NASA on all steps leading to the employment of local contractors or personnel and the use of materials, supplies, and services in the area. With this kind of assistance, NASA is able to carry out site improvement, building construction, antenna erection, and equipment installation expeditiously and with assurance that the general appearance and composition of the structure conform to local regulations and are in harmony with the surrounding area.

9. Where the cooperating agency undertakes construction of the station, it enlists the support of other governmental agencies within the country wherever appropriate. The preliminary station design furnished by NASA is put into final specifications and plans. Construction is carried out under the supervision of the cooperating agency. By means of this

cooperation, NASA obtains the full benefit of the host country's managerial, architectural, engineering, and construction knowledge and skills, including local material, supplies, and services.

10. The stringent technical requirements and the many aspects of national and local regulations necessitate the active participation of a broad spectrum of host country technical and administrative personnel without which the establishment of an effective station would not be possible. The problems are many and varied, and the cooperation in this area of effort stands as a monument to the capability and understanding of the agencies of the host country.

Technical Operation of the Station

11. In those cases where NASA has operations responsibility, it executes this through a US contractor who is directed, in accordance with the terms of the intergovernmental agreement, to hire qualified personnel of the host country to the maximum extent feasible. In keeping with this commitment, NASA arranges for training of such personnel so as to increase the number who are employed. Over the long term, they replace the US contractor personnel.

12. Where the cooperating agency executes this responsibility, it provides for the operation of the station, in accordance with overall network technical standards, through a national contractor or personnel of its cooperating agency.

13. The equipment is highly complex in order to provide the accuracy and reliability needed for successful performance of space-flight missions. Large antennas equipped with advanced systems such as masers and parametric amplifiers are needed to acquire extremely weak signals from spacecraft at very remote distances which are severely limited in transmitter power. Sensitive servomechanisms and computer-like digital ranging systems combine to provide the accurate trajectory determination necessary for effective mission control. Telemetry data received from the spacecraft is processed and sorted by digital data handling equipment and computers to prepare it in the proper format for communication to the mission control centers. Commands and other forms of data to be transmitted to the spacecraft are generated and formatted by digital computers and transmitted by very high power transmitters to assure reliable reception by the spacecraft.

14. Each station performs these technical functions using thoroughly integrated systems representing, in most cases, the most recent advances in the state-of-the-art. The operations personnel must become thoroughly familiar with these systems to assure effective systems performance. By conducting these operations, they gain a valuable proficiency in advanced electronic techniques.

Training

15. The intergovernmental agreements provide for training of personnel assigned to the NASA tracking station from the host country. The training is required to transform a capable technician or engineer into a specialist in the area he will be working at the station. The training is accomplished primarily by two methods. One method provides for key station personnel to come to one of the NASA Centers in the US for formal training on one or more of the systems discussed in the previous section. This training consists of both classroom and system operation training. The length of training varies nominally from six weeks to six months depending on the particular training course being taken. This key man returns to the station located in his country and trains other personnel on the system for which he is responsible. This type of training is usually accomplished prior to the installation of new equipment at the station. The second type of training is accomplished after a station has been in operation for a period of months or for a specific new mission. Here, an instructor is sent to the overseas station to conduct a specific course of instruction.

16. Some overseas stations have set up cooperative work/study programs. For example, in the Malagasy Republic the NASA station and the Electronics Technical School operated

by the Ministry of Posts and Telecommunications have entered into a cooperative arrangement for the training of Malagasy nationals as equipment operators and technicians. This school was originally established to train personnel for the island's communications system. It is well supplied with modern equipment. At present, seventeen Malagasy students alternate between work at the NASA station and study at the technical school. Students are paid for their work during their tour of duty at the station. During the formal training periods, they pay their own tuition and support. Seventeen students have already completed the program and are qualified for permanent employment at the station.

Communications

17. As a matter of policy, NASA depends upon communications organizations of the respective countries to provide communications which assure the best possible service. In space programs, the complexity of both spacecraft missions requires a high-capacity communications system of extreme reliability to permit immediate reaction to changing conditions. Without reliable communications, the time-critical decisions which are so important in meeting mission objectives could not be made and the mission would be jeopardized.

18. Maintenance of a world-wide system of the required size, complexity, and reliability, necessitates continual monitoring of all circuits and facilities. We have had to initiate new techniques and standards to control communications channels so they could perform at these demanding levels. The communications industries developed a series of standard devices to monitor the quality of circuits and error rates in real-time data throughout the entire network. These have been installed throughout the world and are now finding application for general public use and by industry. Not many years ago, teletype speeds varied between countries. Today, in each of the fourteen countries which serve NASA facilities, uniform teletype speeds have been provided to meet the needs of instantaneous reporting from space. This introduction of uniform standards and practices represents progress toward world-wide standards. Moreover, the space-research-generated need for constantly greater amounts of information at higher speeds benefits international communications networks and improves their abilities to accommodate the ever-growing requirement for increased communications.

A. To engineer and operate the reliable world-wide communications network which integrates this global tracking system requires the cooperative efforts of twenty-five communications organizations throughout the world. The twenty-five cooperate with a single objective in mind --

..t of providing the most advanced and reliable communications within their capabilities in order to assure total success of the space flight missions they support.

Use of Station Equipment by Host Country Scientists

20. Intergovernmental agreements provide for use of station equipment by host-country scientific personnel for scientific experiments which they may wish to conduct during mission-free periods. In several countries, numerous and varied scientific experiments have been conducted with the large, sensitive antennas, the tracking radars, and the optical equipment. A specific example of an effort currently underway is a research program which is probing the recently observed phenomenon of the quasars -- those stars which emit spectacularly high energy. Here, Australian scientists have joined with scientists at the California Institute of Technology in the United States to receive the quasar radio data simultaneously at two widely separated points on the earth's surface - Woomera in Australia and Goldstone in California. Previously, these interferometer-type tests were conducted by Australian scientists at two less-widely spaced NASA stations in Australia - Woomera and Canberra. This allowed verification of the signal acquisition techniques and data processing before expanding to the two-continent experiments. The results of this investigation should provide significant

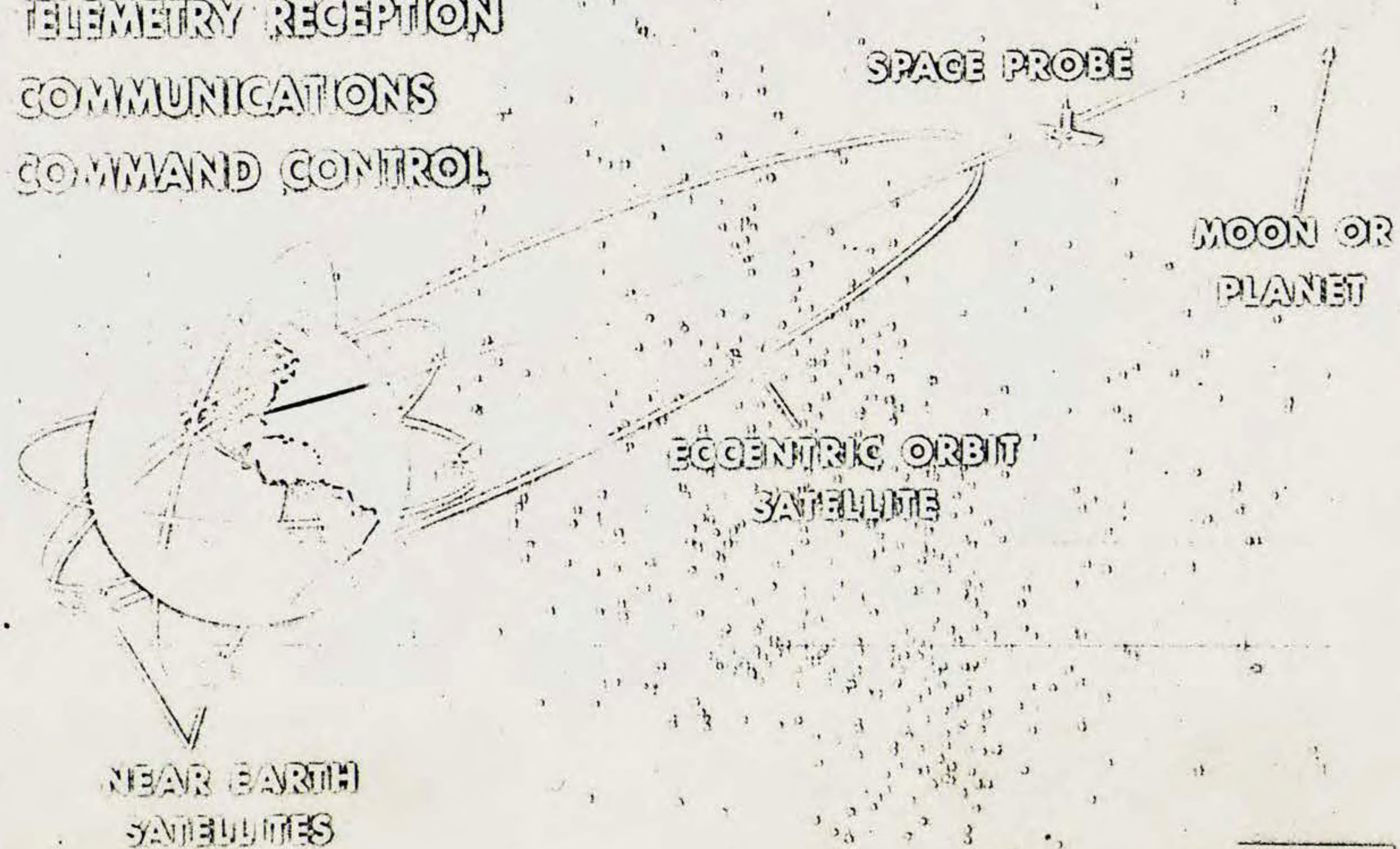
insight into the size and intensity of these mysterious celestial bodies.

Summary

21. From the foregoing, it can be seen that the benefits of cooperation in tracking and data acquisition are truly mutual and international and that they affect a broad spectrum of technical and administrative activity in both the US and the host countries. Quite apart from direct economic benefits, there is great advantage in active participation in the design, construction, and operation of the most advanced radar, telemetry, computing, and communications systems. Only by active participation do personnel become expert in the techniques of the latest developments in communications equipment and abot to transfer this knowledge effectively to the needs of their own countries. Experiments by individual national scientists at NASA facilities enrich the international scientific community. But most important, cooperation in tracking and data acquisition provides an opportunity for men in many lands to share the stimulus and challenge of exploring the universe.

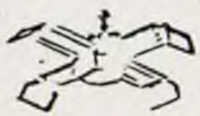
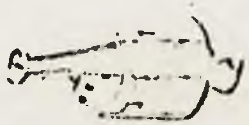
TRACKING AND DATA ACQUISITION

- TRACKING
- TELEMETRY RECEPTION
- COMMUNICATIONS
- COMMAND CONTROL



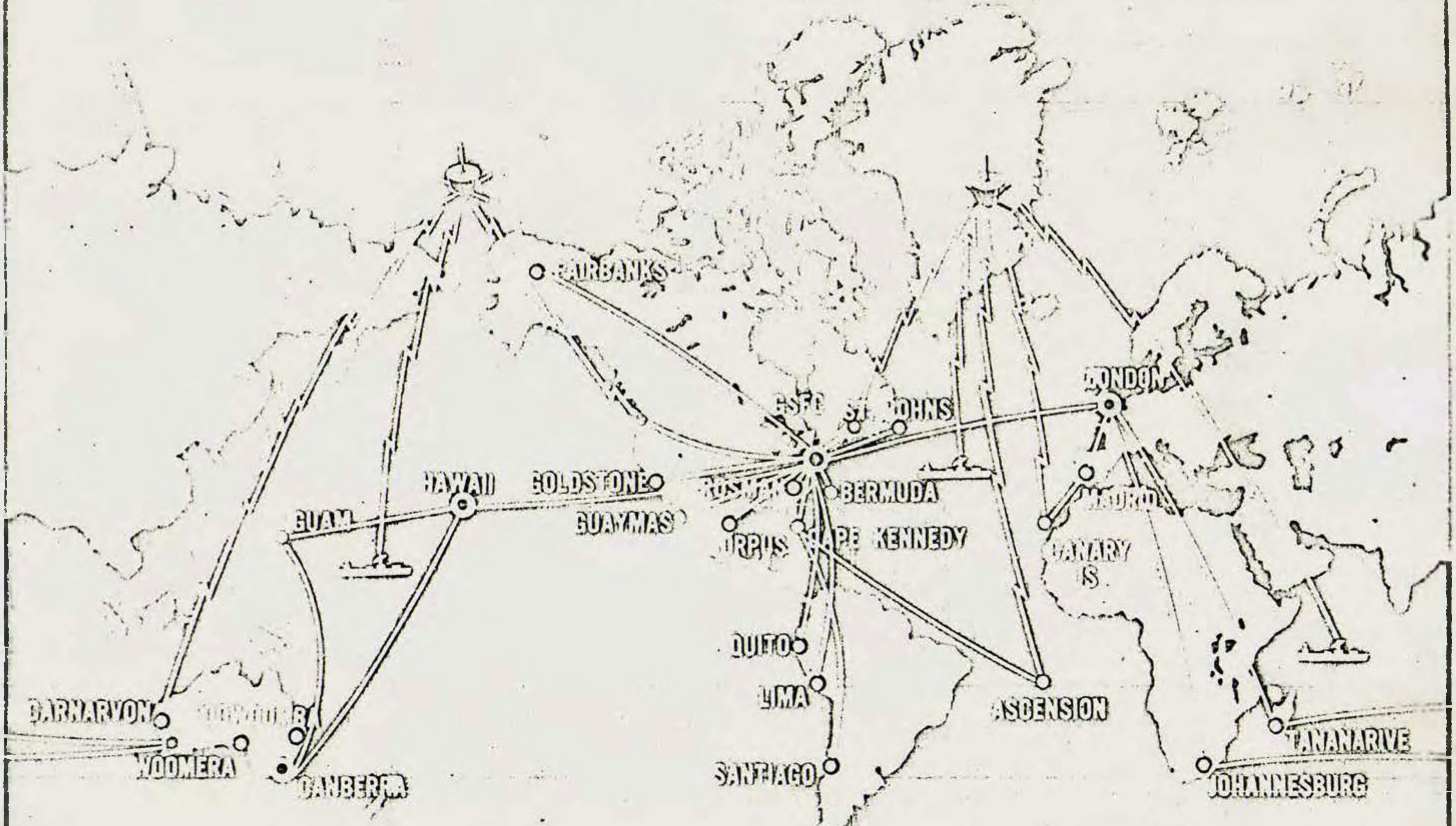
NASA T63-61

REQUIREMENTS FOR VARIOUS PROGRAMS

MISSION	REQUIREMENTS	NETWORK CHARACTERISTICS
SCIENTIFIC AND APPLICATIONS SATELLITE  	o GEOGRAPHICAL COVERAGE SPECIAL AND BROAD o VARIETY OF o ORBITS o TRACKING ACCURACIES o DATA HANDLING	o 14 FIXED STATIONS o MOBILE STATIONS o A VARIETY OF ANTENNAS o MINITRACK TRACKING o RANGE & VELOCITY TRACKING o AUTOMATION OF SYSTEMS
LUNAR AND PLANETARY 	o EXTREME RANGE (WEAK SIGNALS) o COMMAND CONTROL AT EXTREME DISTANCES o CAPABILITY OF CONTINUOUS CONTACT	o LARGE ANTENNAS o EXTREMELY SENSITIVE RECEIVERS o POWERFUL TRANSMITTERS o 3-STATION LONGITUDES
MANNED SPACE FLIGHT 	o ASTRONAUT SAFETY o VITAL DECISIONS IN FLIGHT o LUNAR DISTANCES	o EXTREMELY RELIABLE ELECTRONICS o BACKUP FACILITIES o RAPID COMPUTATIONS o 11-STATIONS - 30' ANTENNA o 3-STATIONS - 85' ANTENNA o 5-INSTRUMENTATION SHIPS o 8-INSTRUMENTATION AIRCRAFT

NASA T64-473

NASA COMMUNICATIONS NETWORK



⊙ DENOTES SWITCHING CENTER


NASA ASTRONAUTS

NASA ASTRONAUTS

The National Aeronautics and Space Administration's space flight team is based at Manned Spacecraft Center in Houston, Texas. Since the inception of the manned space flight program 66 astronauts have been selected. Of this number 55 are still participating in the program on a full-time basis.* The seven original astronauts were named in April 1959. Additional astronauts and scientist-astronauts have been added from time to time.

** John Glenn is a special consultant to the NASA Administrator. Dr. Duane E. Graveline and Scott Carpenter have resigned. Eight are deceased.*

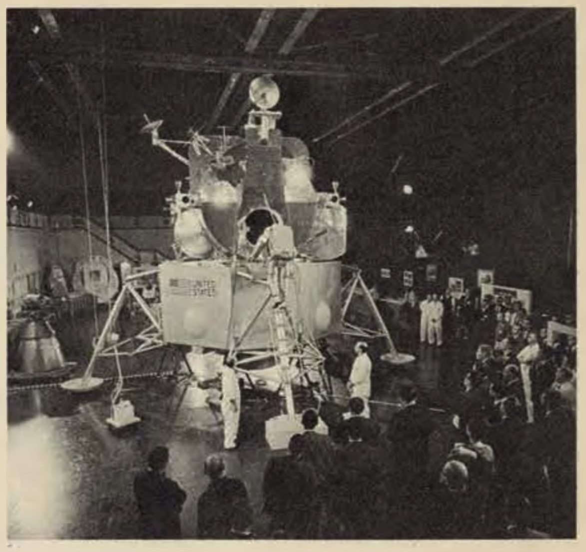
WASHINGTON, D.C. — OCTOBER 1967

Information concerning other educational publications of the National Aeronautics and Space Administration may be obtained from the Educational Programs Division, Office of Public Affairs, NASA, Washington, D. C., 20546.

U.S. GOVERNMENT PRINTING OFFICE : 1968 O—290-288

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C., 20402 - Price 35 cents

A



B

C

After Project Mercury the astronaut team devoted full time to the Gemini Program, and to preparations for manned space flight to the moon in the Apollo Program. The Gemini Program provided scientists and engineers with much information required for the eventual success of a lunar landing mission. Gemini crewmen: proved that man can exist in a weightless environment for at least 14 days (twice the number of days required for a lunar landing mission); developed the techniques of rendezvous and docking, so vital to the Apollo Program; and proved it is feasible to place one space vehicle into orbit and utilize it later to furnish propellant power for docked vehicles.

The Gemini crewmen also proved that extravehicular activity for relatively long periods of time is feasible and that man is capable of performing certain duties while outside the spacecraft.

A. Astronauts prepare for space flight.

B. Demonstration of embarking method from full scale Lunar Module mock-up.

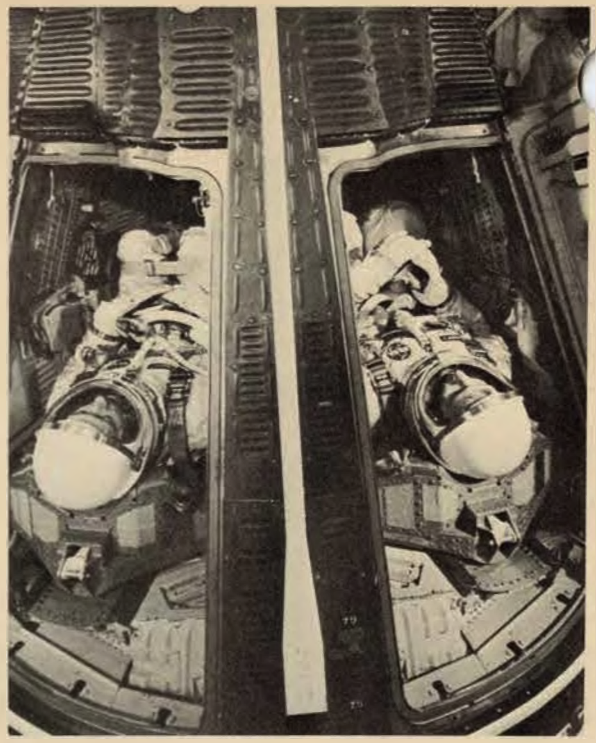
C. Gemini space suit preflight checkout.

D. Engineers seal astronauts in their Gemini spacecraft prior to flight.

E. Astronauts in Gemini spacecraft preparing for simulated launch.

F. Astronauts use celestial globe to study locations of star constellations.

D



E

Pilots of Gemini missions gained experience in flying their spacecraft through controlled reentry maneuvers to preselected landing points. This was accomplished with remarkable accuracy.

Much of the information obtained in Mercury and Gemini is utilized in the Apollo Program with its primary objective of landing astronauts on the lunar surface and returning them to earth prior to 1970.

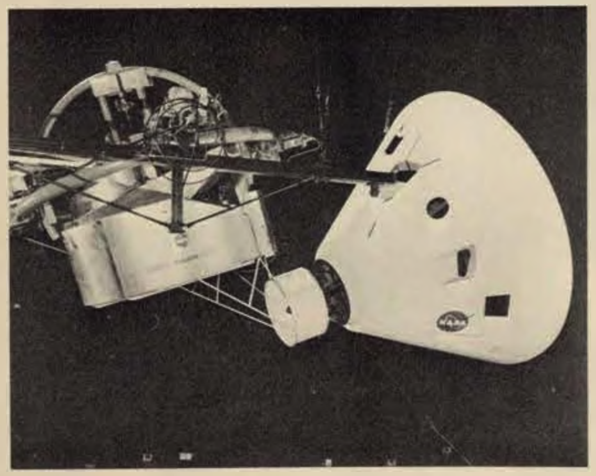
Many persons have asked why men volunteer for such assignments. There is no simple answer to this question, for each astronaut has strong individual characteristics. Perhaps the one characteristic found in each of them is a spirit of adventure—a desire to explore the unknown.

Each of the astronauts would like to be a member of the first crew to accomplish a lunar mission. All realize, however, that only three can fly that mission so each continues to participate in the extensive training programs required and thus make significant contributions to the effort required for ultimate success.

F

ASTRONAUT TRAINING

G. Astronaut in Visual Docking Simulator during rendezvous training.



Basic objectives of astronaut training are:

1. To provide highly trained flight crew members who are capable of operating at peak efficiency in the space environment —either in normal flight or emergency situations, and

2. To provide crew members who are trained to conduct scientific experiments during manned space missions either by actively participating in such experiments or by serving as observers on passive experiments.

These objectives are met, primarily, through utilization of a number of formal training courses. Such courses include technological and scientific subjects, operations familiarization, environmental and contingency training, spacecraft and launch vehicle design and development, and an aircraft flight program.

The courses in technology and science cover a variety of subjects such as space navigation, flight mechanics, astronomy (with emphasis on selenology, which is the study of the moon), physics of the upper atmosphere and space, bioastronautics, advanced propulsion systems, aerodynamics, space communications, meteorology, geology, geophysics, geochemistry, guidance and control, and computer technology.

H

H. Astronaut in Apollo prototype space suit.

I. Weightlessness is experienced briefly in airplane flying parabolic arc.

I

Computers are used extensively in guidance and navigation systems in both the Gemini and Apollo Programs. Astronauts assigned to Gemini flights were given a basic digital computer course prior to receiving advanced courses on the Gemini on-board computer. Similarly, crewmen assigned to Apollo flights are instructed in the basic principles of inertial guidance systems in the Apollo guidance and navigation course.

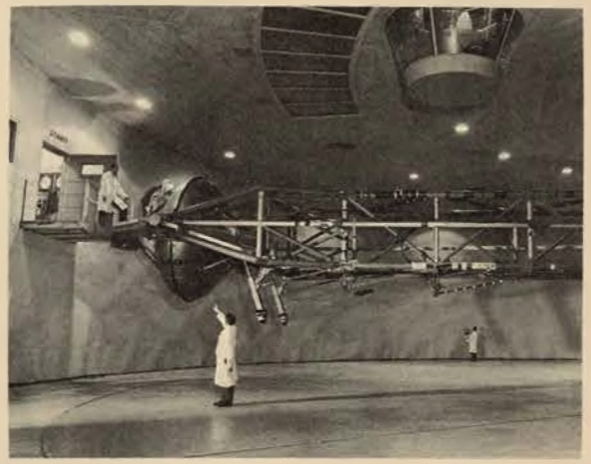
In the area of operations, the astronauts in each new group selected are given a thorough orientation on activities at NASA installations as well as at the plants of some of the contractors. This orientation is followed by more detailed briefings at a later time. Many of the astronauts are assigned specific operational duties during the manned flights.

In environmental familiarization training, astronauts are exposed to acceleration and deceleration g-forces, weightlessness, simulated lunar gravity, vibration and noise, and other environmental factors. To achieve this, various special devices and techniques had to be developed. For example, a device which supports five-sixths of the astronaut's weight is used to simulate lunar gravity. This provides the feeling to the astronaut that he weighs only one-sixth of his normal weight. Weightlessness is experienced by the astronauts for extremely short periods of time in an aircraft which is flown in a parabolic arc.

Possibility of contingency landings is slight but astronauts must be prepared for any eventuality. Contingency training stresses survival techniques and is conducted in geographical locations where extreme environmental conditions exist. Tropical survival training is accomplished in Panama, desert survival training in western desert areas of the United States and water survival training in the Gulf of Mexico and Galveston Bay, near Houston.

Astronauts are continually involved in study of spacecraft and launch vehicles. This training is accomplished through the study of basic handbooks on these vehicles, through instruction by NASA and contractor special-

J. Astronaut entering centrifuge for test of "G" force effects.



ists, and by active participation in design engineering reviews and vehicle validation tests. This type of study and review extends to special equipment such as hand tools, the portable life support system, the tether, and other manned maneuvering devices, all designed for extravehicular activity; and to personal equipment, such as pressure suits, with different suit configurations to meet special mission requirements.

Aircraft flight training is accomplished primarily in T–33 and T–38 aircraft and each astronaut is required to log a minimum of 100 hours flying time each year. They also receive helicopter flight instruction because of the similarity of this activity to landing the lunar module on the moon. Since actual space flight opportunity is so limited, this training is vital to astronauts in maintaining their "flight readiness."

When a crew is named for a mission, its members undertake an intensive program geared to preparing them to a point of maximum efficiency for their particular flight. Much time is devoted to flying simulated missions, reviewing pertinent subject material, and becoming thoroughly familiar with the experiments to be conducted on their mission. The assigned crew devotes major emphasis to their spacecraft. From the time they are assigned to a mission, they follow their spacecraft through the final phases of fabrication, through the many tests performed at the factory, altitude chamber runs of parts of the mission with the mission spacecraft, through additional tests at Cape Kennedy, and finally through the mating with the launch vehicle and additional combined tests on the launch pad prior to the scheduled lift-off.

Physical fitness is very important in a program which inflicts the stresses that are induced by manned space flight. All astronauts are in top physical condition when they are selected and NASA holds them personally responsible for maintaining such conditions. Therefore, due to the other requirements of the overall training program, each astronaut undertakes a physical fitness program tailored to his own needs.

THE TEAM

EDWIN E. ALDRIN, JR.

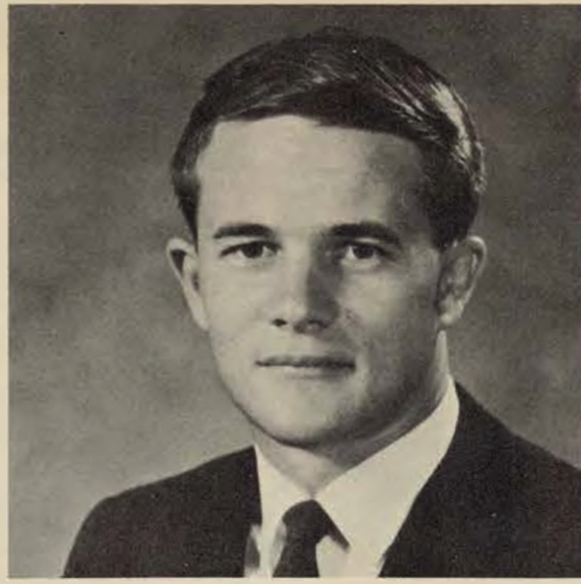
was born in Montclair, New Jersey, January 20, 1930. He was graduated from the United States Military Academy in 1951 with a bachelor of science degree.

A member of the United States Air Force, Aldrin completed his pilot training at Bryan, Texas, in 1952. He flew combat missions during the Korean conflict; he also served a tour as aerial gunnery instructor at Nellis Air Force Base, Nevada, and attended Squadron Officers' School at the Air University, Maxwell Air Force Base, Alabama. Aldrin flew as a flight commander with the 36th Tactical Fighter Wing at Bitburg, Germany.

Aldrin completed work for his doctor of science degree in astronautics at Massachusetts Institute of Technology in 1963 and was assigned to the Gemini Target Office of the Air Force Space Systems Division, Los Angeles, California. He was later assigned to the Manned Spacecraft Center, Houston, Texas, to coordinate Department of Defense participation in Gemini experiments.

He was one of the 14 astronauts selected by NASA in October 1963. He was pilot of the backup crew for the Gemini IX mission and pilot for the Gemini XII flight. He has received the NASA Exceptional Service Medal for his space flight achievements.

Aldrin is married to the former Joan A. Archer of Ho-Ho-Kus, New Jersey. They have three children: James, born September 2, 1955; Janice, born August 16, 1957; and Andrew, born June 17, 1958.



JOSEPH P. ALLEN IV

was born June 27, 1937, in Crawfordsville, Indiana. He received a bachelor of arts degree in math-physics from DePauw University in 1959, a master of science degree in physics from Yale University in 1962, and a doctorate in physics (nuclear physics) from Yale in 1965.

Allen was one of eleven scientist-astronauts selected by NASA in August 1967.

Prior to his selection, Allen was a research associate at the University of Washington, Seattle.

He is married to the former Bonnie Jo Darling of Elkhart, Indiana. They have no children.

WILLIAM A. ANDERS

was born in Hong Kong, October 17, 1933. He was graduated from the United States Naval Academy with a bachelor of science degree in 1955. After graduation, Anders was commissioned in the Air Force and received flight training. He received his master of science degree in nuclear engineering from the Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio. In 1962 he served as a nuclear engineer and instructor pilot at the Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico.

Anders was one of the 14 astronauts selected by NASA in October 1963. He was pilot of the backup crew for the Gemini XI mission.

Anders is married to the former Valerie E. Hoard of Lemon Grove, California. They have five children: Alan, born February 18, 1957; Glen, born July 3, 1958; Gayle, born December 30, 1960; Gregory, born December 10, 1962; and Eric, born July 6, 1964.

NEIL A. ARMSTRONG

was born in Wapakoneta, Ohio, August 5, 1930. He graduated from Purdue University with a bachelor of science degree in aeronautical engineering in 1955.

Armstrong was a naval aviator from 1949 to 1952 and flew combat missions during the Korean conflict.

After graduation from Purdue University, Armstrong joined the NASA Lewis Flight Propulsion Laboratory, and later transferred to NASA's High Speed Flight Station at Edwards Air Force Base, California. As an aeronautical research pilot, Armstrong was an X–15 project pilot flying that aircraft to over 200,000 feet and at approximately 4000 miles per hour. Other flight test work included piloting the X–1 rocket research airplane, the F–100, the F–101, F–102, F–104, F5D, B–47, and the paraglider.

Armstrong was one of the nine astronauts selected by NASA in September 1962. Armstrong was command pilot for the Gemini VIII mission flown March 16, 1966, and backup command pilot for the Gemini V and XI missions.

He is the recipient of the 1962 Institute of Aeronautical Sciences Octave Chanute Award and the NASA Exceptional Service Award for his work in manned space flight.

Armstrong is married to the former Janet Shearon of Evanston, Illinois. They have two children: Eric, born June 30, 1957; and Mark, born April 8, 1963.

290-288 O-68—2

ALAN L. BEAN

born in Wheeler, Texas, March 15, 1932, was graduated from the University of Texas in 1955 with a bachelor of science degree in aeronautical engineering.

After graduation, Bean was commissioned in the United States Navy. He received pilot training and was assigned to Attack Squadron 44 at Jacksonville Naval Station for four years. He then attended the Navy Test Pilot School at Patuxent, Maryland, and served as project officer there on various aircraft for Navy preliminary evaluation, initial trials, and final board of inspections and survey trials. Bean's last Navy assignment was with Attack Squadron 172 at Cecil Field, Florida.

Bean was selected by NASA as one of 14 chosen in October 1963. He was the command pilot for the backup crew for the Gemini X mission.

He is married to the former Sue Ragsdale of Dallas, Texas. The Beans have two children: Clay, born December 18, 1955; and Amy, born January 21, 1963.

FRANK BORMAN

was born in Gary, Indiana, March 14, 1928. Raised in Tucson, Arizona, he graduated from the United States Military Academy in 1950 with a bachelor of science degree.

After receiving pilot training at Williams Air Force Base, Arizona, he was assigned to various fighter squadrons in the United States and the Philippines. In 1957 he became an instructor in thermodynamics and fluid mechanics at the Military Academy.

Borman received a master's degree in aeronautical engineering from California Institute of Technology in 1957. He was graduated from the USAF Aerospace Research Pilots School in 1960 and remained there as an instructor until 1962.

Borman was one of the nine astronauts selected by NASA in September 1962. He was command pilot for the Gemini VII mission, which established a number of records, including the longest manned space flight performed up to that time (330 hours and 35 minutes). He participated in the first rendezvous of two manned maneuverable spacecraft (Gemini VII and Gemini VI) on December 15, 1965.

Borman has been awarded the NASA Exceptional Service Award and was corecipient of the 1966 Harmon International Aviation Trophy for his space flight achievements.

He is married to the former Susan Bugbee of Tucson, Arizona. The Bormans have two children: Frederick, born October 4, 1951; and Edwin, born July 20, 1953.

VANCE D. BRAND

was born in Longmont, Colorado, May 9, 1931. He received a bachelor of science degree in business administration from the University of Colorado in 1953, and a bachelor of science degree in aeronautical engineering from the same university in 1960. Brand received a master's degree in business administration from the University of California at Los Angeles in 1964.

He served with the United States Marine Corps as a commissioned officer from 1953 to 1957. Brand completed naval flight training in 1955 and subsequently was designated a naval aviator and served a 15-month tour of duty in Japan as a jet fighter pilot.

Brand was one of the 19 astronauts selected by NASA in April 1966. Prior to his selection, he was assigned as an engineering test pilot for Lockheed Aircraft Corporation at the West German F–104G Flight Test Center at Istres, France. He worked for Lockheed from 1960 to 1966 and was employed initially as a flight test engineer. He later attended the U.S. Naval Test Pilot School at Patuxent River, Maryland, as a civilian under Lockheed sponsorship.

He is married to the former Joan Virginia Weninger of Chicago, Illinois. The Brands have four children: Susan, born April 30, 1954; Stephanie, born August 6, 1955; Patrick, born March 22, 1958; and Kevin, born December 1, 1963.

JOHN S. BULL

was born in Memphis, Tennessee, September 25, 1934. He received a bachelor of science degree in mechanical engineering from Rice University in 1957.

He entered active duty with the Navy in June 1957 and received his flight training at Kingsville, Texas. From March 1959 to November 1960, he flew F–3 Demons while assigned to Fighter Squadrons 121 and 92. He was later assigned to Fighter Squadron 114 at the Naval Air Station, Miramar, California, where he flew the F–3 Demon and the F–4 Phantom II. He has also been assigned to carrier duty in the western Pacific on three different tours. He graduated from the United States Naval Test Pilot School in February 1964, and his last assignment prior to his selection as an astronaut was as a project test pilot in the Carrier Suitability Branch at the Naval Air Test Center, Patuxent River, Maryland.

Bull was one of the 19 astronauts selected by NASA in April 1966.

He is married to the former Nancy Laraine Gustafson of Seattle, Washington. The Bulls have one child, Jeffrey, born July 27, 1965.

GERALD P. CARR

was born in Denver, Colorado, August 22, 1932. He received a bachelor of science degree in mechanical engineering from the University of Southern California in 1954; a bachelor of science degree in aeronautical engineering from the U.S. Naval Postgraduate School in 1961; and a master of science degree in aeronautical engineering from Princeton University in 1962.

He entered the United States Navy in 1949. Upon his graduation from the University of Southern California in 1954, he received his commission in the Marine Corps. He received flight training at Pensacola, Florida, and Kingsville, Texas. He was then assigned to Marine All-Weather Fighter Squadron 114. From 1962 to 1965, he served with Marine All-Weather Fighter Squadron 122 in the United States and the Far East. His last assignment prior to his selection as an astronaut was with the Test Directors Section, Marine Air Control Squadron 3, a unit responsible for carrying out testing and evaluation of Marine tactical data systems.

Carr was one of the 19 astronauts selected bv NASA in April 1966.

He is married to the former JoAnn Ruth Petrie of Santa Ana, California. The Carrs have six children: Jennifer, born July 31, 1955; Jamee and Jeffrey, born July 3, 1958; John, born April 4, 1962; and Jessica and Joshua, born March 12, 1964.

EUGENE A. CERNAN

was born in Chicago, Illinois, March 14, 1934. He was graduated from Purdue University in 1956 with a bachelor of science degree in electrical engineering.

Cernan was commissioned by the United States Navy after completing the Navy Reserve Officer Training Corps program at Purdue and entered flight training. He was assigned to Attack Squadrons 126 and 113 at Miramar, California, Naval Air Station. In 1961, Cernan entered the United States Naval Postgraduate School at Monterey, California, where he received a master of science degree in aeronautical engineering.

Cernan was one of the 14 astronauts selected by NASA in October 1963. Cernan was pilot for the Gemini IX mission launched June 3, 1966, and performed a two hour and seven minute space walk (extra vehicular activity). He was pilot of the back-up crew for Gemini XII.

He received the NASA Exceptional Service Medal for his space flight accomplishments during the Gemini IX mission.

Cernan is married to the former Barbara J. Atchley of Houston, Texas. They have one daughter, Teresa, born March 4, 1963.

PHILIP K. CHAPMAN

was born March 5, 1935, in Melbourne, Australia. Chapman became a United States citizen on May 8, 1967. He received a bachelor of science degree in physics from Sydney University (Australia) in 1956, and a master of science degree in aeronautics and astronautics from Massachusetts Institute of Technology (M.I.T.) in 1964. He received his doctorate in physics (instrumentation) from M.I.T. in 1967.

Chapman was an auroral/radio physicist with the Antarctic Division, External Affairs Department, Commonwealth of Australia from 1957 through 1959. He was with the Australia National Antarctic Research Expedition, IGY, in 1958. In 1960 and 1961 Chapman was a staff engineer in electro-optics with Canadian Aviation Electronics, Dorval, Quebec. Prior to his selection as a scientist-astronaut he was a staff physicist in the Experimental Astronomy Laboratory at M.I.T.

Chapman was one of eleven scientist-astronauts selected by NASA in August 1967.

Married to the former Pamela Gatenby of Herberton, Queensland, the Chapmans have one child, Peter Hume, born in 1960.

MICHAEL COLLINS

was born in Rome, Italy, October 31, 1930. He attended the United States Military Academy and was graduated in 1952 with a bachelor of science degree.

After graduation, Collins was commissioned by the United States Air Force and served as an experimental flight test officer at the Air Force Flight Test Center, Edwards Air Force Base, California. He tested performance, stability, and control characteristics of Air Force aircraft, primarily jet fighters.

Collins was one of 14 astronauts selected by NASA in October 1963. He served as backup pilot for the Gemini VII mission. He was pilot of the prime crew for Gemini X launched July 18, 1966, and during that mission Collins proved man's capability for performing extravehicular tasks relative to a target vehicle. He performed three separate periods of extravehicular activity during this flight.

He received the NASA Exceptional Service Medal for his accomplishments on the Gemini X mission.

Collins is married to the former Patricia M. Finnegan of Boston, Massachusetts. They have three children: Kathleen, born May 6, 1959; Ann, born October 31, 1961; and Michael, born February 23, 1963.

CHARLES CONRAD, JR.

was born in Philadelphia, Pennsylvania, June 2, 1930. He was graduated from Princeton University in 1953 with a bachelor of science degree in aeronautical engineering.

He entered the Navy following his graduation from Princeton. Conrad attended the Navy Test Pilot School at Patuxent River, Maryland, and following completion of that course was a project test pilot in the Armaments Test Division there. He also served at Patuxent as a flight instructor and performance engineer. Just prior to his selection as an astronaut, Conrad served as safety officer for Fighter Squadron 96 at the Naval Air Station, Miramar, California.

Conrad was one of nine astronauts selected by NASA in September 1962. Conrad was pilot on the Gemini V endurance mission launched from Cape Kennedy on August 21, 1965. He was backup command pilot for the Gemini VIII mission and command pilot on Gemini XI launched September 12, 1966.

He was awarded the NASA Exceptional Service Medals for his Gemini V and XI space flight accomplishments.

Conrad is married to the former Jane DuBose of Uvalde, Texas. They have four children: Peter, born December 24, 1954; Thomas, born May 3, 1957; Andrew, born April 30, 1959; and Christopher, born November 26, 1960.

L. GORDON COOPER, JR.

was born March 6, 1927, in Shawnee, Oklahoma. He was graduated from the Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, in 1956 with a bachelor of science degree in aeronautical engineering.

Cooper entered the United States Marine Corps in 1945 and later attended the Naval Academy Preparatory School. He was a member of the Presidential Honor Guard in Washington until his discharge in August 1946. Cooper entered the University of Hawaii, Honolulu, and received an Army commission after attending for three years. He transferred this commission to the Air Force and entered flight training in 1949. Upon completion of this training, Cooper flew with the 86th Fighter Bomber Group in Munich, Germany, for four years. After graduating from the Air Force Institute in 1956, he was assigned to the Air Force Experimental Flight Test School at Edwards Air Force Base, California.

Cooper, one of seven astronauts selected in April 1959, on May 15 1963, piloted MA-9 spacecraft on a 22-orbit mission. Cooper was command pilot for the Gemini V flight launched from Cape Kennedy, August 21, 1965. He was also assigned as command pilot of the back-up crew for Gemini XII.

He has been awarded the NASA Distinguished Service Medal and the NASA Exceptional Service Medal.

Cooper is married to the former Trudy Olson of Seattle, Washington. They have two daughters: Camala, born November 16, 1948; and Janita, born March 15, 1950.

R. WALTER CUNNINGHAM

was born March 16, 1932, at Creston, Iowa. Reared in Venice, California, he received a bachelor of arts degree in physics from the University of California at Los Angeles (UCLA) in 1960 and a master of arts degree in physics in 1961 from that same university.

Cunningham joined the United States Navy in 1951 and entered flight training in 1952. He was assigned to a Marine squadron in 1953 and remains a Marine reservist.

Prior to his selection as an astronaut, Cunningham was with the Rand Corporation where he worked as a research scientist. He performed error analysis and feasibility studies of defense against submarine-launched ballistic missiles and problems of the earth's magnetosphere. His later work at UCLA was the developing, testing, and analyzing results of a triaxial search coil magnetometer which was flown aboard the first NASA Orbiting Geophysical Observatory satellite.

Cunningham was one of the 14 astronauts selected by NASA in October 1963.

He is married to the former Lo Ella Irby of Norwalk, California. The Cunninghams have two children: Brian, born September 12, 1960; and Kimberly, born February 12, 1963.

CHARLES M. DUKE, JR.

was born in Charlotte, North Carolina, October 3, 1935. He received a bachelor of science degree from the United States Naval Academy in 1957 and a master of science degree in aeronautics and astronautics from the Massachusetts Institute of Technology in 1964.

He was commissioned in the United States Air Force in 1957, upon graduation from the Naval Academy. He completed flight training in 1958, and was later assigned to the 526th Fighter Interceptor Squadron at Ramstein, Germany, where he served three years as a fighter interceptor pilot. His last assignment prior to his selection as an astronaut was as instructor in control systems at the Air Force Aerospace Research Pilot School, from which he graduated in 1965.

Duke was one of the 19 astronauts selected by NASA in April 1966.

He is married to the former Dorothy Meade Claiborne of Atlanta, Georgia. The Dukes have two children, Charles, born March 8, 1965; and Thomas, born May 1, 1967.

DONN F. EISELE

was born in Columbus, Ohio, June 23, 1930. He received a bachelor of science degree from the United States Naval Academy in 1952 and in 1960 he received a master of science degree in astronautics from the Air Force Institute of Technology at Wright-Patterson Air Force Base, Ohio.

After graduation from the United States Naval Academy, Eisele chose the United States Air Force as a career. He completed flight training, and later was graduated from the Air Force Aerospace Research Pilot School, Edwards Air Force Base, California. He served as project engineer and experimental test pilot at the Air Force Special Weapons Center, Kirtland Air Force Base, New Mexico. He flew experimental and developmental test flights in jet aircraft in support of special weapons developmental programs.

Eisele was one of the 14 astronauts selected by NASA in October 1963.

He is married to the former Harriet E. Hamilton of Gnaddenhutten, Ohio, and the Eiseles have four children: Melinda, born July 25, 1954; Donn, born March 24, 1956; Matthew, born August 28, 1961; and Jon, born October 21, 1964.

ANTHONY W. ENGLAND

was born May 15, 1942, at Indianapolis, Indiana. He received a bachelor of science degree in geology and physics from the Massachusetts Institute of Technology (M.I.T.) in 1965, a master of science degree in geology and physics from M.I.T. in 1965, and a doctorate in geophysics from M.I.T. in 1967.

England was one of eleven scientist-astronauts selected by NASA in August 1967.

Prior to his selection, England was a graduate fellow at M.I.T.

He is married to the former Kathleen Ann Kreutz of Fargo, North Dakota. They have no children.

JOE H. ENGLE

was born in Abilene, Kansas, August 26, 1932. He received a bachelor of science degree in aeronautical engineering from the University of Kansas in 1955.

He was commissioned in the United States Air Force through the Reserve Officer Training Corps program at the University of Kansas and entered flying school in 1957. Upon completion of flight training, he served with the 474th Fighter Day Squadron and the 309th Tactical Fighter Squadron at George Air Force Base, California. He had assignments in Spain, Italy, and Denmark. In 1961, Engle was graduated from the Experimental Flight Test Pilot School and from the Air Force Aerospace Research Pilot School in 1962. His last assignment prior to being selected as an astronaut was as an aerospace flight test pilot in the X–15 research program at Edwards Air Force Base, California.

Engle was one of the 19 astronauts selected by NASA in April 1966.

He is married to the former Mary Catherine Lawrence of Mission Hills, Kansas. They have two children: Laurie, born April 25, 1959; and Jon, born May 9, 1962.

RONALD E. EVANS

was born in St. Francis, Kansas, November 10, 1933. He received a bachelor of science degree in electrical engineering from the University of Kansas in 1956, and a master of science degree in aeronautical engineering from the U.S. Naval Postgraduate School in 1964.

He was commissioned through the Reserve Officer Training Corps program and completed flight training in 1957. He had carrier duty with two cruises and was assigned to Fighter Squadron 124 in 1961 and 1962, where he served as combat flight instructor on F8 aircraft. His last assignment prior to being selected as an astronaut was on carrier duty flying F8 aircraft in Viet Nam combat operations.

Evans was one of the 19 astronauts selected by NASA in April 1966.

Evans is married to the former Janet Merle Pollom of Topeka, Kansas. They have two children: Jaime, born August 21, 1959; and Jon, born October 9, 1961.

OWEN K. GARRIOTT

was born November 22, 1930, at Enid, Oklahoma. He was graduated from the University of Oklahoma in 1953 with a bachelor's degree in electrical engineering. He was graduated from Stanford University, Stanford, California in 1957 with a master's degree in electrical engineering. He received his doctorate from Stanford in 1960.

Garriott was a consultant to the Manned Space Science Division of NASA's Office of Space Sciences and Applications. He was consultant to the Lockheed Corporation's Space Physics branch. Garriott has served as secretary to the United States Commission, International Scientific Radio Union, and was regional editor of *Planetary and Space Sciences*. From 1961 until 1965, Garriott taught electronics, electromagnetic theory and ionospheric physics at Stanford University and has performed research in ionospheric physics since obtaining his doctorate at Stanford.

Garriott was one of the six scientist-astronauts selected by NASA in June 1965. He completed flight training at Williams Air Force Base, Arizona in 1966.

He is married to the former Helen Mary Walker of Enid, Oklahoma. The Garriotts have four children: Randall, born March 29, 1955; Robert, born December 7, 1956; Richard, born July 4, 1961; and Linda, born September 7, 1966.

EDWARD G. GIBSON

was born November 8, 1936 at Buffalo, New York. He was graduated from the University of Rochester, New York, with a bachelor of science degree and from the California Institute of Technology with a master of science degree. He received his doctorate in engineering physics from the California Institute of Technology in June 1964.

Gibson was a research assistant specializing in jet propulsion and atmospheric physics while studying at the California Institute of Technology. He also wrote several technical papers including some on his work with lasers. After receiving his doctorate, Gibson did aerospace research with the Philco Corporation's Applied Research Laboratories, Newport Beach, California.

Gibson was one of the six scientist-astronauts selected by NASA in June 1965. He completed flight training at Williams Air Force Base, Arizona, in 1966.

Married to the former Julia Ann Volk of the Township of Tonawanda, New York, the Gibsons have two children: Jannet, born November 9, 1960; and John, born May 2, 1964.

RICHARD F. GORDON, JR.

was born in Seattle, Washington, October 5, 1929. He received his bachelor of science degree in chemistry from the University of Washington in 1951.

Gordon entered the United States Navy in 1951 and received his naval aviator wings in 1953. He attended All-Weather Flight School and received jet transitional training before reporting to an all-weather squadron at the Naval Air Station, Jacksonville, Florida. Gordon attended the Navy's Test Pilot School at Patuxent River, Md., in 1957, and serving as a flight test pilot, was the first project test pilot for the F4H Phanton II.

In May 1961, Gordon won the Bendix Trophy Race from Los Angeles, California, to New York, establishing a new speed record of 869.74 miles per hour and a transcontinental record of two hours and 47 minutes.

Gordon was one of the 14 astronauts selected by NASA in October 1963. Gordon was pilot of the backup crew for the Gemini VIII flight and pilot of the prime crew for the Gemini XI mission launched September 12, 1966. He was awarded the NASA Exceptional Service Medal for his accomplishments on that flight.

He is married to the former Barbara Field of Seattle, Washington. The Gordons have six children: Carleen, born July 8, 1954; Richard, born October 6, 1955; Lawrence, born December 18, 1957; Thomas, born March 25, 1959; James, born April 26, 1960; and Diane, born April 23, 1961.

FRED W. HAISE, JR.

was born in Biloxi, Mississippi, November 14, 1933. He received a bachelor of science degree in aeronautical engineering from the University of Oklahoma in 1959.

He served with the United States Navy, beginning in 1952, and was assigned as a U.S. Marine Corps fighter pilot from 1954 to 1956. From 1957 to 1959, he was a fighter-interceptor pilot with the Oklahoma Air National Guard. He served with the Air Force in 1961 and 1962, and was awarded the A. B. Honts Trophy as the outstanding graduate from the Aerospace Research Pilot School in 1964.

Haise was one of the 19 astronauts selected by NASA in April 1966. Prior to his selection, he was a research pilot at the NASA Flight Research Center at Edwards, California. From September 1959 to March 1963, he was a research pilot at the NASA Lewis Research Center in Cleveland, Ohio.

Haise is married to the former Mary Griffin Grant of Biloxi, Mississippi. They have three children: Mary, born January 25, 1956; Frederick, born May 13, 1958; and Stephen, born June 30, 1961.

KARL G. HENIZE

was born October 17, 1926, in Cincinnati, Ohio. He received a bachelor of arts degree in mathematics from the University of Virginia in 1947, and a master of arts degree in astronomy from the University of Virginia in 1948. In 1954 Henize received his doctorate in astronomy from the University of Michigan.

Henize was a Carnegie fellow at Mt. Wilson Observatory from 1954 to 1956, and a senior astronomer at the Smithsonian Astrophysical Observatory from 1956 to 1959. Prior to his selection as a scientist-astronaut he was a Professor of Astronomy at Northwestern University.

Henize was one of eleven scientist-astronauts selected by NASA in August 1967.

He is married to the former Caroline Rose Weber of Bay City, Michigan. They have three children: Kurt Gordon, born in 1955; Marcia Lynn, born in 1956; and Karen Skye, born in 1961.

DONALD L. HOLMQUEST

was born April 7, 1939, in Dallas, Texas. He received a bachelor of science degree in electrical engineering from Southern Methodist University in 1962. He received his M.D. from Baylor College of Medicine in 1967. Prior to his selection as a scientist-astronaut Holmquest was working on his doctorate in physiology at the Baylor College of Medicine. This degree is expected in 1968. He is also, concurrently, completing his internship at Methodist Hospital in Houston, Texas.

Holmquest was one of eleven scientist-astronauts selected by NASA in August 1967.

He is married to the former Charlotte Ann Blaha of Dallas, Texas. They have no children.

JAMES B. IRWIN

was born in Pittsburgh, Pennsylvania, on March 17, 1930. He received a bachelor of science degree from the U.S. Naval Academy in 1951 and a master of science degree in aeronautical engineering and instrumentation engineering from the University of Michigan in 1957.

He was commissioned in the United States Air Force in 1951 and received flight training at Hondo Air Base, Texas, and Reese Air Force Base, Texas. Irwin has served with the F–12 Test Force at Edwards Air Force Base, California, and the AIM 47 Project Office at Wright-Patterson Air Force Base, Ohio. He graduated from the Air Force Experimental Flight Test Pilot School in 1961, and from the Air Force Aerospace Research Pilot School in 1963. His last assignment prior to his selection as an astronaut was as chief of the Advanced Requirements Branch at Headquarters Air Defense Command.

Irwin was one of the 19 astronauts selected by NASA in April 1966.

He is married to the former Mary Ellen Monroe of Corvallis, Oregon. The Irwins have four children: Joy, born November 26, 1959; Jill, born February 22, 1961; James, born January 4, 1963; and Jan, born September 30, 1964.

JOSEPH P. KERWIN

was born in Oak Park, Illinois, February 19, 1932. He was graduated from the College of the Holy Cross, Worcester, Massachusetts, with a bachelor of arts degree. Kerwin received his doctor of medicine degree from the Northwestern University Medical School, Chicago, Illinois, and completed his interneship at the District of Columbia General Hospital, Washington, D.C., and at the United States Navy School of Aviation Medicine, Pensacola, Florida.

Kerwin entered the United States Navy in 1958. He completed flight training at Beeville, Texas, in 1962, and was named the outstanding student in his preflight class. Kerwin served two years as flight surgeon with Marine Air Group 14 at Cherry Point, North Carolina. He later served as flight surgeon for Fighter Squadron 101 at Oceana Naval Air Station, Virginia Beach, Virginia; he then became staff flight surgeon for Air Wing 4, Naval Air Station, Cecil Field, Florida.

Kerwin was one of the six scientist-astronauts selected by NASA in June 1965.

He is married to the former Shirley Good of Danville, Pennsylvania. The Kerwins have two children: Sharon, born September 14, 1963; and Joanna born January 5, 1966.

WILLIAM B. LENOIR

was born March 14, 1939, in Miami, Florida. He received a bachelor of science degree in electrical engineering from the Massachusetts Institute of Technology in 1961, a master of science degree in electrical engineering from M.I.T. in 1962, and a doctorate in electrical engineering from M.I.T. in 1965.

Lenoir was one of eleven scientist-astronauts selected by NASA in August 1967.

Prior to his selection, Lenoir was an Assistant Professor of Electrical Engineering at M.I.T.

He is married to the former Elizabeth May Frost of Brookline, Massachusetts. They have one child, William B. Jr., born in 1965.

DON L. LIND

was born in Murray, Utah, May 18, 1930. He received a bachelor of science degree in physics from the University of Utah in 1953, and a doctor of philosophy degree in high energy nuclear physics from the University of California in 1964.

He served with the United States Navy on active status from 1954 to 1957. Lind completed his flight training in 1955 and was subsequently assigned to carrier duty.

Lind was one of the 19 astronauts selected by NASA in April 1966. Prior to his selection, Lind worked at the NASA Goddard Space Flight Center as a space physicist, where he was involved in experiments to determine the nature and properties of low energy particles within the earth's magnetosphere and interplanetary space. Before 1964, he was employed at the Lawrence Radiation Laboratory, Berkeley, California, doing research in pion-nucleon scattering.

He is married to the former Kathleen Maughan of Logan, Utah. The Linds have five children: Carol, born January 24, 1956; David, born November 29, 1956; Dawna, born September 1, 1958; Douglas, born October 26, 1960; and Kimberly, born April 30, 1963.

JOHN A. LLEWELLYN

was born April 22, 1933, in Cardiff, United Kingdom. Llewellyn became a United States citizen on February 17, 1966. He received a bachelor of science degree in chemistry from University College, Cardiff, in 1955, and a doctorate in chemistry from the same college in 1958.

Llewellyn was a research fellow, National Research Council of Canada from 1958 to 1960. Prior to his selection as a scientist-astronaut he was an Associate Professor at Florida State University.

Llewellyn was one of eleven scientist-astronauts selected by NASA in August 1967.

He is married to the former Valerie Davies-Jones of Cardiff, Wales. They have three children: Gareth Roger, born in 1957; Sian Pamela, born in 1962; and Ceri Elummed, born in 1967.

JACK R. LOUSMA

was born in Grand Rapids, Michigan, on February 29, 1936. He received a bachelor of science degree in aeronautical engineering from the University of Michigan in 1959 and the degree of "Aeronautical Engineer" from the U.S. Naval Postgraduate School in 1965.

He entered the United States Marine Corps in 1959 and completed flight training in 1960 at the U.S. Naval Air Training Command. He was assigned as an attack pilot, and subsequently served in Iwakuni, Japan. Lousma's last assignment before his selection as an astronaut was as a reconnaissance pilot at the Marine Air Station, Cherry Point, North Carolina.

Lousma was one of the 19 astronauts selected by NASA in April 1966.

He is married to the former Gratia Kay Smeltzer of Ann Arbor, Michigan. The Lousmas have two children, Timothy, born December 23, 1963 and Matthew, born July 14, 1966.

JAMES A. LOVELL, JR.

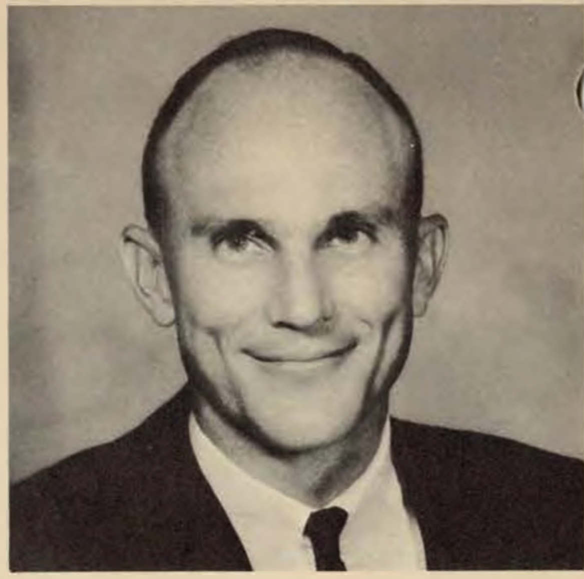
was born March 25, 1928, at Cleveland, Ohio. He received a bachelor of science degree from the U.S. Naval Academy in 1952.

Lovell received flight training following graduation from the Academy. He served in a number of assignments including a four-year tour as a test pilot at the Naval Air Test Center at Patuxent River, Maryland. He was program manager for the F4H weapon system evaluation. Lovell was graduated from the Aviation Safety School at the University of Southern California and served as flight instructor and safety officer with Fighter Squadron 101 at the Naval Air Station, Oceana, Virginia.

Lovell was one of the nine astronauts selected by NASA in September 1962. He was pilot of the Gemini VII mission, which was launched on December 4, 1965, and splashed down after 330 hours and 35 minutes. Lovell served as backup pilot for the Gemini IV mission, backup command pilot for Gemini IX and command pilot for the Gemini XII mission.

He has received the NASA Exceptional Service Medal for his space flight achievements; the 1966 Harmon International Trophy; and the 1966 American Astronautical Society Achievement Award.

Lovell is married to the former Marilyn Gerlach of Milwaukee, Wisconsin. They have four children: Barbara, born October 13, 1953; James, born February 15, 1955; Susan, born July 14, 1958; and Jeffrey, born January 14, 1966.



THOMAS K. MATTINGLY II

was born in Chicago, Illinois, March 17, 1936. He received a bachelor of science degree in aeronautical engineering from Auburn University in 1958.

He entered the United States Navy in 1958 and completed flight training in 1960. From 1960 to 1963 he was assigned to Attack Squadron 35 and flew A1H aircraft on carrier duty. In 1963 he served in A3B aircraft also on carriers. His last assignment prior to his selection as an astronaut was as a student at the Air Force Aerospace Research Pilot School.

Mattingly was one of the 19 astronauts selected by NASA in April 1966.

Mattingly is not married.

BRUCE McCANDLESS II

was born in Boston, Massachusetts, June 8, 1937. He received a bachelor of science degree from the U.S. Naval Academy in 1958; a master of science degree in electrical engineering from Stanford University in 1965; and is working toward a doctor of philosophy degree in electrical engineering at Stanford University.

He was graduated second in his class from the Naval Academy and received flight training at Pensacola, Florida, and Kingsville, Texas. In 1960 he received weapons system and carrier landing training at Key West, Florida. From 1960 to 1964 McCandless was assigned to Fighter Squadron 102 and participated in carrier duty, including the Cuban blockade. In early 1964 he was instrument flight instructor in Attack Squadron 43 at Naval Air Station Apollo Soucek Field, Oceana, Virginia. His last assignment before his selection as an astronaut was at Stanford University doing graduate studies in electrical engineering.

McCandless was one of the 19 astronauts selected by NASA in April 1966.

McCandless is married to the former Bernice Doyle of Rahway, New Jersey. They have two children: Bruce III, born August 15, 1961, and Tracy, born July 13, 1963.

JAMES A. McDIVITT

was born in Chicago, Illinois, June 10, 1929. He was graduated from the University of Michigan with a bachelor of science degree in aeronautical engineering in 1959, first in his class. He received an honorary doctor of philosophy degree in astronautical science from the University of Michigan in 1965.

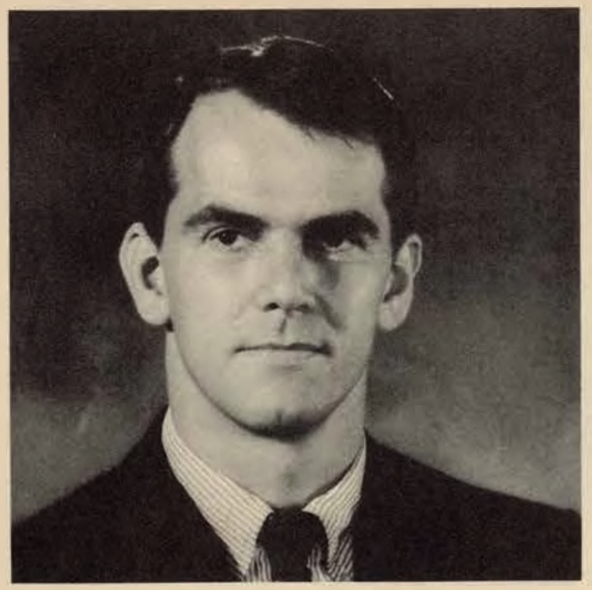
He joined the Air Force in 1951 and, during the Korean War flew 145 combat missions. He is a graduate of the United States Air Force Experimental Test Pilot School and the United States Air Force Aerospace Research Pilot School. He served at Edwards Air Force Base, California, as an experimental test pilot.

McDivitt was one of the nine astronauts selected by NASA in September 1962. He was command pilot for the Gemini IV mission, which was a 66-orbit, four-day mission, launched from Cape Kennedy June 3, 1965.

He received the NASA Exceptional Service Award for his flight. Among other aeronautic and space-related awards, McDivitt has received the Arnold Air Society John Fitzgerald Kennedy Award for 1966.

He is married to the former Patricia A. Haas of Cleveland, Ohio. The McDivitts have four children: Michael, born April 14, 1957; Ann, born July 21, 1958; Patrick, born August 30, 1960; and Kathleen, born June 16, 1966.

290-288 O-68—3



F. CURTIS MICHEL

was born June 5, 1934, at LaCrosse, Wisconsin. He was graduated from the California Institute of Technology (CalTech), Pasadena, California, with a bachelor of science degree in physics in 1955 and received his doctorate in physics from CalTech in 1962.

Michel was a junior engineer working on the Corporal missile program at the Guided Missile Division of Firestone Tire and Rubber Company, Southgate, California, before joining the Air Force in 1955. An Air Force Reserve Officer Training Corps graduate, Michel received flight training at Marana Air Force Base, Tucson, Arizona, and at the Laredo and Perrin Air Force Bases, Texas. Michel taught at Rice University, Houston, Texas, from 1963 until joining NASA.

He is married to the former Beverly Muriel Kaminsky of Sacramento, California. The Michels have two children: Jeffrey, born August 19, 1963; and Alice, born July 30, 1966.

EDGAR D. MITCHELL

was born in Hereford, Texas, September 17, 1930. He received a bachelor of science degree in industrial management from the Carnegie Institute of Technology in 1952, a bachelor of science degree in aeronautical engineering from the U.S. Naval Postgraduate School in 1961, and a doctor of science degree in aeronautics/astronautics from the Massachusetts Institute of Technology in 1964.

Mitchell entered the Navy in 1952, was commissioned in 1953, completed flight training in 1954 and was assigned to Patrol Squadron 29 in Okinawa. In 1957 and 1958 he flew A3 aircraft as part of Heavy Attack Squadron 2 on carrier duty. He was a research project officer with Air Development Squadron 5 in 1958 and 1959. After receiving his doctorate in 1964, he was assigned as Chief, Project Management Division, at the Navy Field Office for Manned Orbiting Laboratory. Prior to his selection as an astronaut, he graduated first in his class at the Air Force Aerospace Research Pilot School.

Mitchell was one of the 19 astronauts selected by NASA in April 1966.

He is married to the former Louise Elizabeth Randall of Muskegon, Michigan. The Mitchells have two daughters: Karlyn, born August 12, 1953; and Elizabeth, born March 24, 1959.

F. STORY MUSGRAVE

was born August 19, 1935, in Boston, Massachusetts. Musgrave has earned seven college degrees. They are: A bachelor of science degree in statistics from Syracuse University in 1958; a masters degree in business administration in operations analysis from UCLA in 1959; a bachelor of arts degree in chemistry from Marietta College in 1960; an M.D. from Columbia University in 1964; a master of science degree in biophysics from the University of Kentucky in 1966; and a doctorate in physiology from the University of Kentucky in 1967.

Musgrave was one of eleven scientist-astronauts selected by NASA in August 1967.

Prior to his selection, Musgrave was a post-doctoral fellow at the University of Kentucky.

He is married to the former Marguerite Patricia Van Kirk of Wayne, New Jersey. They have four children; Lorelie Lisa, born in 1961; Bradley Scott, born in 1962; Holly Kay, born in 1963; and Christopher Todd, born in 1965.

BRIAN T. O'LEARY

was born January 27, 1940, in Boston, Massachusetts. He received a bachelor of arts degree in physics from Williams College in 1961, and a master of arts degree in astronomy from Georgetown University in 1964. He received his doctorate in astronomy from the University of California, Berkeley, in 1967.

O'Leary was one of eleven scientist-astronauts selected by NASA in August 1967.

Prior to his selection, O'Leary was a NASA pre-doctoral trainee in the Space Sciences Laboratory, Department of Astronomy, at the University of California.

He is married to the former Joyce Whitehead of Kennett Square, Pennsylvania. They have no children.

ROBERT A. PARKER

was born December 14, 1936, in New York City, New York. He received a bachelor of arts degree in astronomy and physics from Amherst College in 1958, and a doctorate in astronomy from the California Institute of Technology in 1963.

Parker was one of eleven scientist-astronauts selected by NASA in August 1967.

Prior to his selection, Parker was an Assistant Professor of Astronomy at the University of Wisconsin.

He is married to the former Joan Audrey Capers of Waynesboro, Pennsylvania. They have two children: Kimberly, born in 1962; and Brian, born in 1964.

WILLIAM R. POGUE

was born in Okemah, Oklahoma, January 23, 1930. He received a bachelor of science degree in education from Oklahoma Baptist University in 1951, and a master of science degree in mathematics from Oklahoma State University in 1960.

He entered the Air Force in 1951 and received his commission in 1952. He served with the Fifth Air Force in 1953 and 1954 and flew 43 combat missions over Korea. From 1955 to 1957 he was a member of the USAF Thunderbirds. Pogue has gained flying proficiency in over 50 types and models of American and British aircraft and is qualified as a civilian flight instructor. From 1960 to 1963, he served as mathematics instructor at the USAF Academy in Colorado Springs, Colorado. He is a graduate of the Empire Test Pilots' School in Farnborough, England, and in 1965 he completed a two-year tour as test pilot with the British Ministry of Aviation under the USAF/RAF Exchange Program. Prior to his selection as an astronaut, he was an instructor at the Air Force Aerospace Research Pilot School, Edwards Air Force Base, California.

Pogue was one of the 19 astronauts selected by NASA in April 1966.

He is married to the former Helen J. Dittmar of Shawnee, Oklahoma. The Pogues have three children: William, born September 5, 1953; Layna, born June 9, 1955; and Thomas, born September 12, 1957.

STUART A. ROOSA

was born in Durango, Colorado, August 16, 1933. He received a bachelor of science degree in aeronautical engineering from the University of Colorado in 1960.

Roosa entered the United States Air Force in 1953, and was commissioned in the Air Force after graduation from the Aviation Cadet Program at Williams Air Force Base, Arizona. He flew F–84F and F–100 aircraft during a tour of duty at Langley Air Force Base, Virginia. After graduation from the University of Colorado under the Air Force Institute of Technology Program, he was chief of Service Engineering at Tachikawa Air Base, Japan, for two years.

From 1962 to 1964, Roosa was a maintenance test pilot at Olmsted Air Force Base, Pennsylvania. He graduated from the Air Force Aerospace Research Pilot School in 1965, and was assigned as an experimental test pilot at Edwards Air Force Base, California, prior to his selection as an astronaut.

Roosa was one of the 19 astronauts selected by NASA in April 1966.

He is married to the former Joan C. Barrett of Tupelo, Mississippi. The Roosas have four children: Christopher, born June 29, 1959; John, born January 2, 1961; Stuart Jr., born March 12, 1962; and Rosemary, born July 23, 1963.

WALTER M. SCHIRRA, JR.

was born in Hackensack, New Jersey, March 12, 1923. He received a bachelor of science degree from the U.S. Naval Academy in 1945 and an honorary doctorate in astronautical engineering from Lafayette College, Pennsylvania, in 1966.

He received flight training at Pensacola, Florida. During the Korean conflict, Schirra flew 90 combat missions. Other assignments include project pilot for the F7U3 Cutlass and instructor pilot for the Cutlass and FJ3 Fury; operations officer on a carrier in the Pacific; test pilot training; and suitability development work on the F4H.

Schirra was one of the seven astronauts selected by NASA in April 1959. He was pilot of the MA–8 six-orbit "textbook" flight on October 3, 1962, and command pilot of Gemini VI, December 15–16, 1965, which established a space "first" by performing rendezvous with Gemini VII.

He received the NASA Distinguished Service Medal twice and the Exceptional Service Medal once. Other awards include: American Rocket Society Astronautics Award, 1963; Collier Trophy, 1963; American Institute of Aeronautics and Astronautics Award, 1963; American Astronautical Society Flight Achievement Award, 1966; and the 1966 Harmon International Aviation Trophy.

Schirra is married to the former Josephine Fraser of Seattle, Washington. They have two children: Walter III, born June 23, 1950; and Suzanne, born September 29, 1957.

HARRISON H. SCHMITT

was born in Santa Rita, New Mexico, July 3, 1935. He received his bachelor of science degree in geology from the California Institute of Technology in 1957. He attended the University of Oslo in Norway, 1957 and 1958, and received his doctorate in geology at Harvard University in 1964. Schmitt has been awarded a Fulbright Fellowship, 1957-58; a Kennecott Fellowship in Geology, 1958-59; a Harvard Fellowship, 1959-60; a Harvard Traveling Fellowship, 1960; a Parker Traveling Fellowship, 1961-62; and a National Science Foundation postdoctoral Fellowship, Department of Geological Sciences, Harvard University, 1963-64.

He has done geological work for the Norwegian Geological Survey in Oslo, and for the U.S. Geological Survey in New Mexico and Montana. Prior to his selection as an astronaut, Schmitt was with the U.S. Geological Survey's Astrogeology Department at Flagstaff, Arizona. He was project chief on photo and telescopic mapping of the moon and planets, and was among the USGS astrogeologists instructing NASA astronauts during their geological field trips.

Schmitt was one of the six scientist-astronauts selected by NASA in June 1965. He finished flight training in 1966.

Schmitt is not married.

RUSSELL L. SCHWEICKART

was born in Neptune, New Jersey, October 25, 1935. He received a bachelor of science degree in aeronautical engineering in 1956 and a master of science degree in aeronautics and astronautics in 1963 from Massachusetts Institute of Technology (MIT). His thesis was on stratospheric radiance.

He served as a pilot in the United States Air Force from 1956 to 1960. He was recalled to active duty for a year in 1961. Prior to his selection as an astronaut he was a research scientist at the Experimental Astronomy Laboratory at MIT. His duties there included research in upper atmospheric physics and applied astronomy, as well as research in star tracking and stabilization of stellar images.

Schweickart was one of the 14 astronauts selected by NASA in October 1963.

He is married to the former Clare G. Whitfield of Atlanta, Georgia. The Schweickarts have five chillren: Vicki, born September 12, 1959; Randolph and Russell, born September 8, 1960; Elin, born October 19, 1961; and Diana, born July 26, 1964.

DAVID R. SCOTT

was born in San Antonio, Texas, June 6, 1932. He received a bachelor of science degree from the U.S. Military Academy in 1954, graduating fifth in a class of 633. From 1960 to 1962 he attended Massachusetts Institute of Technology (MIT) and earned both a master of science degree in aeronautics and astronautics and an engineer of aeronautics and astronautics degree. His thesis at MIT concerned interplanetary navigation.

As an Air Force officer, after his graduation from the Military Academy, he received flight training, attended the Air Force Experimental Test Pilot School, and the Air Force Aerospace Research Pilot School.

Scott was one of the 14 astronauts selected by NASA in October 1963. He was pilot of the Gemini VIII flight, March 16, 1966. This flight marked the first successful docking of a spacecraft with a target vehicle in space.

He has been awarded the NASA Exceptional Service Medal and the American Institute of Aeronautics and Astronautics Award in 1966.

Scott is married to the former Ann Lurton Ott of San Antonio, Texas. They have two children: Tracy, born March 25, 1961; and Douglas, born October 8, 1963.

ALAN B. SHEPARD, JR.

was born in East Derry, New Hampshire, November 18, 1923. He received a bachelor of science degree from the U.S. Naval Academy in 1944.

Following destroyer service in the Pacific in World War II, he entered flight training and received his wings in 1947. Shepard's assignments in the Navy include U.S. Navy Test Pilot School at Patuxent River, Maryland, and flight test work there. He participated in experiments in development of the Navy's inflight refueling system; carrier trials for the F2H3; Navy trials of the first angled carrier deck; testing of the F3H, F8U, F4D, F11F; and project test pilot on the F5D. He was graduated from the Naval War College, Newport, Rhode Island, in 1958 and was assigned to the staff of the Commander in Chief, Atlantic Fleet, as air readiness officer.

Shepard was one of the seven astronauts selected by NASA in April 1959 and is now Chief, Astronaut Office. On May 5, 1961, he was this country's first man in space as pilot of the Mercury-Redstone 3, a suborbital flight. The flight attained an altitude of approximately 116 statute miles and the spacecraft traveled about 302 statute miles down the Eastern Test Range.

Shepard was awarded the NASA Distinguished Service Medal in 1961, and the Langley Medal in 1964.

He is married to the former Louise Brewer of Kennett Square, Pennsylvania. They have two children: Laura, born July 2, 1947; and Julie, born March 16, 1951.

DONALD K. SLAYTON

was born in Sparta, Wisconsin, March 1, 1924. He received a bachelor of science degree in aeronautical engineering from the University of Minnesota in 1949, and an honorary doctorate in engineering from Michigan Technological University in 1965.

He entered the United States Air Force in 1942 and became a pilot in 1943. During World War II he flew 56 combat missions in B–25s over Southern Europe and seven combat missions over Japan. From 1949 to 1951, he worked as an aeronautical engineer for the Boeing Company in Seattle, Washington, until being recalled to active duty and assignment to 12th Air Force Headquarters. In 1955, Slayton attended the Air Force Flight Test Pilot School at Edwards Air Force Base, California. From 1956 to 1959, he was an experimental test pilot at that base.

Slayton was one of the seven astronauts selected by NASA in April 1959. On November 29, 1961, he was named as the pilot of MA–7, the second manned orbital mission. On March 15, 1962, it was announced that a heart condition would prevent Slayton from making the flight. In November 1963, he resigned his commission as Air Force major, and continued with NASA Manned Spacecraft Center in the dual role of astronaut and Director, Flight Crew Operations, MSC.

Slayton was awarded the NASA Distinguished Service Medal in 1965.

He is married to the former Marjorie Lunney of Los Angeles, California. They have one son, Kent, born April 8, 1957.

THOMAS P. STAFFORD

was born in Weatherford, Oklahoma, September 17, 1930. He received a bachelor of science degree from the U.S. Naval Academy in 1952.

He was commissioned in the Air Force and completed flight training and advanced interceptor training. He served five years as a fighter-interceptor pilot and subsequently was graduated from the Air Force Experimental Flight Test School in 1959. He is coauthor of *Pilot's Handbook for Performance Flight Testing* and *Aerodynamics Handbook for Performance Flight Testing.*

Stafford was one of the nine astronauts selected by NASA in September 1962. On December 15–16, 1965, with Astronaut Walter M. Schirra, Jr., as command pilot, he was pilot of the Gemini VI flight, which established a space "first" by achieving rendezvous with the orbiting Gemini VII. Stafford was command pilot of the Gemini IX mission on June 3, 1966, during which pilot Eugene A. Cernan spent two hours and 7 minutes in extravehicular activity, and multiple rendezvous was achieved using three different techniques.

Stafford has twice been awarded the NASA Exceptional Service Medal and received the American Astronautical Society Flight Achievement Award in 1966. He was also awarded the 1966 Harmon International Aviation Trophy.

He is married to the former Faye L. Shoemaker of Weatherford, Oklahoma. They have two children: Dionne, born July 2, 1954; and Karin born August 28, 1957.

JOHN L. SWIGERT

was born in Denver, Colorado, August 30, 1931. He received a bachelor of science degree in mechanical engineering from the University of Colorado in 1953 and a master of science degree in aerospace science from the Rensselaer Polytechnic Institute in 1965, and a master of science degree in business administration from the University of Hartford in 1967.

He served with the United States Air Force from 1953 to 1956. After completing flight training, Swigert was assigned as a fighter pilot in Japan and Korea.

Swigert was one of the 19 astronauts selected by NASA in April 1966. Prior to his selection, he was an engineering test pilot for North American Aviation, Inc., from 1964 to 1966. Swigert was corecipient of the AIAA Octave Chanute Award for 1966 for his participation in demonstrating the Rogallo Wing as a feasible land landing system for returning space vehicles and astronauts. From 1957 to 1964 he was a research engineering test pilot for Pratt and Whitney Aircraft.

Swigert is not married.

WILLIAM E. THORNTON

was born April 14, 1929, in Goldsboro, North Carolina. He received a bachelor of science degree in physics from the University of North Carolina in 1952, and an M.D. degree from the University of North Carolina in 1963.

Thornton was the Director of the Electronics Division, Del Mar Engineering Labs, Los Angeles, from 1956 to 1962. He was an instructor at the University of North Carolina Medical School in 1963 and 1964. In 1964 and 1965 Thornton was an intern at Wilford Hall USAF Hospital, Lackland Air Force Base, San Antonio, Texas. From 1965 to 1967 Thornton was associated with the Aerospace Medical Division, Brooks Air Force Base, San Antonio, Texas.

Thornton was one of eleven scientist-astronauts selected by NASA in August 1967.

He is married to the former Elizabeth Jennifer Fowler from Great Britain. They have two children: William Simon, born in 1959; and James, born in 1961.

PAUL J. WEITZ

was born in Erie, Pennsylvania, July 25, 1932. He received a bachelor of science degree in aeronautical engineering from Pennsylvania State University in 1954 and a master of science degree from the U.S. Naval Postgraduate School in 1964.

He received his Navy commission through the Reserve Officer Training Corps at Pennsylvania State University and was assigned to destroyer duty in 1954. He completed flight training in 1956. From 1956 to 1960 he was assigned to the Naval Air Station in Jacksonville, Florida, as tactics instructor. From 1960 to 1962 Weitz served as project officer for various air-to-ground delivery tactics projects at China Lake, California. Prior to his selection as an astronaut, he was a detachment officer-in-charge at the Naval Air Station at Whidbey, Washington.

Weitz was one of the 19 astronauts selected by NASA in April 1966.

Weitz is married to the former Suzanne M. Berry of Erie, Pennsylvania. They have two children: Mathew, born September 23, 1958; and Cynthia, born September 25, 1961.

ALFRED M. WORDEN

was born in Jackson, Michigan, February 7, 1932. He received a bachelor of science degree from the U.S. Military Academy in 1955 and master of science degree in astronautical/aeronautical engineering and instrumentation engineering from the University of Michigan in 1963.

He was commissioned in the Air Force after graduation from the Military Academy and completed flight training in Texas and Florida. From 1957 to 1961 he served as pilot and armament officer with the 95th Fighter Interceptor Squadron at Andrews Air Force Base, Maryland. He attended Instrument Pilots Instructor School at Randolph Air Force Base, Texas, in 1963. He was graduated from the Empire Test Pilots' School in Farnborough, England, in 1965, and from the Aerospace Research Pilots' School in 1965. When he was selected as an astronaut, he was assigned as an instructor at the Aerospace Research Pilot School.

Worden was one of the 19 astronauts selected by NASA in April 1966.

He is married to the former Pamela Ellen Vander Beek of Bayside, New York. The Wordens have two children: Merrill, born January 16, 1958, and Alison, born April 6, 1960.

JOHN W. YOUNG

was born in San Francisco, California, September 24, 1930. He received a bachelor of science degree in aeronautical engineering from Georgia Institute of Technology in 1952.

Young entered the United States Navy in 1952. From 1959 to 1962 he served as a test pilot and program manager of the F4H weapons system project. In 1962 Young set world time-to-climb records in the 3000 meter and 25,000 meter altitudes in the F4B Navy fighter. He also served with Fighter Squadron 143 at Miramar, California.

He was one of the nine astronauts selected by NASA in September 1962. He was pilot of the first manned Gemini flight, Gemini III, on March 23, 1965, with Astronaut Virgil I. Grissom as command pilot. This was a three-orbit mission in which the flight crew performed the first orbital maneuver conducted by man. He was selected as backup pilot for the Gemini VI mission. Young was command pilot of the Gemini X mission. Among Gemini X's accomplishments were dual rendezvous with two Agena target vehicles, combined maneuvering of Gemini/Agena X, space flight to 475 miles above the earth, and three periods of extravehicular activity by the pilot.

Young was awarded the NASA Exceptional Service Medal in 1965 and in 1966.

He is married to the former Barbara V. White of Savannah, Georgia. The Youngs have two children: Sandy, born April 30, 1957; and John, born January 17, 1959.

HIGHLIGHTS OF MANNED SPACE FLIGHTS

	Date	Flight Time (Hrs: Min: Sec:)	Revo-lutions	Spacecraft Name	Remarks
Project Mercury Alan B. Shepard, Jr.	5/5/61	00:15:22	Sub-orbital	Freedom 7	America's first manned space flight.
Virgil I. Grissom	7/21/61	00:15:37	Sub-orbital	Liberty Bell 7	Evaluated spacecraft functions.
John H. Glenn, Jr.	2/20/62	04:55:23	3	Friendship 7	America's first manned orbital space flight.
M. Scott Carpenter	5/24/62	04:56:05	3	Aurora 7	Initiated research experiments to further future space efforts.
Walter M. Schirra, Jr.	10/3/62	09:13:11	6	Sigma 7	Developed techniques and procedures applicable to extended time in space.
L. Gordon Cooper, Jr.	5/15–16/63	34:19:49	22	Faith 7	Met the final objective of the Mercury program—spending one day in space.
Project Gemini Virgil I. Grissom John W. Young	3/23/65	04:52:31	3	Gemini–III	America's first two-man space flight.
James A. McDivitt Edward H. White, II	6/3–7/65	97:56:12	62	Gemini–IV	First "walk in space" by an American astronaut. First extensive maneuver of spacecraft by pilot.
L. Gordon Cooper, Jr. Charles Conrad, Jr.	8/21–29/65	190:55:14	120	Gemini–V	Eight day flight proved man's capacity for sustained functioning in space environment.
Frank Borman James A. Lovell, Jr.	12/4–18/65	330:35:01	206	Gemini–VII	World's longest manned orbital flight.
Walter M. Schirra, Jr. Thomas P. Stafford	12/15–16/65	25:51:24	16	Gemini–VI–A	World's first successful space rendezvous.
Neil A. Armstrong David R. Scott	3/16–17/66	10:41:26	6.5	Gemini–VIII	First docking of two vehicles in space.
Thomas P. Stafford Eugene A. Cernan	6/3–6/66	72:20:50	45	Gemini–IX–A	Three rendezvous of a spacecraft and a target vehicle. Extravehicular exercise—2 hours 7 minutes.
John W. Young Michael Collins	7/18–21/66	70:46:39	43	Gemini–X	First use of target vehicle as source of propellant power after docking. New altitude record—475 miles.
Charles Conrad, Jr. Richard F. Gordon, Jr.	9/12–15/66	71:17:08	44	Gemini–XI	First rendezvous and docking in initial orbit. First multiple docking in space. First formation flight of two space vehicles joined by a tether. Highest manned orbit—apogee about 853 miles.
James A. Lovell, Jr. Edwin E. Aldrin, Jr.	11/11–15/66	94:34:31	59	Gemini–XII	Astronaut walked and worked outside of orbiting spacecraft for more than 5½ hours—a record proving that a properly equipped and prepared man can function effectively outside of his space vehicle. First photograph of a solar eclipse from space.

M. SCOTT CARPENTER

was born in Boulder, Colorado, May 1, 1925. After World War II he entered the University of Colorado and received a bachelor of science degree in aeronautical engineering.

Carpenter participated in the V–5 flight training program sponsored by the United States Navy at the University of Colorado in 1943.

Carpenter was one of the seven astronauts selected by NASA in April 1959. He served as backup pilot to John Glenn on the Mercury-Atlas 6 flight. Carpenter commanded the MA–7 three-orbit flight on May 24, 1962, and was awarded the NASA Distinguished Service Medal for his space voyage. Later he resigned from the astronaut program to return to the Navy and pursue his interest in deep sea exploration.

He is married to the former Rene Louise Price of Clinton, Iowa. The Carpenters have four children: Marc, born November 29, 1949; Robyn, born March 4, 1962; Kristen, born June 26, 1955; and Candace, born October 8, 1956.

JOHN H. GLENN

was born July 18, 1921, in Cambridge, Ohio, and attended Muskingum College at Concord, Ohio. Entering the Naval Aviation Cadet Program in 1942, he was commissioned in the Marine Corps in 1943.

In April 1959 he was selected as an astronaut for Project Mercury. As pilot of "Friendship 7" spacecraft, Glenn was the first American to make an orbital flight. Launched from Cape Kennedy, Florida, the flight reached a maximum altitude of 162 miles and made 3 orbits in four hours, 55 minutes, 23 seconds, before landing in the Atlantic Ocean near Grand Turk Island.

Awarded the Distinguished Flying Cross five times, Glenn also holds the Air Medal with 18 clusters. He retired from the Astronaut Program in 1964, and became a consultant to NASA's Administrator in February 1965.

His wife is the former Anna Margaret Castor. They have two children, John David and Carolyn Ann.

CHARLES A. BASSETT II

was named as an astronaut by NASA in October 1963.

A Major in the United States Air Force, he was born in Dayton, Ohio, December 30, 1931. Following graduate work in electrical engineering at the University of Southern California he entered the military service in October 1952.

Major Bassett lost his life in an aircraft accident during a routine flight to St. Louis, Missouri on February 28, 1966.

THEODORE C. FREEMAN

was named an astronaut by NASA in October 1963.

A Captain, United States Air Force, Freeman was born in Haverford, Pennsylvania, February 18, 1930. A graduate of the U.S. Naval Academy, Freeman received his Master of Science degree from Michigan University in 1960.

Captain Freeman died in an aircraft accident during a routine test flight at Ellington Air Force Base, October 31, 1964.

ROGER B. CHAFFEE

was named an astronaut by NASA in October 1963.

He was born in Grand Rapids, Michigan, February 15, 1935. He graduated from Purdue University with a bachelor of Science degree in Aeronautical Engineering in 1957. Joining the Navy later that year, he rose to the rank of Lieutenant Commander.

Commander Chaffee met death while participating in a simulated countdown of an Apollo spacecraft on January 27, 1967.

EDWARD G. GIVENS, JR.

was one of the 19 astronauts selected by NASA in April 1966.

Major Givens was born in Quanah, Texas, January 5, 1930. He received a bachelor of science degree from the U. S. Naval Academy in 1952.

Prior to his selection as an astronaut, he had been assigned to the Air Force's Space Systems Division Office at the Manned Spacecraft Center, Houston, Texas.

Major Givens lost his life in an off-duty automobile accident on June 6, 1967.

VIRGIL I. GRISSOM

was pilot of the Mercury-Redstone 4 (Liberty Bell 7) sub-orbital mission, July 21, 1961, which attained an altitude of 118 miles and traveled 302 miles in 15 minutes and 37 seconds. He was also commander of Gemini III, a three-orbit mission flown on March 23, 1965.

A Lieutenant Colonel in the U.S. Air Force, Grissom was born in Mitchell, Indiana, April 3, 1926, and named astronaut by NASA April 1959.

He met death during a simulated countdown of an Apollo spacecraft, January 27, 1967.

EDWARD H. WHITE

pilot for the four-day Gemini mission in June, 1965, was the first American to "walk" in space. He spent 21 minutes outside the spacecraft during the flight's third orbit.

Born in San Antonio, Texas, November 14, 1930, he was a graduate of the U.S. Military Academy, and became a Lieutenant Colonel in the U.S. Air Force. He was named as an astronaut by NASA in September 1962.

He met death while participating in a simulated countdown of an Apollo Spacecraft mission on January 27, 1967.

ELLIOT M. SEE, JR.

was named as an astronaut by NASA in September 1962.

Born in Dallas, Texas, July 23, 1927, he obtained his Master's degree in Engineering from the University of California in 1962.

Mr. See served three years in the Navy and was employed as a test pilot for ten years by the General Electric Company.

See lost his life in an aircraft accident during a routine flight to St. Louis, Missouri, on February 28, 1966.

CLIFTON C. WILLIAMS, JR.

was one of the 14 astronauts selected by NASA in October 1963.

He was born in Mobile, Alabama, September 26, 1932 and received his bachelor of science degree in mechanical engineering from Auburn University in 1954.

Williams was a graduate of the Navy Test Pilot School at Patuxent, Maryland. At the time of his selection as an astronaut, he was attending the Marine Corps Intermediate Staff and Command School at Quantico, Virginia.

Astronaut Williams lost his life in the crash of his T–38 jet trainer on October 6, 1967.

APOLLO FLIGHT CREWS

(as announced November 20, 1967)

FIRST MANNED FLIGHT (UPRATED SATURN I)

Prime Crew	Command Pilot, Walter M. Schirra, Jr. Senior Pilot, Donn F. Eisele Pilot, Walter Cunningham
Backup Crew	Command Pilot, Thomas P. Stafford Senior Pilot, John W. Young Pilot, Eugene A. Cernan
Astronaut Support Team	John L. Swigert, Jr. Ronald E. Evans William R. Pogue

SECOND MANNED FLIGHT (SATURN V)

Prime Crew	Commander, James A. McDivitt Command Module Pilot, David R. Scott Lunar Module Pilot, Russell L. Schweickart
Backup Crew	Commander, Charles Conrad, Jr. CM Pilot, Richard F. Gordon LM Pilot, Alan L. Bean
Astronaut Support Team	Edgar D. Mitchell Fred W. Haise, Jr. Alfred M. Worden

THIRD MANNED FLIGHT (SATURN V)

Prime Crew	Commander, Frank Borman CM Pilot, Michael Collins LM Pilot, William A. Anders
Backup Crew	Commander, Neil A. Armstrong CM Pilot, James A. Lovell LM Pilot, Edwin E. Aldrin
Astronaut Support Team	Thomas F. Mattingly II Gerald P. Carr John S. Bull

EP-34

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APPENDIX B-III-7

APOLLO APPLICATIONS PROGRAM CONGRESSIONAL HISTORY 1965-1968
(Sheet 1 of 5)

	(1) FY 1966 NASA Authorization Spring, 1965	(2) Report: National Space Goals for Post Apollo Period - August, 1965 (Senate)	(3) FY 1967 NASA Authorization Spring, 1966
CONTENT	Program called Apollo Extension Systems (AES). Earth Orbital Experiments Applications. Space Science. Earth oriented applications. Support for space travel. Lunar Orbit Operations. Lunar Surface Operations LEM Shelter.	Space Technology Operations. EVA, Adv. Technology and supporting res. Space Science/ Applications. Astronomy, Bio-medicine, earth sciences and resources. Lunar Science/ Exploration. Experiment Pallet. LEM Lab. (Earth Orbiting). Program Definition.	Presented amplifie material similiar to FY 1966. Earth orbit up to 90 day using rendezvous, resupply and orbit assembly, conduct operational, scientific and technological experiments. Use of spent stages discussed under Adv. Missions. Future National Space Objectives - House Oversight Publ. July 1966
SCHEDULE	Fiscal year 1966 Apollo Extension effort will be devoted to design studies and identification of long-lead components and subsystems required to capitalize fully on Apollo hardware capabilities.	Flight schedule presented shows mid-1968 (earliest possible to early 1970.	Program definition to be completed end of CY 1967 - Manned Orbital assembly resupply beginning in mid 1968 - ending early 1970's.

APOLLO APPLICATIONS PROGRAM CONGRESSIONAL HISTORY 1965-1968
(Sheet 2 of 5)

	(1) FY 1966 NASA Authorization Spring, 1965	(2) Report: National Space Goals for Post Apollo Period - August, 1965 (Senate)	(3) FY 1967 NASA Authorization Spring, 1966
COST	$48 million - Apollo mission support R&D line item.	Same order of magnitude as development of Apollo program.	$41.9 million under Apollo mission support - long lead items to to hold open potential options. Discussed cost as a function of program completion year. Fulton opposed AAP in House Report. Committee requested AAP plans be submitted to them well in advance of budget for orderly review.

APOLLO APPLICATIONS PROGRAM CONGRESSIONAL HISTORY 1965-1968
(Sheet 3 of 5)

	(4)	(5)	(6)
	Report: Apollo Program Pace and Progress - House Oversight Published March 10, 1967	FY 1968 NASA Authorization House & Senate	FY 1968 NASA Authorization - R&D Adjustments for Apollo AS-204 Accident - April 24, 1967
CONTENT	Presented July - October, 1966. Program evolution showing AAP leading to a space station. Workshop, Airlock, M&SS, Docking adapter and ATM presented.	Orbital Workshop, ATM, experiments, AAP-1 thru AAP-4 and LM and SS missions described in detail. Five types experiments described: Scientific, Technological, medical, engineering, and DoD. AAP-A and AAP-B experiments described. Payload packages described (Meteorology and earth resources). Plus land landing and six man CM.	AAP-1A revision explained - AAP-1A has primary objective of conducting science and technology experiments. A new mission would be flown-single launch - between the Workshop and ATM missions. Following the ATM mission-single resupply mission. Alternate plans call for launch of a second Workshop and ATM in 1970.
SCHEDULE	Launch S-IV-B Workshop by end of 1968, with re-visit. 28 day and 56 day missions with solar observation operations described.	Initial mission AAP-1 AAP-1 and AAP-2 could be as early as 1968. 1969 involve three kinds of missions: 1. Qualification of lunar mapping and survey system. 2. Long duration flights 28 - 56 days. 3. Solar Astronomical observations. Embyonic space station placed in orbit by AAP-1 thru AAP-4 flights would be revisited and reused beginning with additional flights in 1969. Missions for CY 1969 described as well as the 1970's.	Mission 1A to take place last half of Calendar Year 1968. Six month delay in Orbital Workshop flight forecast from previously planned 1968 launch dates.

APOLLO APPLICATIONS PROGRAM CONGRESSIONAL HISTORY 1965-1968
(Sheet 4 of 5)

	(4)	(5)	(6)
	Report: Apollo Program Pace and Progress - House Oversight Published March 10, 1967	FY 1968 NASA Authorization House & Senate	FY 1968 NASA Authorization - R&D Adjustments for Apollo AS-204 Accident - April 24, 1967
COST	Congress told very substantial sums would have to be committed in FY 1968. Received $41.9M. Mueller stated sum $220M less than requested from Bureau of Budget. Effect of FY 1967 cut by BuBud increase runout costs of Apollo program. Shortage of funds in 1967 will cause FY 1968 funding to be larger than it would have been otherwise (to avoid lapse in production).	Budget request $454.7M. Requested approved of AAP program as defined.	No change in funding total as result of accident. Space vehicle and experiments line items changed, however.

APOLLO APPLICATIONS PROGRAM CONGRESSIONAL HISTORY 1965-1968
(Sheet 5 of 5)

	(7) FY 1968 NASA Authorization Committee Reports House & Senate	(8) FY 1968 Program Operating Plan Hearings Nov. 1967
CONTENT	Specific AAP program elements selected for initation in FY 1967 and FY 1968 1. Orbital Work-shop. 2. Support Systems for long duration flight. 3. LM modified for 2 week stay time. 4. LM and SS. 5. Six man CM land landing. 6. Earth Orbital Science Applications Specialized 7. Manned solar telescope (ATM).	Operating plan presented based on Appropriations. AAP program reduced to a sharply limited number of flights with limited objectives. Centered around Orbital Workshop and ATM. In CY 1970 a pre-cursor training mission for scientist-astronautics with earth orbital experiments will be flown followed by dual launch missions of Orbital Workshop and ATM. If space vehicles are available one or more revisit flights will be made and a second flight of the Orbital Workshop and ATM. Face necessity to terminate Saturn IB after Vehicle #215.
SCHEDULE		Need to minimize expenditures in FY 1969 as well as FY 1968 - First AAP flights will not take place until CY 1970.
COST	Authorized $347.7M (Appropriations action provided $315.5M).	POP plan allocates $253.2M. Funds will not be available under the 1968 POP for either a second revisit to the first cluster or a second cluster of the Workshop and ATM unless the limited beginning that can be made in FY 1968 can be carried forward in FY 1969.