# PRELIMINARY HISTORY

OF

# NASA

# 1963 - 1968

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BOOK 10

Table B-VI-1

NASA EMPLOYMENT

1958 - 1968

| | Total | Permanent Civil Service | Support Contractor Employee Head Count |
|---|---|---|---|
| October 1958 ---------------- | 7,966 | 7,867 | (1) |
| June 30, 1959 ---------------- | 9,235 | 9,123 | (1) |
| June 30, 1960 ---------------- | 10,232 | 10,085 | (1) |
| June 30, 1961 ---------------- | 17,471 | 16,536 | (1) |
| June 30, 1962 ---------------- | 23,686 | 22,052 | (1) |
| June 30, 1963 ---------------- | 29,934 | 28,385 | (1) |
| June 30, 1964 ---------------- | 32,499 | 31,285 | (1) |
| June 30, 1965 ---------------- | 34,049 | 32,697 | (1) |
| June 30, 1966 ---------------- | 35,708 | 33,538 | 26,962 |
| June 30, 1967 ---------------- | 35,860 | 33,677 | 29,257 |
| Nov. 1, 1967 ---------------- | 34,281 | 33,507 | 33,768 |
| May 31, 1968 ---------------- | 33,202 | 32,320 | 31,511 |

(1) Data not available

Appendix B-VI

# A P P E N D I X   T O   C H A P T E R   V I

# M A N A G E M E N T   A N D   O R G A N I Z A T I O N

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(NOTE: See A ppendix B-II for related data, such as Administrator Webb's Diebold Lecture to the Harvard Business School)

This Copy For ___________

PRESS BRIEFING (ON THE RECORD)

AT THE WHITE HOUSE

WITH GEORGE CHRISTIAN AND JAMES WEBB, DIRECTOR, NASA

12:43 P.M. EDT

SEPTEMBER 16, 1968

MONDAY

MR. CHRISTIAN: Mr. Webb has been visiting with the President this morning and has one news item to give you and possibly a brief report.

MR. WEBB: Gentlemen, the President asked me when I got back from the full week examination of our international programs in Europe and attendance at the United Nations meeting on the Peaceful Uses of Outer Space in Vienna, to give him a report and later asked me to give him a rundown on where we stood in the program.

I have done that. I reminded him that more than a year ago I had told him that I would be 62 on the seventh day of October and would have had, at that time, spent more than 25 years in the full-time service in the government out of the last 40 and that I thought we should consider stabilizing the future of the agency and prepare for my retirement.

We have done that. Dr. Thomas Paine was selected by the President six months ago to be Deputy Administrator. We have added to Dr. Paine two other executives of great capability, Mr. Whittaker, who came in to head up our industry affairs, who was former head of the Federal Systems Division of IBM; Mr. Beggs, who was formerly in charge of the service laboratory and then procurement for Westinghouse.

So we have three experienced executives in the age bracket from 40 to 47 and the President and I are highly pleased with their capability.

He has asked me to remain on as a consultant to Dr. Paine and the agency certainly until the 20th of January and I have agreed to put my time on that and any other matters that the President wishes to ask me to do.

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So I think to make this very short, he has given me permission to retire on the seventh of October after more than a year of preparation for this event.

I would like to say for myself I would not retire if he felt uneasy about it, but we both feel completely confident that we have the strongest team in NASA we have ever had.

Q Mr. Webb, what will you do afterwards?

MR. WEBB: You will remember I partially retired twice before. But I certainly don't intend to take any full-time job. I have a number of quite important interests in the field of education and foreign affairs.

As you may know, I have been quite active in the Washington International Center, the Merridan House Foundation, which receives all the foreign sponsored visitors received in this country. I have done a number of things like this and will continue much of that.

You may remember that I was Chairman of the Municipal Manpower Commission at the time I took this job. I expect to examine again, after some rest, what the areas of modern technology that we have developed in the space program can do to solve some of the problems we have in the urban area.

I have a strong feeling that in the space program we have developed a combination of work that involves the economic, social and political institutions required to join together for success.. That experience can be useful in some of the problems that relate to our urban civilization.

So, I am going to put some time in. I don't expect to take any paying job.

Q How long were you in NASA?

MR. WEBB: It will be eight years on Valentine's Day, the 14th of February of next year. So it is just four months short of 8 years.

Q Mr. Webb, is Dr. Paine going to be your successor?

MR. WEBB: Yes, the President asked me to tell him and I have just telephoned him from here to tell him that the President would name him as the Acting Administrator.

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Q In terms of missions, how do you think you leave NASA?

MR. WEBB: I leave NASA well prepared and with a conservative financial structure to carry out the missions that have been approved. They will go forward. What we have not been able to do under the pressures on the budget has been to fund new missions for the 1970's. So, there is going to be a period when there will be fewer flights than would in my view have been important to do.

I could say it to you in a very simple way: We planned with the President's leadership in 1961 and his recommendations to President Kennedy to develop an ability to fly six Saturn V's per year and 6 Saturn I's per year.

As we went forward, we expected this launch rate to force the preparation of payloads that would give us a larger amount of experience and permit us then to decide what to do.

Under the reductions in the budget beginning in 1964 when the $600 million reduction was made in one year, we have reduced that anticipated flight schedule, or production schedule, to first four per year of each and then two per year of each. We have now cancelled the production lines on both of these boosters.

So, in effect, what we will have to do is develop a new base of technology for the next generation of boosters. That is number one.

The second thing we will have boosters in storage, since we are not going to fly them and we will be developing payloads for those boosters, but instead of a driving launch schedule that would launch one Saturn a month, you will have a careful examination of what you want to take a big booster out of storage for and fly it.

In other words, they will be there and can be taken out and flown, but the country will have to look with great care into what it is it wants to do with those boosters that will be in storage.

Q Are you satisfied with the program as it stands now? Do you think it is going to meet its Apollo deadline and so forth?

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MR. WEBB: I am not satisfied with the program. I am not satisfied that we as a nation have not been able to go forward to achieve a first position in space.

What this really means is we are going to be in a second position for some time to come. So, I am certainly not satisfied with that. I am satisfied with what we have developed in every field and that we have been flying three successful generations of spacecraft.

We are headed now for the fourth. On the lunar side, we have had unmanned, Ranger, Surveyor, and the Lunar Orbiter. It is a remarkable thing to go through three generations in the first ten years of a program.

In the manned program, we have gone from Mercury to Gemini to Apollo.

I think now the question is what will the fourth generation of spacecraft be. We have a vast amount of capability.

As the USSR proceeds to fly and remains in the number one position, we will have the capability to start new programs as the need is clearly indicated. So we do have the capability. We have worked up to a work force of 420,000 people. At the end of this fiscal year, we will be down to just over 200,000. So we have shown the administrative capability to build up and then to reduce without losing pace in the program.

Q What is the budget?

MR. WEBB: The expenditures will be slightly over $4 billion for this current fiscal year. The new obligational authority which starts the things for the 1970's will be about $3.85 billion. So we are spending out the money appropriated in the previous years and not replenishing the pipelines.

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Q Is Mr. Paine the deputy now?

MR. WEBB. Yes.

Q How do you spell his name?

MR. WEBB. P a i n e just like the famous writer.

Q What about the target for the man on the Moon by 1970? Are you going to get that?

MR. WEBB: I think this will be clear in several months. We have decided to shift from the small Saturn to the big Saturn after this next flight provided the flight is successful. That flight will be in October.

We have decided to put men on the third flight of the big Saturn. That third flight will come in December.

After that, we will have one more major test which will include all the equipment including the Lunar landing module which will come in, say, late February or sometime in March.

If all of those flights go well, we will proceed to fly off rapidly four or five Saturn V flights. On any one of them, we will have the full equipment to go to the Moon, land and come back. But whether or not we will have had enough experience to feel confident in it is the question and I have a hard time answering that.

I will answer it one other way. We did calculate that we needed 15 Saturn V's in the program to make sure that we would do the Lunar landing.

We have funded eight at the moment. We expected as of last January when the President sent up his budget to fly all eight of them before 1970. Now we can only fly seven. So the real question is can we make the landing by number seven?

The next three or four months are going to tell how well this equipment goes. I think that will give you an indication.

Q What has taken the urgency, if I may put it that way, out of the U. S. space program? Is it the need to spend money elsewhere -- Vietnam, the ghettos?

MR. WEBB: I think this is right. I think also there have been always needs. I think a good many people have tended to use the space program as a sort of whipping boy, if you want to call it that. People in all kinds of areas of research would say, "If I just had some of that money the space program has," and this in a sense has produced a slightly different atmosphere than we had after Sputnik and Gagarin's flight. But in essence if it were not for the fiscal problems faced by the President and the Director of the Budget I would believe that the program would have been supported in the Congress and in the country

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at a higher level than it [illegible] I don't think the base of support has been [illegible] eroded.

[illegible] this is [illegible] by the fact that even with all the troubles that we have had on budget matters Congress still supported this [illegible] of over $4 billion this year.

Q [illegible] where you thought you had reached parity with the Russians?

MR. WEBB: I thought we had reached parity with the Russians about two or two and one-half years ago in every field except the flight of the large boosters and large spacecraft. They have been ahead of us in this field all the time and I have said so in every presentation of the budget to the Congress and for the last four years I have stated that while we have developed options, each of these four budgets would not close that gap with the big spacecraft.

What I pointed out was that they had been flying 10,000 and 15,000-pound spacecraft and recovering them at will. The Gemini is only 7,000 pounds. We have had two flights with the Apollo on the Saturn V. But we were just coming into that area of matching them with these flights.

So we have not been ahead of them or equal to them in the big boosters and the big spacecraft at any time. The 12 Saturns a year would have brought us there I think without any doubt. If we could have done that in late '67 or early '68, I think we would have forged ahead. But they are still moving at the rate that they have built up to, in fact, increasing it.

So while we are reducing down to a half to two-thirds of our previous program, they are still increasing.

Q Mr. Webb, does the President naming Dr. Paine as Acting Administrator indicate that he does not intend to nominate a new Administrator?

MR. WEBB: You had better ask the President that. He has told me to tell Dr. Paine he was going to name him Acting Administrator on the 7th of October. I think I can only say that he has expressed the strongest confidence in Dr. Paine.

Dr. Paine is one of the outstanding men in this country, both in science, in technology, engineering and in management. He has had 19 years in GE before he came to us managing important activities. He was a submarine man and worked up to be executive officer of a submarine during World War II. He is qualified to run the job without a doubt.

I don't want to speak for the President.

Q What was his last position with GE?

MR. WEBB: He was the Executive Officer of an Organization called TEMPO which is a technology development

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unit on the West Coast -- Santa Barbara, California. Before that he had run one of their large laboratories at Schenectady and Lynn, Massachusetts.

So he has had 19 years. They had selected him to move up in the higher echelons and be in the corporate offices that would be responsible for all the affairs of GE. He chose to come into the Government to widen out his horizons and broaden. So it was his choice. GE, I am sure, did not want him to leave.

Q You say it was about six months ago that he was made Deputy Administrator?

MR. WEBB: Yes.

Q How old is he?

MR. WEBB: He was 46 when he was appointed.

Q Mr. Webb, you say we were approaching parity about 2-1/2 years ago with the exception of the big boosters and payloads. Where do we stand now with your departure?

MR. WEBB: We are not conducting the program at a level that will bring parity.

Q Have we fallen dangerously behind their progress?

MR. WEBB: I am not going to use an adjective like that. What I said is that under the President's leadership facing all the problems we have funded the flights in a conservative way that were required to meet our commitments, the flights we have committed ourselves to, and that this will give us experience, Saturn V and Apollo experience, out to the Moon. It will give us up to 6,000 hours of flight experience.

This gives a capability to do what we have to do in the future. Any danger to the United States that would come from the Russian program would be visible in time to use this capability to start out. But they are going to have the reality and the image of being out in front for a number of years to come. How dangerous that is you will have to judge yourself.

Q You seem to be saying they have topped the Saturn V which they haven't?

MR. WEBB: I have been testifying for three years in the Congress that they were building a booster bigger than the Saturn V and they will be flying it soon.

Q I would like to clarify one point. Your decision is entirely on the grounds of length of service. It doesn't reflect any dissatisfaction with the Administration?

MR. WEBB: Nonewhatever. The President and I discussed this more than a year ago. We examined the factors

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of it in writing and the effort we have made is to create an agency that could operate without me.

I am ve anxious that come January 20 and then July 1, 1969, which is the beginning of a fiscal year, the agency will be in the strongest possible position.

I believe and the President will have to speak for himself that to go through a period of operation with my being available for advice but not making the decisions will leave them in the strongest possible position for January 20.

Then they will have to go through what the new President does with President Johnson's budget on space and then you will enter the fiscal year.

So everything he and I have looked at has been how to leave the agency in the strongest position to do its work in a non-political way.

THE PRESS: Thank you.

END (AT 1:05 P.M. EDT)

# THE MANAGEMENT OF A NATIONAL SPACE PROGRAM

by

Dr. Robert C. Seamans, Jr.



United Nations Conference
on
The Exploration and Peaceful Uses of Outer Space

Vienna, Austria

August 1968

## INTRODUCTION

On March 5, 1958, President Eisenhower recommended that the "leadership of the [U.S.] civil space effort be lodged in a strengthened and redesignated National Advisory Committee for Aeronautics (NACA)," and that legislation be enacted "to give NACA the authority and flexibility" to carry out "an aggressive space program [that] will produce important civilian gains in general scientific knowledge..." Just a month before this recommendation, the Senate had created the Special Committee on Space and Astronautics with the Majority Leader, Senator Lyndon B. Johnson, designated Chairman. The House of Representatives formed a select committee on Astronautics and Space Exploration on March 5, and it designated Congressman John W. McCormack, its Majority Leader, as Chairman.

These actions within the period of one month by the Republican President and by the Democratic-controlled Congress were signals of the national resolve that was subsequently expressed in the legislation which states "that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind."

This legislation--the National Aeronautics and Space Act of 1958--marked the beginning of a long series of decisions that have had great national and international significance during the intervening ten years.

It was and is today the keystone legislation that provides the framework for our U.S. space program.

The legislation provides for a single organization responsible for all civilian space activities. As recommended by the President, the U.S. space program was structured around the National Advisory Committee for Aeronautics (NACA), which comprised approximately 8,000 employees in its Washington Headquarters offices, three aeronautical research laboratories--Langley, Lewis, and Ames--located respectively in Virginia, Ohio, and California, and an experimental flight test station in the California desert. The Vanguard Satellite Project team, which had been part of the Naval Research Laboratory, was transferred immediately to the newly formed National Aeronautics and Space Administration (NASA) in 1958. The Jet Propulsion Laboratory, operated for the Army by the California Institute of Technology, was transferred to NASA in 1959, and in 1960, the research and development laboratories of the Army's Redstone Arsenal became part of NASA and was subsequently named the Marshall Space Flight Center.

This was the nucleus from which grew a team of over four hundred thousand government, industry and university specialists participating in continuing aeronautical research and new space activities. This peak level occurred in 1966, and has since been reduced to about three hundred thousand.

The policy, program and administrative decisions that were made during the succeeding ten years and the means evolved to translate decisions into reality are the subjects of this paper. The steps that were taken to evolve from an amalgamation of aeronautical research and missile research and development organizations into a cohesive team is a chronology worthy of study by those concerned with future new ventures.

POLICY AND PROGRAM DECISIONS, 1958 to 1961

Within the broad goals set by the Space Act, specific program and project undertakings are decided by NASA and the executive and legislative bodies of our government. I will briefly discuss some of these specific projects and then discuss the organizational approaches and management techniques that were evolved to plan, coordinate, direct, control and evaluate the work that was required to achieve these goals.

The NACA organization had been increasingly involved in the study of space during the year prior to the creation of NASA, but the first flight projects were brought under NASA auspices via transfer from other government organizations. The first was Project Vanguard, America's earth satellite activity conceived as a portion of the International Geophysical Year, and initiated by the Naval Research Laboratory. NASA also assumed the direction of lunar probe and earth satellite projects previously under the auspices of the Army and Air Force. Several rocket engine projects were also transferred to NASA during this initial period, including the study of an engine, five of which today provide 7½ million pounds of thrust during the Saturn V first stage burning.

In the summer of 1958, when space legislation was under review in the Congress, a study team was formed at the Langley Aeronautical Laboratory of the NACA to explore the possibilities of the development and operation of manned space vehicles. By the time NASA was established, this team had developed plans to launch a one-man capsule into orbit. These plans were approved by NASA's first Administrator, Dr. T. Keith Glennan, On October 7, 1958. In the years immediately following, Mercury dominated public interest in space and served as a focus for manned space flight growth into follow-on activity.

Between 1958 and 1961, the NASA space program continued to grow and diversify. A variety of small geophysical and atmospheric research satellite projects were added to the program. The Tiros meteorological satellite was launched, and the design of a larger Nimbus satellite was commenced. Observatory satellites were initiated to provide opportunities for many scientists to place their instruments for geophysical experiments, and solar and celestial astronomy on "spacefaring buses". The lunar probes were phased out and lunar exploration was centered on Ranger for photography, and Surveyor for soft-landed experiments.

By the end of 1960, the first of a series of decisions had been made regarding space communications research projects. The 100-foot diameter inflated sphere, ECHO, had been orbited and demonstrated passive space communications capabilities, and the Administrator announced that NASA would launch--at cost--active communications satellites developed commercially, A national program of space launch vehicles was needed for these approved projects and to satisfy anticipated needs. It was decided in 1959 that NASA would undertake the development of Scout, an all-solid propellant launch vehicle for small satellites, the intermediate size Thor Delta and the Atlas Centaur with liquid hydrogen as fuel in the second stage. The Department of Defense agreed to develop the Thor Agena, Atlas Agena, and Saturn launch vehicles. The Saturn, with its eight engines in the first stage, was a project to test the efficiency of clustering propulsion systems and to provide a capability for 20- to 30,000-pound payloads if clustering proved successful. This project was the responsibility of the development laboratories at the Army's Redstone Arsenal, and became a NASA responsibility when these laboratories were transferred to NASA in 1960.

From these beginnings, a diversified program of manned and automated spacecraft operations in the fields of geophysics, lunar science, solar and celestial astronomy, meteorology, and space communications was evolved through mission failures and successes, through periods of criticism and dissent, and periods of full support and acclamation. However, the policy and broad goals established for a balanced space program provided the basis for sustained momentum on all fronts.

PROGRAM PLANNING: MANNED LUNAR LANDING

When President Kennedy assumed office in January 1961, there were still decisions to be made that would have a major impact on the resources required for space exploration. These decisions covered many fields, including communications and planetary exploration, but manned space flight missions beyond Mercury and the related development of large launch vehicle capability clearly had the greatest effect on the budget. All of these missions were reviewed from the standpoint of scientific and technical returns, economic growth, national purpose, and international implications.

During 1959 and 1960, government and industry teams had been conducting extensive studies of manned flights out to distances of 250,000 miles from earth. These studies included circumlunar missions and long duration earth orbital missions for a crew of three astronauts. From these studies, it became obvious that even using rendezvous and docking techniques much larger launch vehicles would be required for manned space explorations beyond the limited capability of Mercury. During the winter of 1961, the commitment of the United States to extensive space exploration was debated within the Administration, with the Congress, and in public forums. Discussion of the issues took place at the Presidential level and in the Space Council under the Chairmanship of Vice President Johnson. In May of 1961, President Kennedy delivered a special State of the Union Message in which he recommended an accelerated space effort. In this address he stated, "Now is the time to take longer strides." He recommended that the nation "commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to earth."

As the discussions and debate within the new Administration proceeded during the first months of 1961, the depth of the manned lunar studies was intensified. By May, over 10,000 separate work packages were identified. Each item of work was specified in terms of its objectives, its manpower requirement, its time schedule, and its relationships to other work packages. In many cases the work could be conducted in parallel; however, many other tasks had to be arranged in serial order. These definable tasks and work packages were programmed in terms of schedules and resources on a digital computer in order to determine the criticality of each task to the achievement of the overall objective.

Figure 1 indicates the typical buildup of manpower for such an undertaking. The lunar landing program started with the mission studies that were commenced in 1959. During the planning phase important decisions were reached. Direct ascent to the moon was compared with missions involving earth orbit rendezvous and lunar orbit rendezvous, and the lunar rendezvous mode was selected. Launch vehicle requirements were established and sites were chosen, some old and some new, for the major government operations. The complete program had to be planned and analyzed, including site selection and construction of major new facilities for hardware fabrication, test, assembly and launching; construction of a new worldwide tracking network and flight operations center; the selection and building of industry teams; and the selection and training of the operations teams, including the astronauts who would fly the missions. Prior to the first manned launching many development flight tests of the launch vehicle and spacecraft must take place to obtain performance data, correct malfunctions that may occur, and to provide operational experience for the ground crews. By the time the first operational flights occur, the equipment should be developed and validated, and as a consequence, the manpower levels are substantially reduced. The first Apollo operational flight is planned for 1968 and will provide earth orbital experience using the Saturn I. The second flight, planned for 1968 or early 1969, will use the Saturn V. The larger launch vehicle will place the complete Apollo spacecraft into a highly elliptical orbit that will permit simulation of many of the lunar maneuvers. From these and follow-on missions, data will be retrieved and evaluated that will provide the necessary background and experience for the lunar landing mission.

As I indicated, the mission plan finally accepted was the lunar orbit rendezvous which is shown schematically in Figure 2. Payload savings using this mode were so great that a single Saturn V, placing 50,000 pounds into earth orbit, could perform the mission. For the lunar mission using earth orbit rendezvous, two Saturn V's are required and for direct ascent to the lunar landing, a launch vehicle with twice the capability of Saturn V was needed. Figure 2 shows that in the lunar orbit rendezvous-type mission the spacecraft travels first in earth orbit. Following the completion of one orbit, the third stage of the Saturn V is re-ignited and the spacecraft is inserted on a trajectory to the moon with a transit time of about three days. Near themoon the spacecraft propulsion module brakes the spacecraft into lunar orbit, whereupon two astronauts enter the lunar module, descend and land on the lunar surface. The third astronaut remains in lunar orbit in the spacecraft command module attached to the propulsion module. After exploration on the lunar surface, the two astronauts use the lunar module for lift-off and rendezvous with the spacecraft module still in orbit about the moon. After rendezvous, docking and transfer to the command module, the astronauts discard the lunar module and again use the propulsion module to insert the spacecraft on a return trajectory. Three days later, after jettisoning the propulsion module, the spacecraft reenters the atmosphere and lands on the ocean, using parachutes to brake the final descent.

Since the command and propulsion modules are kept in lunar orbit, this mode permits a major reduction in propulsive energy. Another advantage of this mode is the resulting maneuverability of the lunar module which can be designed uniquely for operation in the lunar environment and for landing on the lunar surface. It is clear that rendezvous and docking with the command module after lift-off from the moon is critical, and that considerable experience in this type of operation is required in earth orbit before the Apollo spacecraft can be committed to a manned lunar landing. This requirement was the genesis of the two-man Gemini spacecraft program initiated in late 1961. Gemini rounded out the major manned flight activities planned for the lunar landing program.

Figure 3 shows how this integrated pattern of activities has fitted together to date. The Mercury program proved man's ability to survive and fly the spacecraft, and to perform some minimal tasks in space in its four manned orbital flights. The Gemini program clearly demonstrated the ability of trained pilots to function in space for fourteen days, to rendezvous and dock in space efficiently, and further demonstrated some abilities and limitations in extra-vehicular activity. Vehicle and spacecraft tests in the Apollo program to date have qualified all the systems of the lunar mission for manned flight. The unmanned exploration of the moon has mapped over 90% of the total lunar surface, has provided a well-defined "road map" for the Apollo astronauts to follow, has demonstrated the feasibility of soft landing on the surface, and has chemically analyzed and manipulated the lunar soil. The ground facilities, including the complex of ground, air, and sea stations for global tracking and data acquisition, have been developed and today stand ready for the lunar landing.

Let me now return to the facilities questions that loomed so critically in 1961 and 1962. We gave high priority to a review of all possible launch sites. Two major facilities were in existence--one on the West Coast in California for polar launches, and the other at Cape Kennedy (then Cape Canaveral), for more nearly equatorial lauches.

The West Coast was not suitable for the Apollo type missions which require near equatorial orbital flight prior to injection on trajectories to the moon, and Cape Kennedy was already crowded and had no space for additional major launch facilities. A team accomplished in launch facilities and launch operations was formed in the spring of 1961 under the leadership of General L. I. Davis, Commander of the Eastern Test Range, and Dr. Kurt Debus, Director of NASA Launch Operations. This team reviewed possible sites such as Hawaii, New Mexico, Texas, and Georgia, and concluded that from the standpoint of both time and cost, the existing Cape Kennedy operation should be expanded and land should be acquired on Merritt Island in Cocoa Beach, Florida, adjacent to Cape Kennedy. In this way, the existing downrange tracking and data acquisition facilities could be utilized. Consequently, in the summer of 1961, NASA requested authorization of the Congress to acquire 75,000 acres of additional land on Merritt Island.

Initially, all facility plans had to consider the options of the three mission modes just discussed, and the widely varying flight hardware that would be involved in each. With the Lunar Orbit rendezvous decisions, the launch facilities for the Saturn V moved forward rapidly. Previous problems and limitations encountered at the seashore launch site prompted us to depart from the practice of erecting the vehicles and performing checkout on the open launch stand. To avoid the salt, sand and high humidity of the launch stand, we decided to construct the Vehicle Assembly Building (Figure 4), in which to erect and check out the launch vehicle and spacecraft. This building solved the environmental problems, but presented a new one--transportation of the fully assembled 365-foot tall vehicle over the three miles that separates the assembly building from the launch stand.

A variety of schemes were investigated for a transporter, including rail and barge. Experience gained in the open-pit coal mines in our country led us finally to undertake the development of a tracked vehicle transporter on a roadway. Figure 4 shows the Saturn V on the transporter enroute to the launch pad. The Vehicle Assembly Building is in the background, and the Launch Control Center is the lower structure on the left. The transporter carries the fully assembled vehicle and its umbilical tower and computerized automatic checkout equipment to the launch pad, hydraulically lowers it there into launch position, and returns to the safety of the area of the Assembly building where you can note in the figure another transporter awaiting use. In this fashion the flight hardware and all the associated equipment used during the checkout in the assembly building remain on the launch pad ex ctly as tested. Only the communications and digital data lines between the umbilical tower and the launch control center are changed following transport of the vehicle to the launch pad. The effectiveness of this departure from previous methods appears from the first tests of the Saturn V to have more than justified the efforts and risks involved in undertaking its development.

The size of the Saturn vehicle stages created the need for additional special facility and transportation considerations.

Transportation of a 33-foot diameter, 138-foot long first stage by land or air routes is clearly impractical. Even the shorter but equal diameter second stage was precluded from such modes of transportation to the launch site. We considered final assembly at the launch site, but did not want to crowd this area unnecessarily. We investigated water transportation with the U. S. Navy and found available barges and ocean-going vessels that permit roll-on and roll-off of the launch vehicle stages. In order to minimize transit time, we located as much as possible of the fabrication and testing on the Gulf Coast.

The next figure (Figure 5) indicates how the Saturn vehicle complex of geographically dispersed contractor and government facilities were tied together with these ocean-going ships and barges. The Marshall Space Flight Center in Huntsville, Alabama is responsible for the development of the Saturn IB and the Saturn V. At the Marshall Center, government engineers, scientists and managers direct the planning and development of the Saturn vehicles.

Barges can transport Saturn stages from the Marshall Center to the Gulf of Mexico using the Tennessee, Ohio and Mississippi Rivers. Developmental fabrication and testing takes place at the Marshall Center, but contractor effort is located at the Michoud Plant, New Orleans, Louisiana, for fabrication of the first stages of the Saturn I and the Saturn V, and at Seal Beach, California, for the fabrication of the second stage of the Saturn V. The location of these plants as well as the location of the Mississippi Test Facility, where the first two stages of the Saturn V are statically fired, are shown in Figure 5.

Figure 6 is an aerial view of the Marshall Space Flight Center that shows the laboratories and administrative space in the distance, and the special development test facilities in the foreground. The specialized facilities include engine and stage static firing stands and dynamic test stands for determining the structural properties of the entire Apollo Saturn vehicle.

The Michoud Plant was an existing government-owned manufacturing facility, suitable for assembly of the Saturn first stages. Rather than build new facilities, we requested our two Saturn first-stage contractors to utilize this plant, which is shown in Figure 7. This plant covers ov r 40 acres and has a 40-foot overhead clearance throughout. A high bay area was added to permit checkout of the first stage of the Saturn V in a vertical position.

A remote area was needed for static testing due to the hazardous operations and the noise of the engine firings. The Army Corps of Engineers, who acted as NASA's agent on all major facility construction, was given the assignment of locating a suitable area. Much of the land along the Gulf is swampy and not suitable for heavy construction; however, we were fortunate that land was located in Mississippi on higher ground more suitable for construction. This location, shown in Figure 8, is only 50 miles from the Michoud Plant and can be reached by water, using the Pearl River that was dredged for this purpose. The waterway is used not only to bring in the stages, but to bring in the fuel and oxidizer. Following satisfactory test firing of the stages, they are prepared for shipment and are transported by water to the Ke nedy Space Center in Florida for launch operations.

The upper stages of the Saturn I and Saturn V vehicles are produced in facilities on the West Coast. The 33-foot diameter second stage of the Saturn V is shipped from California to Mississippi for test and then on to Florida for launch, as already discussed. The Saturn I second stage and the Saturn V third stage are similar and are manufactured at Huntington Beach and statically tested in Sacramento. These stages are 22 feet in diameter and are flown directly to the Kennedy Space Center in a specially modified aircraft eloquently named "The Pregnant Guppy."

The facilities complex that I have described provides the prime resources for the launch vehicle development, test, and launch operation. Additional facilities are required for spacecraft development and space operations. The manned spacecraft team responsible for Mercury was originally formed at Langley, Virginia. This group of about one thousand technical and administrative people were heavily loaded in pursuit of Mercury and consequently had to be extensively augmented for Apollo and Gemini. It was decided that this team should also be located on the Gulf Coast, and an ideal location was found for this activity at Houston, Texas. The group was located in Houston, first in rented space, and finally, in 1963, was moved into specially constructed facilities known as the Manned Spacecraft Center. This new center, shown in Figure 9, houses the offices, laboratories, special test facilities and training facilities, as well as the operations center for all NASA manned space flights.

This facilities build-up was required early in the manned flight program in order to achieve the schedules established during the program planning phase. It was decided that rather than attempt to build a new NASA team to direct and manage the construction program, we would make use of the existing capability of the Army Corps of Engineers as our construction agents. This policy decision accelerated the accomplishment of our facilities goals and avoided the necessity of establishing our own facilities construction organization at a time when we needed to focus on the development of our flight program and organizing for that effort.

## ORGANIZING FOR THE LUNAR MISSION

The organization for the lunar mission must be understood in the context of the total NASA organization, as all elements within NASA have had a role in the Apollo activities. However, as will be seen rom this discussion, certain elements within NASA have been working exclusively on Apollo, whereas other elements have had responsibility not only to support Apollo, but to conduct other major scientific and technical developments.

Figure 10 shows the NASA organization structure in the fall of 1963. External staff functions reported directly to the Administrator. The internal operations, including industrial activity, reported to a general manager, called the Associate Administrator. The technical program had four major elements, indicated on the chart, the Manned Space Flight Program, the Space Science and Applications, Advanced Research and Technology, and Tracking and Data Acquisition Programs. Each program office had cognizance over a portion of NASA's program for detailed direction and for institutional management of the field centers in which the technical activity was conducted, and in which contractor direction and management was vested. I have already referred to the Manned Space Flight Center and installations. The Launch Operations Center, shown in this figure, was renamed the Kennedy Space Center, in memory of President Kennedy soon after his death.

Space Science and Applications includes responsibility for defining all scientific objectives in space, whether manned or unmanned, as well as the application of this knowledge and technology to operational systems, i.e., for meteorology and communications. This program office also includes responsibility for development and operation of all unmanned probes and satellites. The Goddard Space Flight Center that grew from the original nucleus of Naval Research Laboratory personnel is charged with most astronomical and geophysical missions, while the Jet Propulsion Laboratory is involved primarily with lunar and planetary missions.

The Advanced Research and Technology Office is working on advanced techniques for aeronautics and space exploration. Its centers include the four original NACA laboratories and, since 1964, a fifth center has been added for electronic research.

The Tracking and Data Acquisition Office directs the construction and operation of tracking stations and communications networks supporting all major flight projects, including the manned flights. The Tracking and Data Acquisition Office was separately established so that multi-purpose stations and networks would be developed and operated to meet the needs of a variety of missions without undue duplication of effort.

The Associate Administrator, as general manager, had cognizance over all program activities and was required to approve program plans and allocation of resources against those plans. Maintaining a balance among the diverse programs of automated scientific and applications spacecraft, aeronautics, advanced research, and manned space flight was a primary responsibility of the Associate Administrator.

Not shown on this chart are the numerous industrial firms and universities which perform the largest portion of design and development of the space hardware. When the U.S. space program reached its peak in 1966, over 380,000 men and women in industry and universities were working on the program, and over 90% of NASA funds were expended to support their activities. NASA's policy is to utilize industry for production wherever possible, but also to maintain a full government competence in all technical and administrative phases to effectively oversee the expenditure of public funds. Industry is a responsible partner in the U.S. space endeavor; and befitting such an arrangement, a fair fee for responsible work is paid. We believe that profit is a strong motivation which penetrates an industrial organization and greatly increases the corporate management awareness of plant activities, and in the long run greatly enhances the probability for success. Adequate profit potential, coupled with close monitoring of industry activities by highly competent government personnel, has proven to be a most effective approach to the large and diverse undertaking of the space program.

In the matter of industrial procurement, our procedures involve participation by all levels of the organization. The next chart, Figure 11 illustrates the steps required to place a firm under contract for development, test and operation of a major element of a project. Initiation of the plan for procurement action is the responsibility of the project manager in the center. This plan is reviewed at various levels in the center and in Headquarters and is approved by senior Headquarters officials. The Procurement Plan is an extensive and detailed document describing the objectives of the procurement in terms of the technical requirements and the schedules for delivery and launching. The Procurement Plan also outlines the methods for contracting, the administrative procedures to be followed, and the type of contract envisioned. On the basis of this plan, a Request for Proposal is prepared in the center and is approved by the Headquarters staff. The Request for Proposal is released to industry, usually followed by a bidders' briefing, at which time the request is discussed with all interested contractors and all questions are answered publicly. This public airing of the Request for Proposal and all questions and answers assures that equal information is available to all contractors.

SEB

Prior to the receipt of the proposals from industry, a Source Evaluation Board is established which is composed of personnel from Headquarters and field centers. Both administrative and technical personnel are appointed to the Board. Prior to receipt of the proposals, the Board formally outlines the methods which they will use to review and evaluate the proposals. A formal scoring system is then established by which the Board will present its evaluation to the Administrator. The Source Evaluation Board presents its findings to the Administrator, who makes the final decision after consultations with the key members of the organization. On the basis of his selection, the field center then negotiates the contract, and it is finally approved by the Headquarters functional staff.

Turning now to the organization of the Manned Space Flight program, and Apollo in particular, we find that the Associate Administrator for Manned Space Flight has a staff in Washington responsible for program management and for various centralized staff functions. Within each of the program areas of manned flight, including Gemini, Apollo, and Apollo Applications, there is a designated Director and supporting staff in Headquarters with implementing organizations primarily in the three field centers at Houston, Huntsville, and Cocoa Beach.

Figure 12 illustrates the organizational structure for the Apollo program. The Apollo Program Director has responsibility and authority for overall planning, systems engineering, scheduling, budget and cost control, and performance evaluation necessary to ensure the achievement of all program objectives. Within the Apollo Program Office in Headquarters are five sub-offices, as indicated on the chart--Program Control, Systems Engineering, Test, Reliability and Quality Assurance, and Flight Operations. These functions are duplicated in parallel project offices at each of the field centers in order to provide timely information to the Headquarters program office, and to implement decisions made by the program office. Each center project office has a Project Manager whose responsibility and authority over his project, or portion of the program, is similar to that of the overall Headquarters Program Manager, but restricted to his own center activity. At the Manned Spacecraft Center in Houston, the management team has responsibility for the Apollo spacecraft--the command module, the propulsion module, and the lunar module. The Marshall Space Flight Center in Huntsville has responsibility for the Saturn launch vehicles, and the Kennedy Space Center in Cocoa Beach has responsibility for launch operations.

Each of these centers is responsible for the solicitation, negotiation, and management of the industrial contracts in support of that portion of the Apollo Program specified above. In addition to the direct project office responsibilities, these centers provide broad support to Apollo in such fields as astronaut training, scientific experiment development, and special testing.

MANAGEMENT PROCEDURE

By January of 1961, the formal management procedures had been instituted for three classes of activities. These procedures established a Project Planning and Implementation System to control program content, a system of Financial Operating Plans to control funds, and a Program Management System of systematic progress and problem reporting. Over the years, the names for these systems have been changed; refinements and additions have been made; and the formats used have changed, but enduring is the need for such systems to plan and control resource budgets; to wisely apply resources against specific objectives; and to systematically review progress toward these objectives and make decisions regarding needed schedule adjustments in light of the resources and objectives. Thus, management strives always to maintain a balance between performance, cost and time, as shown by the three-way balance in Figure 13.

This management process is a continuous one with annual budget cycles and more frequent review cycles. In NASA, as in any broad-gauged research and development organization, most of the projects are conceived in the minds of scientific and technical personnel in the field. In this context, I'm referring to NASA centers, other government centers, individual concerns, and universities. Based on their ideas, the NASA center personnel must prepare an implementation plan and obtain approval of the plan before resources can be applied. As a consequence, for each new project a formal Project Approval Document is prepared and signed by general management which specifies the project name, the specific objectives, the overall technical plan, major items to be procured, management responsibilities, schedules, resource requirements, reporting procedures, and other pertinent information which serves as a contract between general management and the Program Director. As each phase of the project is completed, necessary revisions to the Project Approval Document are presented to general management. Only with general management approval is authorization provided for the next phase of the project.

The importance of phased project implementation and close control of schedules is obvious from Figure 14. At the beginning of the project relatively few people are required, as shown by the typical manpower buildup similar to Figure 1. Each phase, however, refines the ability to understand the full ramifications of the project, and therefore the estimates of resource requirements to complete the effort can be refined and improved. The dashed curve represents the manpower requirements estimated during the planning phase. In actuality, the first operational launching is often delayed and as a consequence the manpower requirements are greater. Manpower on the project, in-house and in the contractor's plant, cannot be indiscriminately turned on and off; and it is manpower that represents all but the smallest fraction of project costs. Consequently, when delays occur for whatever reason not only the manpower but the total cost of the project is increased.

In the Apollo program, there are five critical checkpoints for each of the major elements. At each checkpoint a formal board is constituted to assure that the specific objectives and prescribed quality of work has been achieved. Figure 15 shows the relationship between these checkpoints and the phase of program activities. On the basis of definition studies and technical feasibility experiments conducted during the planning phase, the basic design approach is approved for major elements as part of the preliminary design review. Following detailed engineering design, a critical review is held and specifications and drawings are then approved for manufacture. The purpose of the first article configuration inspection is to assure that the articles are built according to the approved design following tooling and manufacture. Tests of all hardware are conducted under conditions duplicating as nearly as possible the environment of launch, orbital flight, and/or re-entry. The tests include the static firing already discussed, vibration tests, and thermal vacuum tests, as well as complete system tests using flight hardware. This permits a design certification review to insure that all flight and ground systems are qualified for flight. The flight readiness test is conducted at the Kennedy Space Center with all equipment prepared and programmed for the flight mission. In this test the countdown procedures are followed, including the fueling and arming of pyrotechnics up to the time of simulated launch. Based on this comprehensive test, the flight readiness review is held just prior to launch to determine whether all flight and ground systems are ready for the mission.

To anyone involved in research and development, it is obvious; but it must be emphasized that schedules are not fixed quantities but must be reviewed and altered frequently as the program progresses. As already stated, this review process in NASA is a monthly routine. The monthly status reviews focus the attention of the NASA general management and the key program executives on decisions affecting the balance between performance, cost and schedules of all major projects. The next several figures will illustrate the types of schedule charts used in such reviews of the Gemini program which is now completed.

The Gemini launch schedule for the years 1962 through 1966 is shown in Figure 16. The expected or approved dates are shown vertically, and the reporting dates are shown horizontally. Ideally, the approved dates do not change, and the twelve curves, one for each of the twelve Gemini launchings, would be horizontal lines intersecting the 45 degree solid line shown on the trend chart at the time of launch. The original plan for Gemini shows the expected completion date for all twelve launches was June 1965. Detailed definition of all tasks and work packages took place during 1962 and the winter of 1963. These tasks were incorporated in contracts with the prime and subcontractors along with cost and schedule. During 1962, technical features were added to Gemini, such as fuel cells, which were not originally considered part of the program plan. Based on the definitized program approved in the winter of 1963, it can be seen that the first nine Gemini launchings were still further delayed; but the final three not only held their 1963 schedule, but were launched ahead of the orginal schedule. It should be noted that since the last three Gemini's were ahead of schedule, a cost savings accrued, permitting transfer of funds to the Apollo program. Much credit is due the program, project, and contractor teams for this achievement.

If schedules are to be maintained, each organizational element, be it a Headquarters activity, field center group, or a contractor team, must know specifically their accountability. Consequently, compatible, consistent schedules must be available for all levels in the organization. Figure 17 shows the so-called Level I Gemini flight schedule as it was reviewed December 10, 1965. The flight of Gemini VI was replanned and the schedule changes approved following the failure to place the Agena target vehicle into orbit for Gemini VI. As a result of the review of the status of Gemini VI launch vehicle and spacecraft, a decision was made to remove Gemini VI (rendezvous-equipped spacecraft) from the launch pad and replace it with the Gemini VII spacecraft equipped for a 14-day mission. This was done with the expectation that Gemini VI could be returned to the pad and launched within 10 days following the launch of Gemini VII, thereby permitting rendezvous experimentation between the two manned spacecraft in lieu of waiting for a replacement Agena vehicle. The chart dated December 10, 1965, indicates that Gemini VII was launched on December 4, 1965, and the Gemini VI was scheduled to be launched on December 12, 1965. The Level I chart was in turn supported by Level II charts for each of the Gemini missions. Figure 18 is the detailed schedule for the launch operation portion of Gemini VI. This chart shows the dates for all significant events needed to turn the launch stand around and prepare for the launch of the Gemini VI-mission following the launching of Gemini VII. On December 5th, the launch vehicle was to be erected and the spacecraft mechanically mated. Electrical mating was planned for completion on December 7th, with final systems test on December 8th, and simulated flight completed on December 9th. The pre-count was then commenced on December 10th. Behind this plan for the launch operations must be detailed schedules for all daily activities.

This next level, Level III, shown in Figure 19, is schedule information for contractors and test conductor personnel. In this example, the work to be accomplished is shown only for December 7th. It can be seen that the electrical mate of the spacecraft with the launch vehicle and the ground complex is to be completed soon after midnight, and that the steps are to be taken immediately in preparation for the final systems test that will occur the following day.

This launch operations plan was followed almost precisely up to and including engine ignition on December 12th. However, the first stage engines were automatically shut down prior to release of the launch vehicle hold down arms. The malfunction was diagnosed, the countdown was recycled and Gemini VI was still launched in time for a rendezvous mission with Gemini VII before the end of its fourteen-day mission.

It is obvious from the foregoing example that flight schedules are dynamic. Each level of management must key its activities to the flight schedule and develop detailed schedules consistent with the management of its particular portion of the project.

The impact of schedule changes can be far-reaching and many factors of a technical, operational, administrative, and legal nature have to be considered in the decision-making process.

At each level the manager that makes the schedule decision should have a range of alternatives available from which to choose and innovate, and he should involve the managers most knowledgeable in the program details in the decision-making process.

Once a decision is made to change a flight schedule, the same channels that provided inputs for the decision must be used to communicate the decision. This is most important and must be formalized to ensure that the many organizational tiers supporting the schedules in the field center, the contractor plants, and the worldwide tr network are quickly revised in consonance with the overall schedule decision. Such detailed schedule revision is necessary, of course, to assure that manpower and funds are not applied to provide service or equipment before such is needed or can be used. On occasion, increased effort on certain components of the program can hold a faltering schedule, or even advance a launch date. Once a schedule is slipped, it is rare that substantial time is regained. Gemini, however, did illustrate the possibility of recovering schedule slips. Without frequent in-depth program reviews by all concerned, opportunities to compress schedules will be missed, and needs for schedule adjustments will frequently go unvoiced and promote inefficient and uncoordinated progress throughout the program.

PROGRAM FLEXIBILITY AND PUBLIC RESPONSIBILITY

It should be noted that in the United States the President and the Congress have a major role in forming the overall policy, accepting or rejecting specific program goals and establishing annual program support levels. NASA is charged with and given authority to manage the specific program, project, and individual flight objectives and schedules. Schedules and detailed working plans are set by considerations of the scientific and technical objectives for which NASA is answerable to the President, the Congress, and the public. NASA's performance as good stewards of public funds is the keystone to continued support.

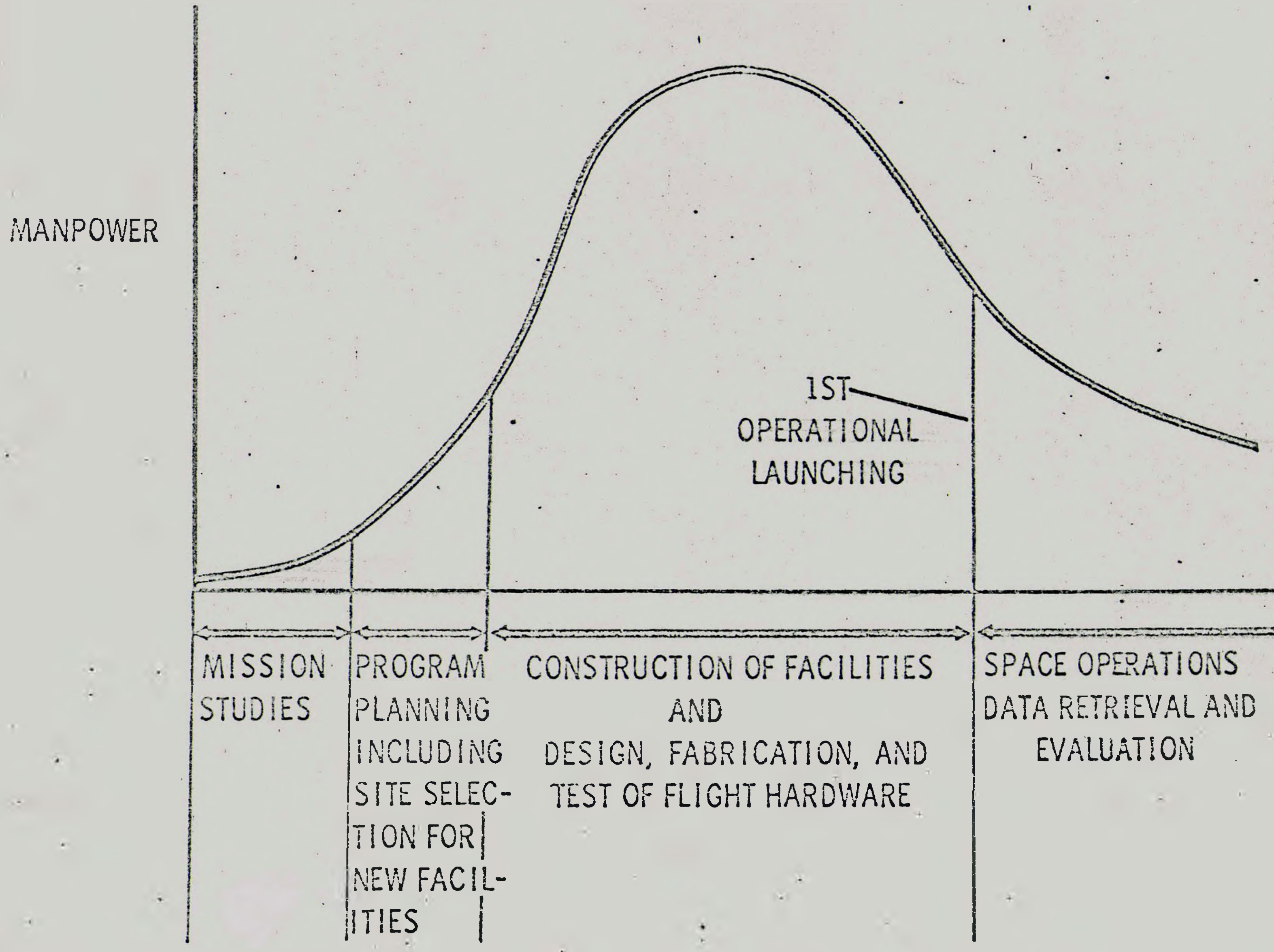
Despite difficulties such as the Gemini VII/VI mission I have just described, we have been sufficiently flexible and innovative to realize a steadily improving record of mission success. We use a hardboiled system when measuring our successes. If all of the primary objectives of a flight, as prescribed and made public in advance of the mission, are not fully met we give the mission a zero score. We score our missions either 0 or 100 percent, though many flights are partially successful and yield much valuable information, often enough to have justified the resource investment.

The final chart, Figure 20, illustrates our record under the scoring approach. As can be seen from this chart, many difficulties were experienced during the early years of the space effort. In 1958, there were four unsuccessful launches. Then for three years slightly over half the missions were successful, and more recently, over three-quarters of the flights have been completely successful. In 1967, there were 22 major missions, of which 20 met all of their prime objectives. We are gratified, but not satisfied, with this record. The cost for each mission is high, and the returns justify these costs only when objectives are met.

In the final analysis, total success, on time and within cost, is the goal of the NASA organization.

# # #

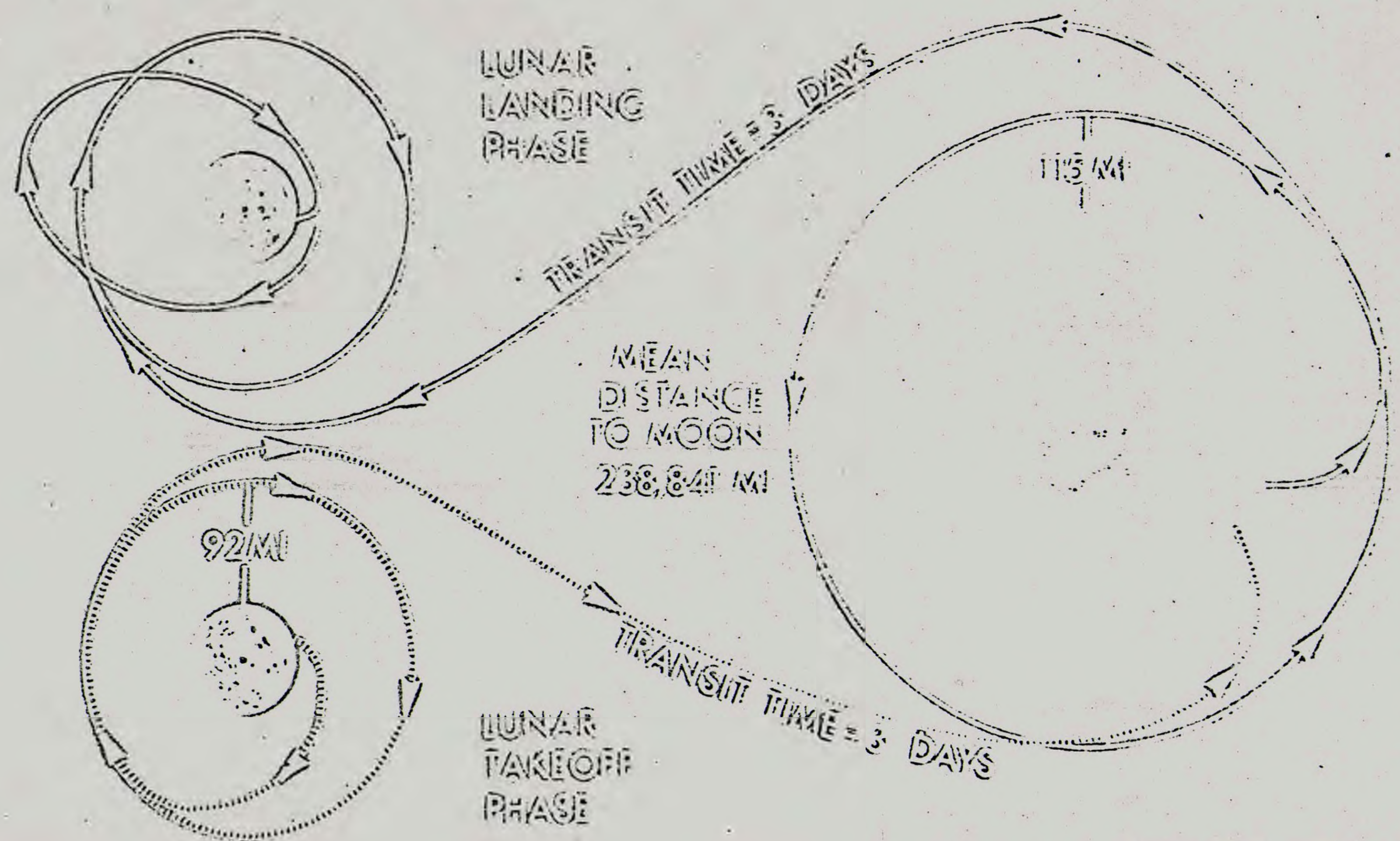
# PROGRAM MANPOWER VS. TIME



APOLLO MISSION PROFILE

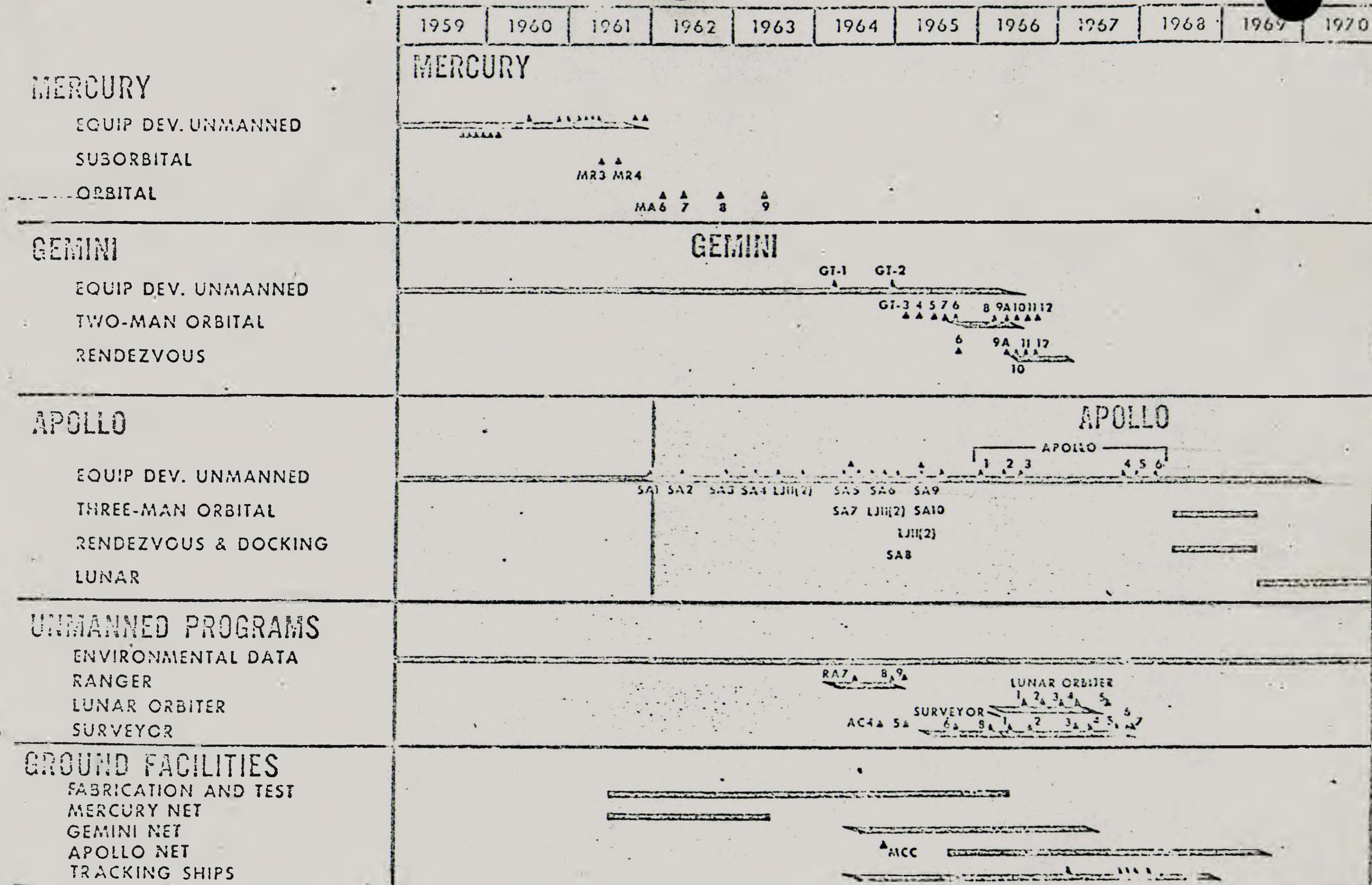
# LUNAR ORBITAL RENDEZVOUS MODE

## TYPICAL MISSION PROFILE




NASA M64-168

# MANNED LUNAR LANDING PROGRAM
## TIME PLANNING OF KEY OBJECTIVES



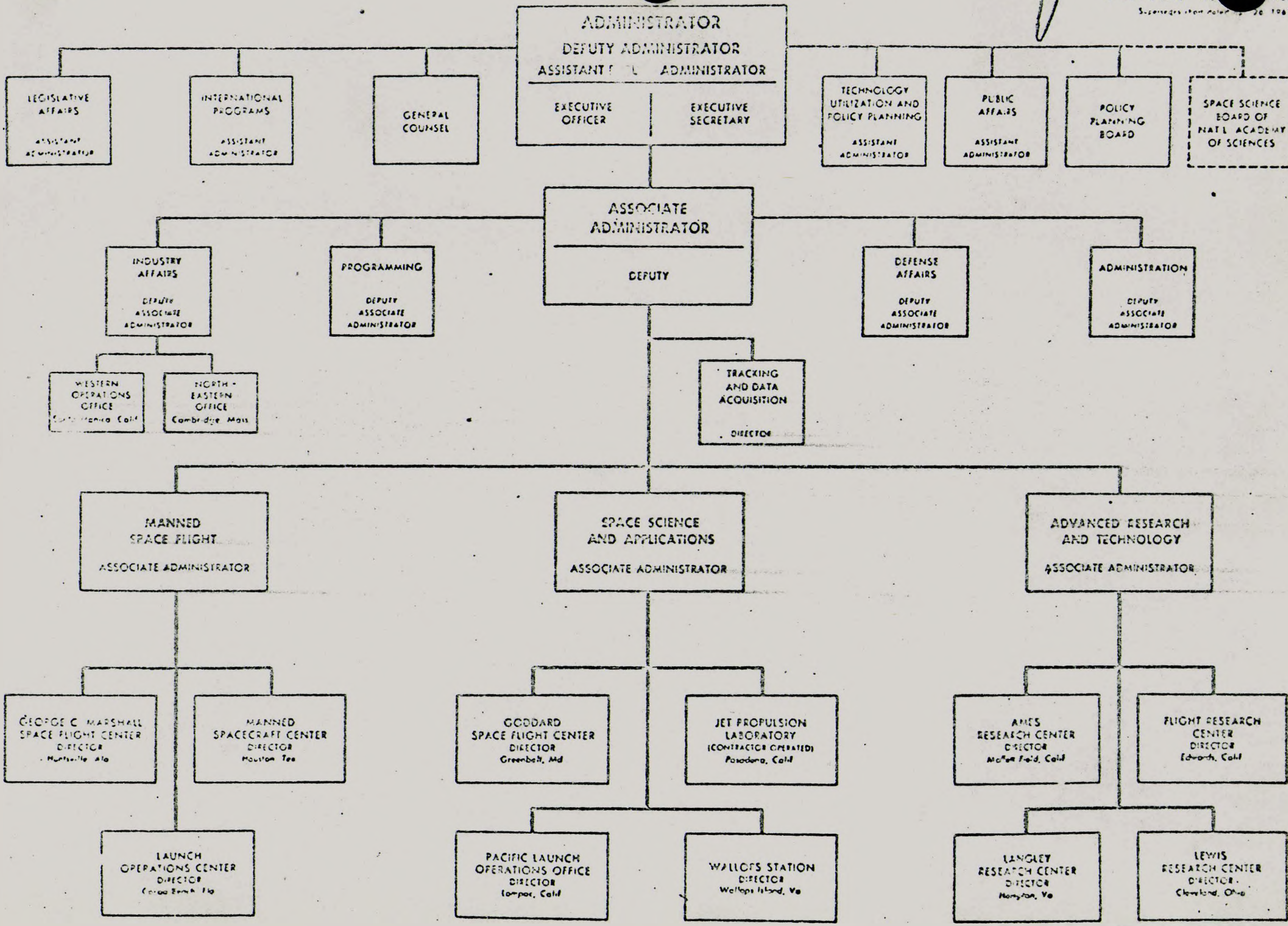
LOCATION OF PRINCIPAL LAUNCH VEHICLE FACILITIES

Figure 5

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APPROVED

EFFECTIVE DATE No 1963



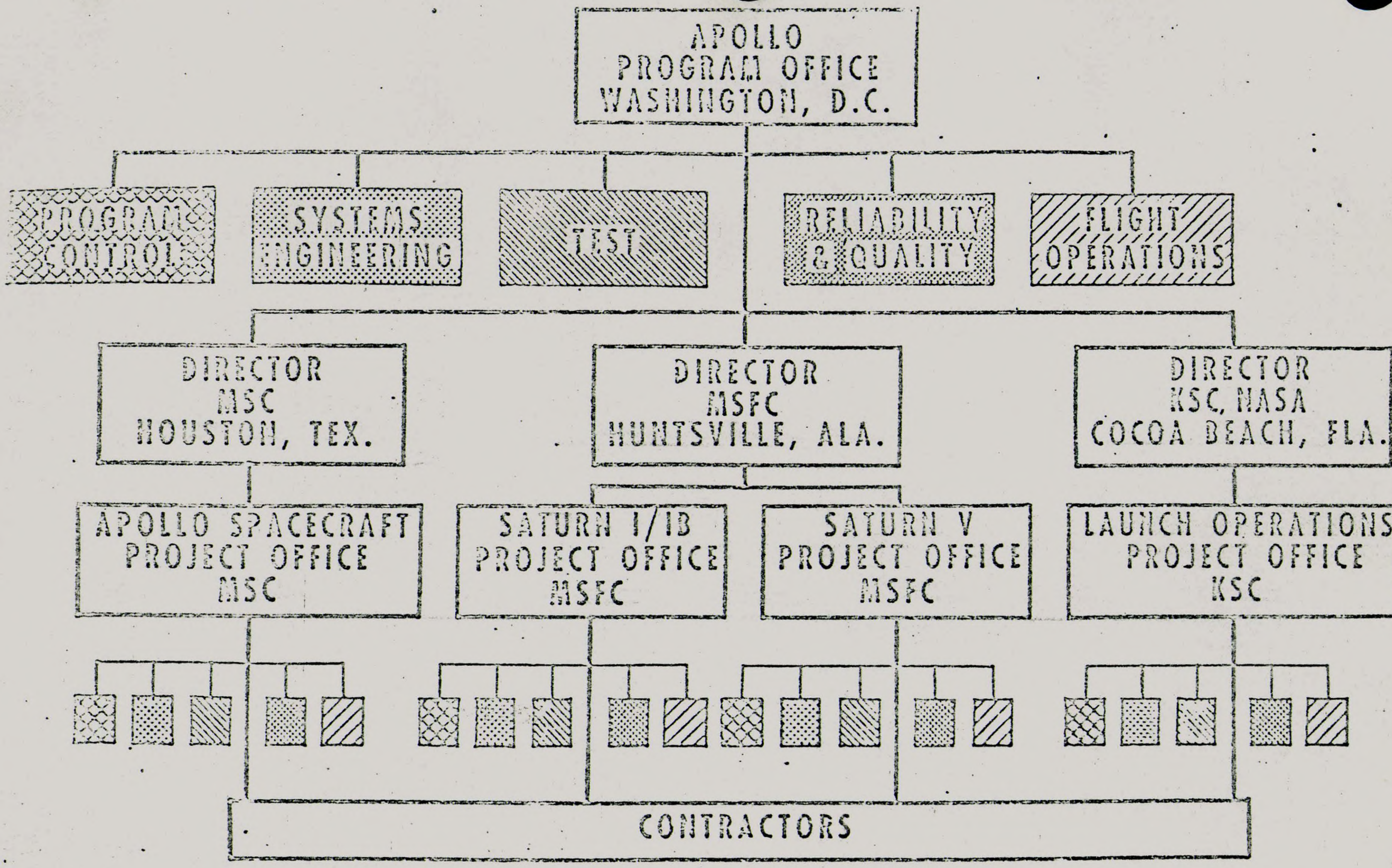

U.S. GOVERNMENT PRINTING OFFICE 1963

# PROCEDURES AND AUTHORITY FOR PROCUREMENT ACTIONS

| | PROJECT MGR AT FIELD CENTER | CENTER DIRECTOR AND STAFF | HEADQTRS PROGRAM OFFICE | HEADQTRS STAFF | ADMINISTRATOR |
|---|---|---|---|---|---|
| PROCUREMENT PLAN | INITIATES → | REVIEWS → | REVIEWS → | REVIEWS → | APPROVES |
| REQ. FOR PROPOSAL | INITIATES → | REVIEWS → | REVIEWS → | APPROVES | |
| EVALUATION BY SOURCE BOARD | PARTICIPATES ⇄ | PARTICIPATES ⇄ | PARTICIPATES ⇄ | PARTICIPATES | |
| SELECTION OF CONTRACTOR | | | | | MAKES SELECTION |
| FINAL CONTRACT | NEGOTIATES → | REVIEWS → | REVIEWS → | APPROVES | |

NASA AD66-848
3-15-66

# APOLLO PROGRAM MANAGEMENT




NOTE: FUNCTIONAL OFFICES AT CENTERS ARE SHOWN CODED TO CORRESPOND WITH FUNCTIONAL OFFICES IN WASHINGTON PROGRAM OFFICE.

NASA M64–84

Figure 13

# BALANCE BETWEEN PERFORMANCE, SCHEDULE, AND COST

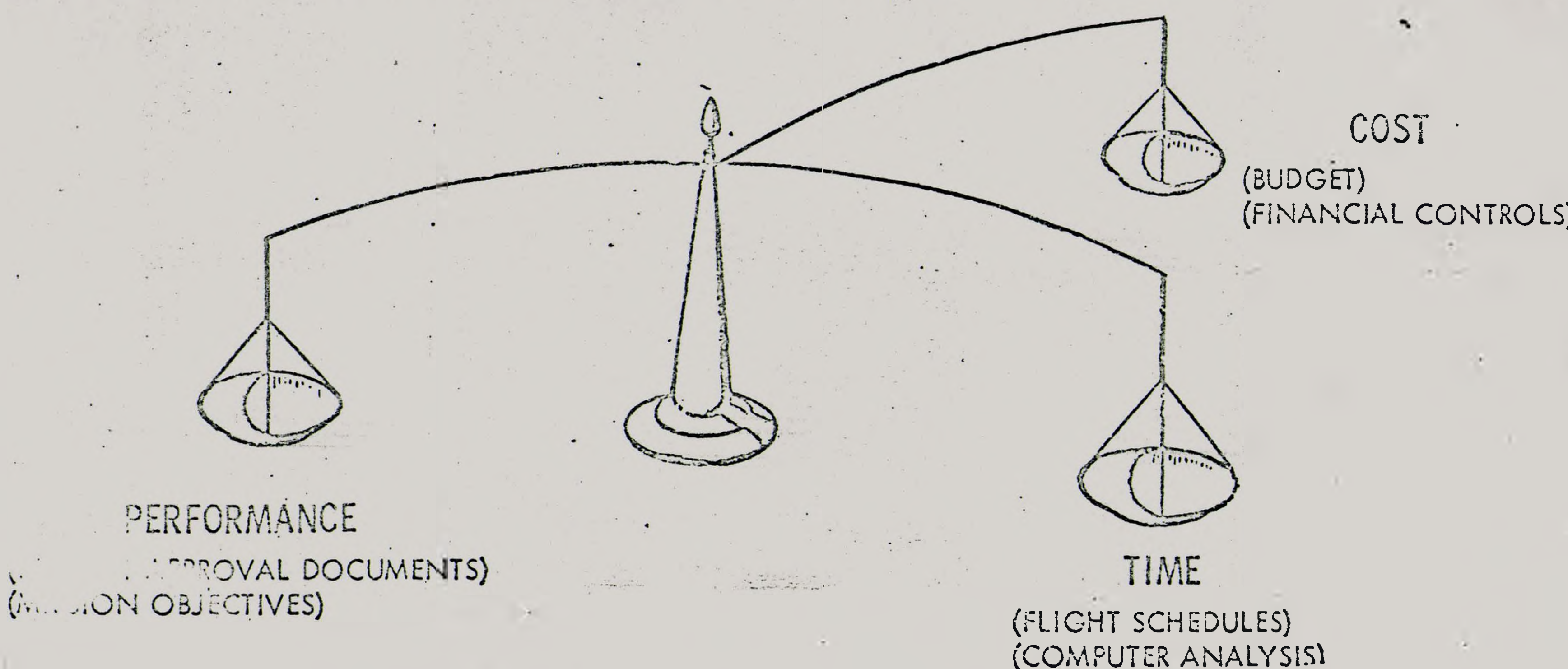
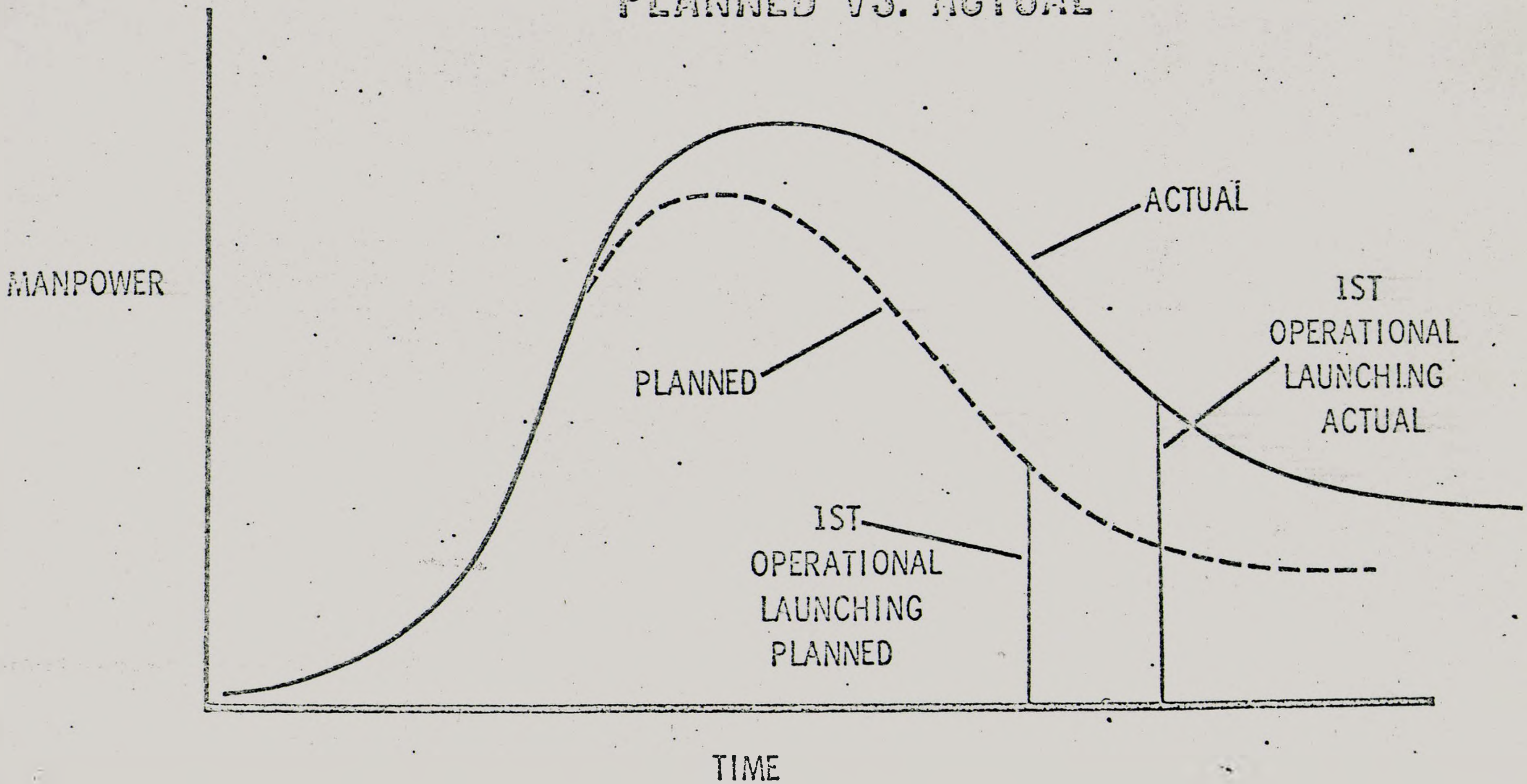


Figure 14

# PROGRAM MANPOWER VS. TIME
# PLANNED VS. ACTUAL



# APOLLO REVIEW PROCESS

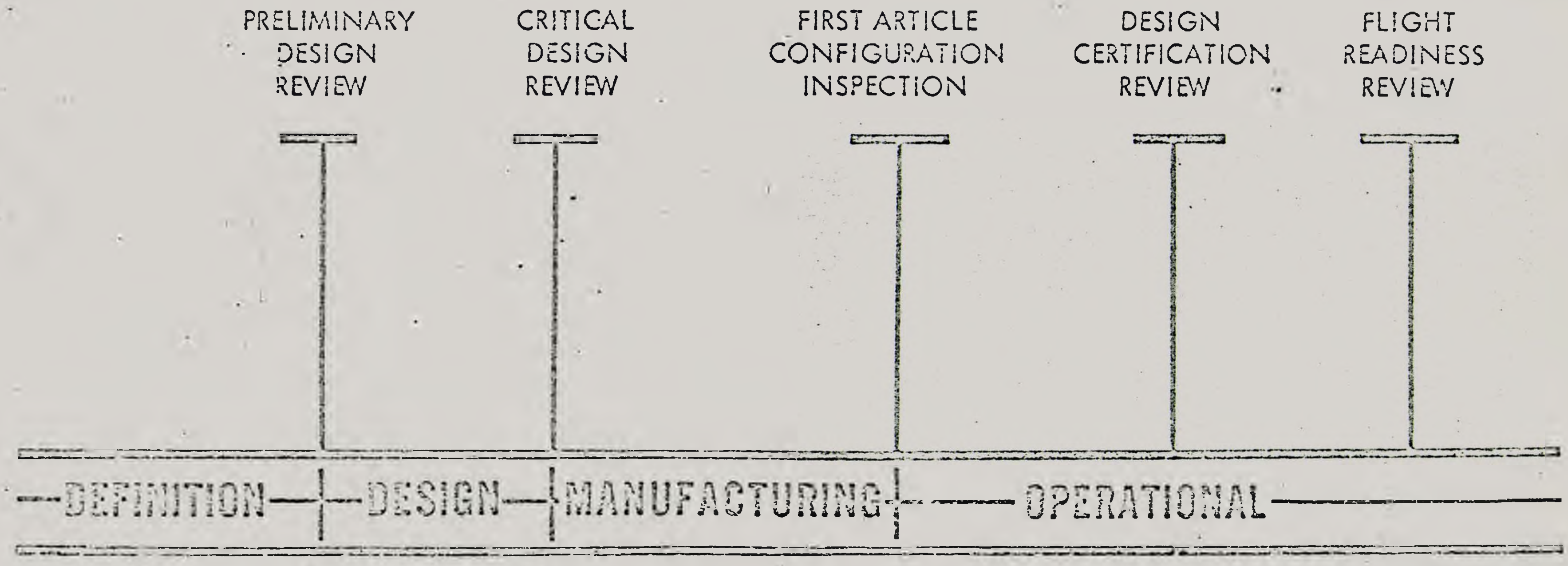


Figure 16

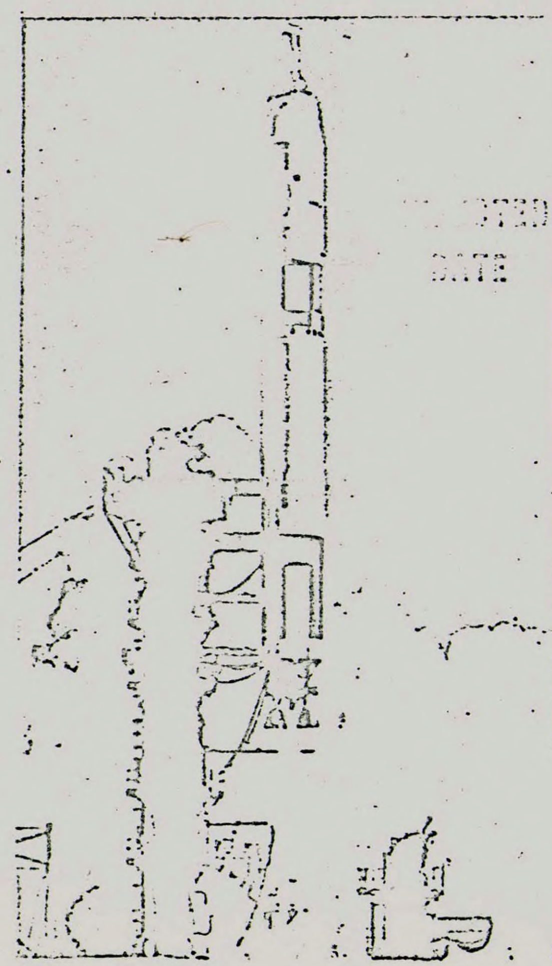
MANNED SPACE FLIGHT

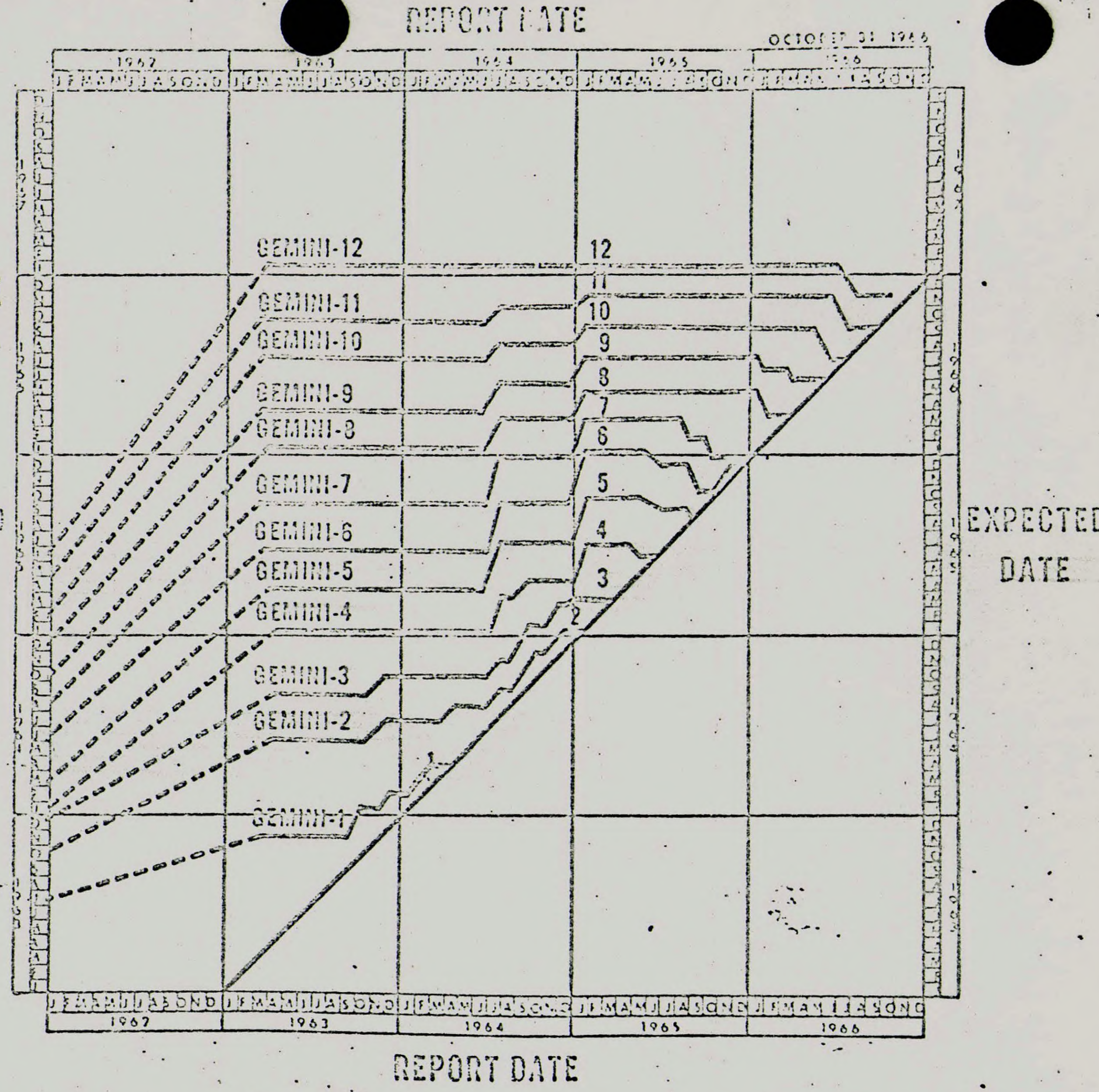
SCHEDULE TREND

FOR

# GEMINI

MASTER LAUNCH SCHEDULE






NASA HQ MG66-8791
10-18-66

Figure 17

MANNED SPACE FLIGHT SCHEDULE

# GEMINI LAUNCHES MASTER SCHEDULE

LEVEL 1

SCHEDULE RESPONSIBILITY: GEMINI PROGRAM DIRECTOR

STATUS RESPONSIBILITY: ACTING DIRECTOR, GEMINI PROG. CONTROL

CONTRACTOR: NOT APPLICABLE

PROJECT:

SCH'D NO: MG2d M2e

ORIGINAL SCHEDULE APPROVAL 1 7 (Date)

LAST SCHEDULE CHANGE 5 19 65 (Date) (No) (Initials)

STATUS AS OF 12 10 65 (Date) (Initials)

CY 1963 · CY 1964 · CY 1965 · CY 1966 · CY 1967 (J F M A M J J A S O N D)

| | MILESTONES |
|---|---|
| 1 | GEMINI I-LAUNCH ENVIRONMENT |
| 2 | UNMANNED |
| 3 | GEMINI II-SYSTEMS QUAL. |
| 4 | UNMANNED |
| 5 | GEMINI III-FIRST MANNED FLIGHT |
| 6 | GEMINI IV - 4 DAYS DURATION |
| 7 | GEMINI V - 8 DAYS DURATION |
| 8 | GEMINI VI-MODE I RENDEZVOUS DEV. (NOTE 1) |
| 9 | GEMINI VII-14 DAYS DURATION (NOTE 2) |
| 10 | GEMINI VIII-MODE II RENDEZVOUS DEV. |
| 11 | GEMINI IX - DUAL RENDEZVOUS |
| 12 | GEMINI X - LEM RENDEZVOUS SIMULATION |
| 13 | GEMINI XI - DUAL RENDEZVOUS |
| 14 | GEMINI XII - LEM RENDEZVOUS SIMULATION |
| 15 | |
| 16 | |
| 17 | |
| 18 | |
| 19 | |
| 20 | |

NOTE:
STATUS DECEMBER 10 -
GEMINI VII LAUNCHED DEC. 4
AND IN ORBIT UNTIL DEC. 18.
GEMINI VI PLANNED LAUNCH
DATE - DEC. 12

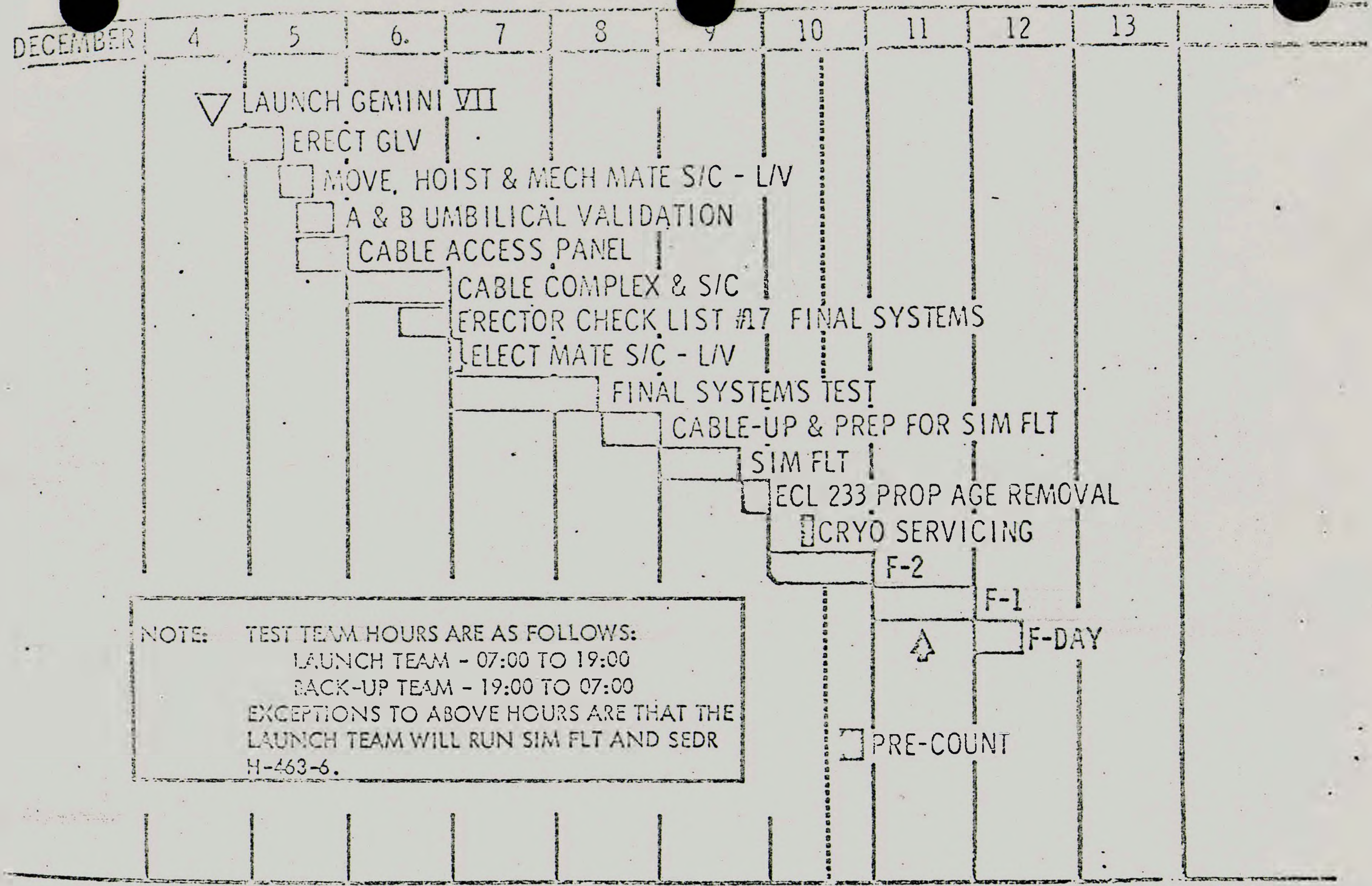
NOTES

1 GEMINI VI SCHEDULED FOR DECEMBER 13, 1965; 2:30 PM EST

2 GEMINI VII LAUNCHED DECEMBER 4, 1965

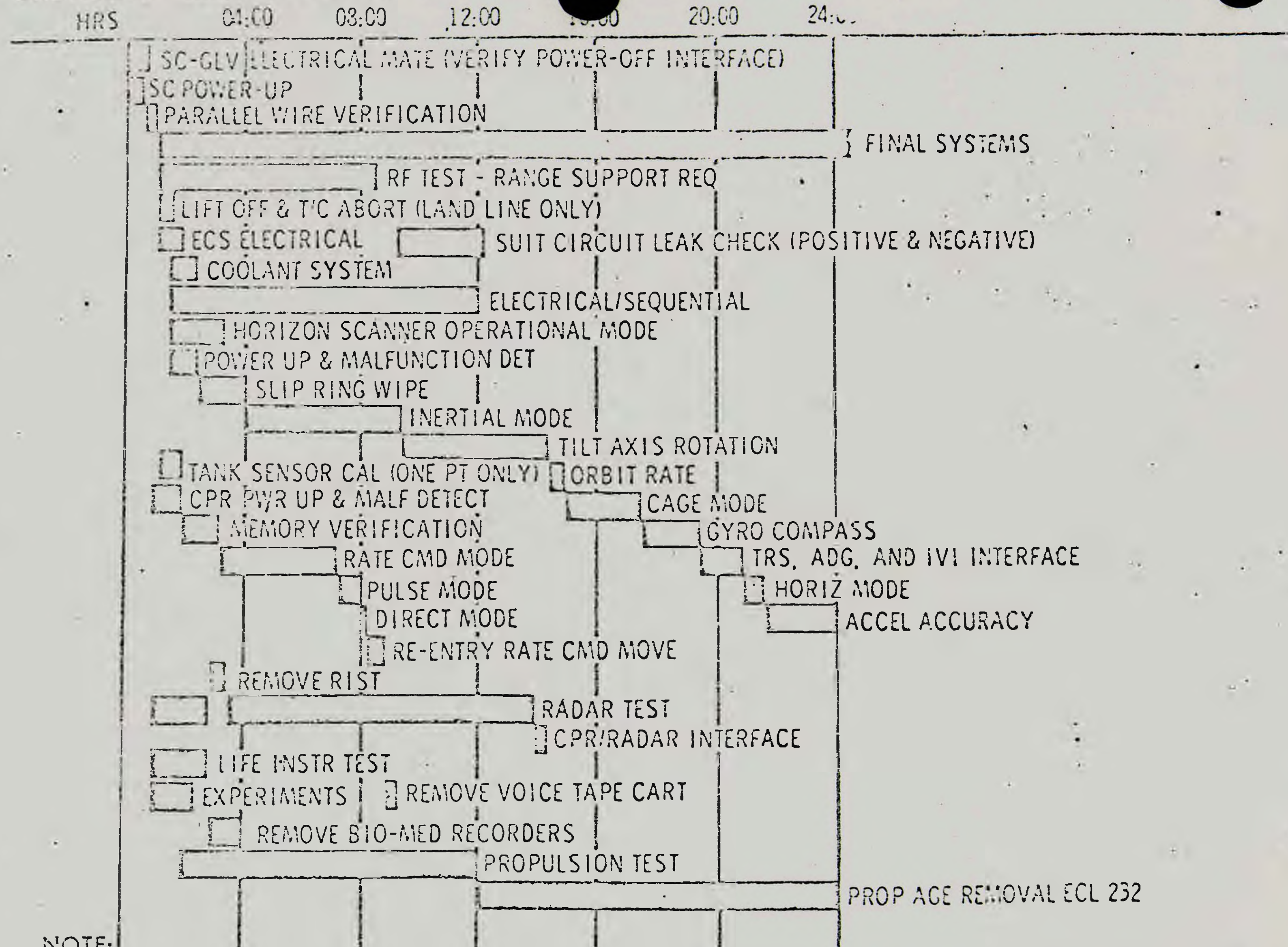
# GEMINI VI LAUNCH OPERATIONS

Figure 18




MG65-12,166

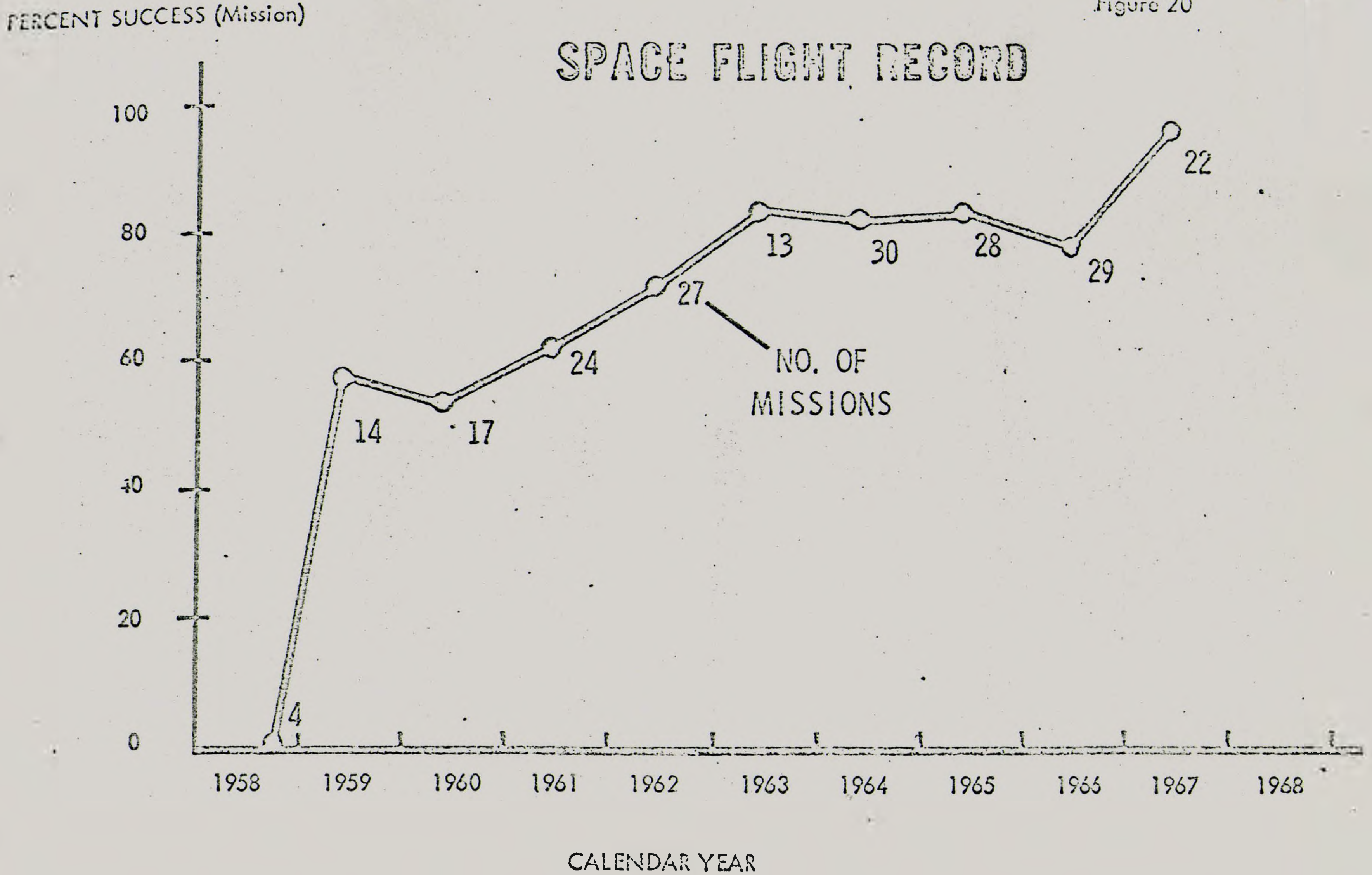
GEMINI VI LAUNCH OPERATIONS DECEMBER 7, 1965 Figure 1




NOTE:
FIN SYS TEST WILL START WHEN CABLING IS COMPLETE, PRIOR TO SC-GLV ELECTRICAL MATE IF REQUIRED.

MG65-12,168

Figure 20



PERCENT SUCCESS (Mission)
SPACE FLIGHT RECORD
100
80
60
40
20
0
4
14
17
24
27
13
30
28
29
22
NO. OF MISSIONS
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
CALENDAR YEAR

Address by
James E. Webb, Administrator
National Aeronautics and Space Administration
American Astronautical Society Symposium
on
"Space Projections from the Rocky Mountain Region"
Denver, Colorado
July 15, 1968

Mr. Chairman, Senator Allott, Governor Love, Governor Hathaway, Governor Williams, Mayor Currigan, Distinguished Guests, Friends.

It is a great pleasure to be in Denver and to see so many friends from industry and the universities in the Rocky Mountain area who have been working with us in NASA in the advancement of research and development in aeronautics and space. I must confess that I feel a little like "this is where I came in". Just about 30 years ago I was here at the Brown Palace with many leaders in aviation like Jimmy Doolittle, Tom Morgan, Casey Jones, Roscoe Turner, John Victory and Bill Enyart, trying to find ways to get the country to move faster in aviation. World War II was approaching. The occasion was the Annual meeting of the National Aeronautic Association. Just as in aviation 30 years ago private citizens and public officials had to work together to build centers of power for good governmental decisions, but outside the formal institutions of government, so must we today in both aeronautics and space. So again we meet at the Brown Palace as members of the American Astronautical Society.

In 1961, when the Twentieth American Assembly met at Columbia University's Arden House on the subject of outer space Dr. Henry Wriston, the American Assembly's President, called that Assembly a "Non-partisan venture in space education". The Assembly's report gave strong support to "the national space program as an intrinsically valid enterprise" and stated: "Space technology promises to bring about revolutionary changes in man's life on earth".

In 1961 the American Assembly recognized that at the start of the space age the United States did not have the organizational and management capabilities or the disciplinary and technical capabilities required for success. Large efforts in science, in technology and in their application and use were needed.

Today, as we meet in Denver in 1968 the work of the Twentieth American Assembly is being brought up to date in this just-issued volume: Outer Space, Prospects for Man and Society - Revised Edition. This meeting in Denver and this revised report come at a time when the National Aeronautics and Space Administration (NASA) has passed the peak of its first decade of effort. A research and development work force that totaled over 400,000 men and women was built up and used to apply our large accumulation of aeronautical knowledge to space work, to expand vastly our base of space competence, and then to feed back much of the resulting know-how into aeronautics. One-fourth of this work force has already been disbanded as projects such as Ranger, Lunar Orbiter, Surveyor, Mercury and Gemini were completed. A group of 10,000 men and women - scientists, engineers, teachers, and students have been oriented toward space science and engineering, and most of these are currently at work under NASA funding at about 200 universities. The Department of Defense has developed and operates its own satellite communications and other space systems. Our leaders can now call on a well-established and versatile national capability in aeronautical and space-related science, engineering and administration and expect their questions to be answered. We now can point to the profound influence that our space efforts have had on the geosciences, are having on astronomy, and are beginning to have on the life sciences.

Ten years ago, we were looking forward hopefully to space applications in meteorology, communications, navigation, and geodesy. Today, there are satellite systems and their earth-based components in operation for all of those areas, while still other possibilities are becoming apparent, for example, in earth-resource surveys or world-wide data collection and dissemination.

Dr. Homer Newell, NASA Associate Administrator, has expressed our position in these words:

"In science we are well on our way toward establishing the basis for investigating major areas of natural phenomena that characterize the universe in the places in space where measurements can best be made with a power and an intensity hitherto unavailable to the researcher. A new generation of researchers who, during their formative years, watched the Space Age unfold are entering the scene. They are caught up in the excitement that space represents. They will undoubtedly bring their enthusiasm to bear not only upon space, but also upon the great challenges of today here on our planet earth, such as the problems of oceanography, earth resources, the cities, transportation, population, pollution, and food. They are likely to oppose efforts to delay or sidestep any of these challenges."

This new generation of researchers is reading and studying volumes like this: "Social Indicators" the second in a series prepared by the American Academy of Arts and Sciences under a NASA grant. In this series Raymond Bauer and his colleagues examine the impact of the space program on American Society in a time dominated by rapid technological change. They examine in depth the need to anticipate the effects of that impact. The new generation senses that as the space program changes, so will its impacts change, and that the need to anticipate them remains important.

Continuing with Dr. Newell's words:

> "Ten years ago, the atmosphere, the oceans, and space were more often thought of as separate rather than as closely related media. Today, these three are beginning to be viewed as an inseparable continuum open to human activity, engendering a broader and more cohesive view of our natural environment, and forcing a reassessment of the dimensions of our political environment."

Because we meet in Colorado, and for many other reasons, I am especially glad that Senator Gordon Allott could be here to give us his views. As an outstanding senior member of Congress, he has devoted careful, detailed and constructive consideration and leadership to the problems and potentialities of the nation's aeronautical and space programs. We in NASA have high respect for his perception, his judgment and fairness. We appreciate the large investment of his time he puts into the Congressional review of our program.

It has also been valuable on Saturday and yesterday to have the opportunity to meet with Chancellor Mitchell of the University of Denver, President Morgan of Colorado State University, President Childs of the Colorado School of Mines, President Carlson of Wyoming University and other university officials. Here in Colorado, NASA has been working closely with the University of Colorado, the University of Denver and with Colorado State University in a wide range of multi-disciplinary efforts for a number of years. The University of Denver has shown outstanding leadership in providing a focus for bringing together in fruitful collaboration the efforts of industry and academic institutions in the area of the advancement of science and technology generally and in the understanding of their applications and meaning for the broader problems of our society.

To speak of Denver in aerospace matters is to speak of Martin Marietta, a great company that gave the United States the Titan Booster. Not only has Titan contributed greatly to National security but it flew 20 astronauts in 20 months and they all came back safe and sound. Ball Brothers and other Rocky Mountain companies have also made important research advances. To be in Colorado is also to be reminded of that great organization, the United States Air Force. While we all know that the Air Force Academy at Colorado Springs is the mainstay of Air Force education, we also know that the Headquarters of the North American Air Defense Command at Cheyenne Mountain is a mainstay of our national security. We must also recognize that Colorado is the home of the Environmental Science Service Administration and the National Center for Atmospheric Research. We will hear more of these institutions through papers given at this Symposium.

Accompanying me here today is Mr. James Beggs, who has recently assumed the duties of Associate Administrator for Advanced Research and Technology at NASA and Mr. Frank Smith, Assistant Administrator for University Affairs. I am sure that many of you have known Mr. Beggs through his work as Vice President of the Westinghouse Defense and Space Center, but this may be your first opportunity to meet him in his capacity as the man we look to in NASA to take the leadership in the planning and execution of our work in advanced research and technology. You also have known Frank Smith as a leading engineer and administrator at our Langley Laboratory and as the Director of our 1965 Future Programs Task Force. In the months ahead when we will be flying fewer missions we will be giving our most careful consideration to the research and development efforts needed to provide the concepts, components, and systems that must be built for the future. The work of our office of OART under Mr. Beggs and of University Affairs under Mr. Smith thus assume special importance. At the very heart of the process of technological advance is assurance that research on components, materials and techniques which is focused on the areas of greatest need and promise is not unduly constrained by specific and item system requirements. This is a field and a national necessity on which the industrial and academic institutions of the Rocky Mountain Region might well focus as that in which they can perhaps make their greatest contribution in the years immediately ahead. Mr. Beggs and Mr. Smith are prepared to work with you in this.

As this American Astronautical Society symposium begins its consideration of the future course of the space program and those elements of greatest interest to the Rocky Mountain Region, it may be well to review some of the elements of the general situation today as it affects aeronautics and space.

These are uncertain and unusual times, not only for the space program and for our work in aeronautics but for almost every other important national activity.

The war in Vietnam, the peace talks in Paris, the problems faced by our cities, the economic problems of inflation, of 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 make plans independent of national and regional conditions.

In NASA's aeronautics and space activities adjustments to the needs of these times have taken the form of sharp reductions in our programs and budget. We are conducting the tests and flying out the missions started in the build-up period since 1961 but are not starting new ones, with a very few exceptions. It is already clear, as I have testified in Congress, that with the budget levels we now face for FY 1969, production of the Saturn IB will have to be terminated and that a significant gap in the production of Saturn V will almost certainly be required. It may even be necessary to terminate Saturn V production. I have also testified that it is doubtful that we will be able to proceed with the development of a flight-qualified nuclear rocket engine. We are doing all we can to avoid terminating completely such important activities as the unmanned planetary exploration program, but it is not likely that we will be able to proceed with the Titan/Mars 1973 missions.

We do expect to carry our one flight of the Saturn I Workshop but on a delayed time-table. For a number of years to come, missions to use the manned space flight capabilities developed in the Apollo program will be very limited and Apollo spacecraft production will be curtailed. In aeronautics, the X-15 and B-70 experimental test flights will be terminated, and a number of development projects in short and vertical take-off; supersonic and hypersonic fields will be phased down to an experimental engineering status.

These reductions to a budget which has already been sharply reduced will have many very serious effects on the U. S. position in aeronautics and in space. They are only the most recent in a series of cutbacks and in effect, constitute something like final ratification of a decision that has been in the making since 1966, the decision that the United States will not, at this time, take the steps necessary to continue the advances of recent years. By the end of FY 1969, the work force on NASA projects will be down to just over 200,000, a level ½ that of 3 years ago. As you know, these are not government employees - over 90% of them are in industrial plants and laboratories, so that effects will be widely felt. 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 processes. We must now direct our leadership and our managerial abilities toward the successful run-out of the programs approved in past years and now nearing completion. We must at the same time adjust our organization, programs, contracts, university grants, and facilities to meet the reductions that have been decided on, and in the process, do all we can to lay a sound foundation for the future.

While no one should minimize the serious consequences that will flow from the decisions that have been made, it is also important as we assess our situation that we recognize a number of significant elements of strength.

One element of strength is that the events of the past few months, while they have not led to levels of support needed in aeronautics and space, have nevertheless shown that there does exist a strong continuing core of important support for research and development in both these fields.

Another element of strength is that the U. S. can now count on a facilities base in the NASA complex valued at over four billion dollars and a know-how in industry and a competence in science that can be put to work again when the time comes. We now have a management competence in large scale space development that can restore these assets to operational status with a high degree of efficiency.

In the Executive Branch, the NASA budget that was approved for FY 1969, while reduced below previous years, provided support for the essential features of a strong and continuing program. The amount was $4,370,000. The President, in submitting this budget made it clear, as he had when he agreed to the FY 1968 reductions made by the House Appropriations Committee last year that he was doing so reluctantly, that he still believed strongly in the need for a more vigorous program in aeronautics and space, and that his actions were based entirely on the over-riding financial necessities related to passage of the tax bill and to efforts to control inflation.

In the Legislative Branch, the Senate will consider our FY 1969 budget this week. Reductions of $362 million have already been made and the President has accepted these, as he did those of FY 1968. These actions bring NASA down to the $4 billion level. At this point there seems to be resistance to further reductions and a feeling that we should be permitted to move ahead with as effective a program as possible at this $4 billion level. I believe that this view will prevail as Congress takes the final major actions on our budget this year.

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, I think it is significant that the Congress is standing firm at the $4 billion level for the NASA 1969 budget. I think it shows a recognition of the necessity for the country to stay in business in aeronautics and space research. Senator Allott may have more to say on this.

Among thoughtful people in the country at large, I do not find that public support for the space program is declining. Rather we are in a period in which many have been forced by events to focus on other serious needs and problems to a greater degree than in the past. The problems of how we stand in the world, including our position in Southeast Asia, and the problems faced by our cities, have been with us for many years; but it was not until these approached or passed major points of crisis that there was a general recognition that they demand major commitments of resources and attention on a continuous basis over a long period of years. We in space have seen the same thing happen with Sputnik and with Gagarin. This phenomenon has been called "government by crisis". The result is that many people who in the years following 1961 ascribed to the space program a separate, 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 for the space program is not a changed attitude, but is a reflection of a new awareness of other high priority problems and requirements. This may well lead on to the recognition that many of the other newly-seen problems can only 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.

Let me make it very clear that NASA is still very much in business, and it will stay in business. We are accepting the challenge of the time and will continue a hard-hitting, technically sound program aimed at the most important objectives of the future. At the same time that we are making the necessary internal adjustments, we will also make every effort to prepare for the longer term future.

Perhaps, now we should take a look at some of the things we will be doing in the next twelve months.

The Apollo program is moving forward toward the first manned flight, Apollo 7, this fall. We are confident that the vibration and other problems encountered on the second Saturn V test flight last spring will be solved and that we will be able to fly men on the third Saturn V. With success in these two flights, we will proceed down the home stretch toward the end of the decade with a series of Saturn V flights that should enable us to attempt the first manned lunar landing mission by December of 1969.

In space sciences, we anticipate exciting additions to our knowledge of new elements and regions of the universe from the Radio Astronomy Explorer satellite launched on the 4th of July, and also from the Orbiting Astronomical Observatory to be launched this fall. In both cases we will be making for the first time extended astronomical observations in regions of theelectromagnetic spectrum which cannot be effectively made from the earth. This is scientific exploration of the universe in a manner uniquely possible in the space program. It is man reaching out by means of rocketry to learn much that he has been unable to see, and measure, and use in all his past history.

In our steady progress toward connecting such new knowledge to practical use, we will shortly be launching the Applications Technology Satellite. Unlike its predecessors in this series, this satellite will be stablized by gravity gradient devices. Like the others in this series, it will carry advanced experiments for improving communications, meteorological, and spacecraft technology.

Last June, the Nimbus B meteorological satellite had to be destroyed because of a launch vehicle malfunction. This was a stern reminder of the small margin between failure and success in the use of rockets. Because of the importance of the experiments that were destroyed and because there would be a gap of almost two years in our advanced meteorological program we have decided to repeat the Nimbus B mission in the spring of 1969.

In our continuing planetary program, we will be launching two fly-by missions to Mars in the first part of 1969. Hopefully, these will achieve the kind of success we had with Mariner IV in 1965 and give us valuable close-up looks at this planet. These 1969 flights are now largely paid for and are the next steps in a program for the systematic exploration of the planets. Even at our reduced levels, I believe we can follow the 1969 missions with two orbiter missions in 1971, but will probably have to postpone for another year the start of work on the two Titan-launched orbiter and lander missions which we had hoped to fly in 1973.

The examples I have cited will show that NASA will still be in business in FY 1969. But I am sure I do not have to emphasize that the missions we will be flying were initiated three or more years ago. We are approaching the end of our approved flight programs. The number of new projects started each year has sharply dwindled since 1966 and we will soon see years go by when we will have very few flights. We may see a gap of 2 years in our manned flight program after the landing on the moon, and a second gap, equally long, after the Saturn I Workshop.

Perhaps the most fundamental decisions ahead lie in the field of large launch vehciles. Can we gap production of the Saturn V or will we have to terminate it? We and the DOD are looking carefully at the entire national launch vehicle program to make sure that both NASA and Defense essential needs can be met. This includes re-examination of ways in which NASA can utilize the Titan III in both unmanned and manned programs of the future. We are also examining all factors involved in the development of new and less costly launch vehicles. We will undoubtedly have to consider whether large launch vehicles like the Saturn IB and the Saturn V have served their purpose and to take as a major task for the next period the development of a simpler and less costly launch vehicle for repetetive use. In these considerations we will have to balance the funding requirements for spacecraft to fly on the large boosters we will have in storage against the initial cost of developing new launch vehicle systems that will be more economical in the long run.

Most important of all, in this period we will have to establish as clearly as we can the facts and assumptions on which our executive and legislative leaders can base decisions as to the future course the program should take. In each major area of both aeronautics and space, I believe we must now think not in terms of commitments to particular accomplishments by particular dates, but of so structuring our plans and programs that we can make steady and sure progress toward important goals at rates that can be adjusted to the level of budgetary support that can be provided. This is not the most economical approach; we could accomplish any specific goal more economically if it were possible to have a commitment to support a specific objective and a specific schedule. But in the present national situation it is not reasonable to expect commitments of this type. It is reasonable and essential that our total program receive continuing support at an adequate level. And it is reasonable for the Congress and the public to expect us, with such support, to be able to plan and conduct an effective program over a period of years, and accomplish significant objectives.

In a period of relatively low flight activity it is especially important that we continue a broad program of advanced research to provide the technology required to support the programs that will be required to meet future national needs in aeronautics and space. I believe that there is a need to reconsider our national policies as they affect the research and educational activities of universities. As one aspect of this, the policy of recent years that university programs of agencies like NASA could be reduced in the expectation of equivalent or increased support from other sources has not yet yielded the needed results. NASA's programs with universities have been broad and varied in nature, and have in sum represented a series of important experiments in government-university and government-scientific community relationships. I believe careful assessment of the results of these experiments will show the merit of continuing in the years ahead the important elements of this kind of broad program of interactions between the universities and NASA.

It is my hope that in the sessions to come this symposium will help us all place in perspective the necessary elements of future aeronautics and space research and development program.

Let me emphasize one final thought. I do not regard the space program as competitive with other national needs or endeavors. The space program has important roles to play in the affairs of our nation. We in NASA, in my view, have a dual responsibility. We must make clear and speak out strongly for the needs of the nation in aeronautics and space. We must also do all we can to take our share of the responsibility for the totality of the problems which our nation faces.

These are difficult and challenging times. I want you to know that we in NASA will continue to give these problems our best efforts.

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REFLECTIONS ON GOVERNMENT SERVICE

# I. Doctrine and Practice in Large Scale Endeavors

by

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First of Three Lectures Presented in the
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Address by James E. Webb, May 2, 1968

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## REFLECTIONS ON GOVERNMENT SERVICE

### I. Doctrine and Practice in Large Scale Endeavors

During several periods of Government service covering quite a number of years, it has been my privilege to share in a number of endeavors of large scale and considerable complexity. All had important primary objectives. All had potential for secondary and tertiary effects which could prove harmful or beneficial. Success in meeting the main objectives, and whether the other effects were maximized or minimized, depended in many cases on administrative decisions.

As I have reflected on these experiences, and sought the elements which might prove useful in future programs, I have come to believe that the greatest successes are achieved through deliberate, planned utilization of well known organizational concepts and administrative practices which are based on a well exercised but limited body of doctrine. This limited body of doctrine rests in turn on a quite limited set of theoretical formulations. Further, so much is clearly done without a basis in accepted doctrine that it is difficult indeed to find an administrator experienced in large scale endeavors who can relate the major part of his successful way of working directly to doctrine or theory. He knows that certain things move matters ahead, but is not sure another administrator could or would do the same with the same effect.

Today's need is, I believe, increased emphasis on research that will provide greater knowledge and deeper understanding as to what successful administrative leaders in large endeavors do and with what effect.

The successes we have had in weapons system and space developments in recent years suggest to some the use of the systems management approach to achieve similar success in many other fields, both public and private. And yet there is little to guide those who must decide between alternate approaches. We do know that complex, fully engineered systems work efficiently only when all components contribute properly to the effort.

As to history, in some cases quite large and very successful projects have started with clear-cut goals and required only short periods of gestation. Others, also successful, have been subjected to protracted periods of debate and much vacillation and indecision. Some successes and some failures have been enclosed within larger formal organizations such as a military service or a large diversified corporation. In this situation they could draw upon the parent for resources and could move with great power almost without regard for the niceties of administration. Some projects have received only informal assistance from existing structures and had to begin with virtually no base of power or organizational nucleus.

We all know that for success, every large endeavor with its widespread implications must have good leadership and good management. This sometimes comes from a close correlation between the chosen way of working and accepted administrative doctrine; sometimes from the application of the prior experience of a group of competent leaders; and sometimes from the genius of one man. Careful study shows that very large endeavors seem peculiarly dependent for success on subtleties and flexibilities brought into play by the leadership group or by pressures on that group.

Society needs as much assurance of success as it can have when it commits its resources in large amounts. It needs assurance that the leaders to whom those large resources are entrusted will use them so as to strengthen, and not weaken, existing valuable institutions and groups in the nation's economic, social,and political structure.

Many of today's large endeavors, and those proposed, have management requirements that go beyond the state-of-the-art or proven capabilities of present forms and methods.

Scholarship and research in the disciplines on which future management groups must draw have been too slow to supply the need in such large endeavors. And it is an unhappy fact that research trends do not show that in the future we will be substantially better off.

Harvey Sherman, of the New York Port Authority, recently published a little book entitled <u>It All Depends: A Pragmatic Approach to Organization</u>. In it he points out that: "Programs, key people, or other conditions have changed, but the organization has not kept up . . . . The rapidity of change since World War II, as compared with all of history before that time, is so much greater than the rapidity of organizing to meet this change, that 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 disequilibrium."

Some students of administration believe we should change Sherman's words "desired disequilibrium" to "the lowest level of disequilibrium that will permit maneuverability under assured control."

The subtleties and flexible approaches which have been used to achieve success in many large endeavors can be thought of as a way of maintaining "desired disequilibrium." The skill with which factors of "disequilibrium" are related to the necessary level of stability or "equilibrium" is all important.

In my view, success in the further use of large scale endeavors could be in greater danger from too high a built-in equilibrium than from a needed state of disequilibrium.

NASA is undoubtedly an example of a large scale organized effort. For the ten years of its life, we have been constantly seeking to prepare for and organize to meet substantive and administrative conditions which could not be foreseen. We have sought to avoid those concepts and practices which would result in so much organizational stability that maneuverability would be lost. Our constant effort is to obtain a sufficient real time feedback from the fastest moving parts of our activity to enable us to alter our course as needed. We seek patterns of organization and administration that facilitate fast reaction times to signals of an emergency or of a short duration, unforeseen opportunity. More than most enterprises, we must have speed in decisions and in their implementation. This makes Sherman's concept of "disequilibrium" particularly appropriate to NASA.

Beginning seven years ago, with a total work force of about 75,000 in our laboratories, in the plants of our contractors, and on the campuses of our university associates, we built up in five years to a work force of 420,000. During the past two years we have reduced this number by 140,000, or one-third. We do not know today whether we will have to make further sharp reductions, stabilize at present levels, or start to build up again. And yet, we can point to almost complete success in planning and carrying out a quite complete system for unmanned exploration of the moon. The first of a series of three lunar probes was the Ranger, which gave us the capability for handling a large volume of telemetered data which we could translate into photographs, some of which provided detail one thousand times greater than the best theretofore available. The second-generation lunar probe was the Surveyor, which gave us knowledge of the physical characteristics and composition of the lunar surface and confirmation that our design for a vehicle to land on the moon was workable. Surveyor's best pictures were one thousand times more detailed than those of the Ranger. So these two spacecraft improved previous resolution by a factor of one million. The third generation was the Lunar Orbiter, which photographed the entire front and back of the moon and took such detailed pictures that we could identify the landing site of the Surveyor and correlate the information from Surveyor's detailed but local examination with conditions elsewhere on the moon. We have already selected a number of sites to which we are prepared to send astronauts for further exploration.

Two Mariner spacecraft have traveled to Venus and one to Mars, with large increases in our knowledge and understanding of these sister planets, their relations to the sun, and features common to them and to the earth. Several generations of earth orbital laboratories and deep space probes have explored the sun, the earth, the earth's weather, and provided communications relays. All have added to man's knowledge of the universe in which he lives and his capability to use this new knowledge. In the field of manned flight, Mercury led on to Gemini, with its record of sending 20 men out into space in 20 months and learning what it means to stay in space for 14 days, how to rendezvous and dock two spacecraft traveling 18,000 miles per hour, how to "walk in space," and how to splash down near a recovery ship.

I believe this NASA record, covering a brief 10 years, shows that, given competence in over-all management, this matter of maneuverability and flexibility--that is, the capacity to adjust to and to move forward in an unpredictable and sometimes turbulent environment--is perhaps the most important additional element required for success in the large scale endeavor. These would not be "large scale" unless the need they serve is urgent and important. Assurance of continued support through periods of difficulty is essential. In government enterprises what they do, how they do it, and who does it is almost always highly visible or open to inspection. Reporting of their activities is frequently keyed to the controversial or spectacular. Continued support depends on results. Failures or sensational forecasts of failures reduce internal self-confidence and undermine the essential element of external support.

From a management standpoint the situation is not unlike that faced by the Wright brothers when they decided to couple a human pilot with his senses and muscles to a coordinated system of machine controls. This enabled the pilot to relate what he could see and what he could feel to what he needed to do as he maneuvered his vehicle to meet the air currents and turbulence which he encountered.

The Wright brothers used, for the first time, a system of three-dimensional controls within which all elements worked together in a way natural to the pilot. Extreme problems were encountered by other designers in their attempts to use uncoordinated controls. It was thus their coordinated system of controls more than advances in the engine or structure that produced successful flight. They developed a new kind of linkage of man and machine. They built into their "system" a certain amount of instability and made it work for them.

The problems of using rocket power to reach up through the air and make use of the unlimited environment of space are also those of three-dimensional control. But here, once we leave the air, a working medium is almost non-existent and cannot be relied on for reaction with control surfaces. Rather, a falling-body state is attained where the vehicle is coasting in a state of dynamic equilibrium with little or no resistance. It is falling toward the earth, but its speed is so great it always falls over the edge, and thus continues round and round. No engine has to run. No fuel is consumed.

In a stable orbit, a satellite is the prisoner of forces external to it--the gravity of the earth and the centrifugal force generated by its speed. Any change in its attitude or trajectory requires the use of reaction motors, or jets. Control is not related to lift, thrust, and drag, as in the air, but rather with the ratio of thrust to inertia --elements contained in the vehicle itself.

The vehicle is in motion in a state of dynamic equilibrium, with the external forces balanced, and proceeds on its course until energy is used to change that course.

Is there an analogy here to the new kinds of systems we need to solve problems we now face in urban life, or to achieve economies of scale in programs for undeveloped regions? To succeed in these fields, I believe large scale endeavors are required and must start with a sufficient committed input of power to achieve the equivalent of "flying speed." They will need the ability to retain control through turbulent areas. They must have sufficient maneuverability to hold a course toward chosen objectives. And it may well be that a second generation of such endeavors will need to operate in a state equivalent to that of "dynamic equilibrium." It is quite likely that this will require substantial efforts to modify the environment itself.

There has been little effort to examine in depth the administrative features of our nation's experiences with the many kinds of large scale endeavors we have used. Some view these as so special--as so exceptional

--that little value, other than the historical, attaches to their study. They argue that adjusting government administration to rapidly changing conditions is necessarily a trial-and-error affair that defies systematization.

I would argue the reverse. As we have been able to study and master and apply over and over again the three-dimensional control innovation used by the Wright brothers, I believe we should be able to do something similar with the innovations that have made success possible in an accumulating number of quite diverse large scale endeavors. I believe these offer an important field of study. Such study offers the possibility of an important extension of management doctrine. It may provide a basis for extensions of theory.

The activities of NASA are free of many of the classification restrictions of the Department of Defense and the "trade secret" or proprietary restrictions of large industries. We are now in the process of opening NASA records and operations to responsible scholars for research sponsored by their universities. Through such research we believe we have an opportunity to help develop an increased national capability to carry out large and complex undertakings without each one having to start all over again.

Our society has reached a point where its progress and even survival increasingly depend upon our ability to organize the complex and to do the unusual. We cannot do the things we have to do except by the employment of large aggregations of power in highly specialized forms. We must do this under proper safeguards. We must avoid use of this power haphazardly or arbitrarily or without important elements of social control. I believe we have a critical need for a proven way by which such aggregations of power can be applied in the context of our free institutions.

Many great social problems press in on us. We need the effective application of new knowledge through a diversity of skills drawn from many disciplines. We cannot solve the inner city problem without new approaches and new organizing methods. The same goes for air pollution; water pollution; highway congestion; and the increasingly dangerous imbalance in the world population-food ratio. Piecemeal attacks on these problems will simply not work. Neither will limited concepts of systems engineering or systems management.

The advance of technology is proceeding at a pace that defies the capability of the older concepts and methods to organize its effective use, or to keep under control its full effects. The technological revolution that is now so fully upon us is the most decisive event of our times. No nation that aspires to greatness, or to use its power for good, can continue as it has in the past. Unless it purposefully and systematically organizes for technological advance and works the fruits of that advance into the sinews of its society, it will surely fail its citizens.

The Soviet Union is also faced with these same forces generated by its own technical revolution. The difference is that it is bent upon shifting the balance of technological and general economic power in its favor. And it is working toward technological pre-eminence throughout the world.

The great issue of this age is whether the United States can, within the framework of acceptable institutions, organize the use and development of advanced technology as effectively as the USSR with its totalitarian system of allocating and utilizing human and material resources. The Soviet leaders assert, and really believe, that they have an immense advantage over us. I believe differently. I believe the capabilities of our system give us an immense advantage over all other systems. But we must organize ourselves effectively to develop and not to dissipate its strengths. To realize on such an opportunity is a responsibility that a great people owes to itself and to all mankind.

The use of great aggregations of resources in large scale endeavors to cope with complex and difficult situations is, of course, not unique to our times. There are many instances in history of undertakings requiring tremendous organizational efforts and use of resources. The ancient Chinese built their Great Wall; the Pharaohs, their Pyramids; the Romans, the Appian Way.

In the development of our own nation in the 19th and 20th centuries, the need for a system of canals required new engineering concepts and unique construction practices. The building of the transcontinental railway system is also a case in point. As local railways expanded from a few short lines along the Eastern seaboard into a trans-Allegheny and then a transcontinental net, a virtual organizational and management revolution was required. The American Academy of Arts and Sciences recently published a series of studies which compared the development of our national railway system with our national space program. The striking aspect of this comparison is the extensiveness to which organizational and managerial innovations had to be employed in each case. Efforts to meet "problems inherent in the operation of a large railway, rather than theory or previous experience," determined the nature and content of the new system in which the decisive factor affecting the long-run development of the organizational structure "was the outside environment, rather than operational and technological considerations."

After 1865, "forces within the American economy threw the railroads into cut-throat competition, which in turn emphasized the non-operational problems of rate-making, finance, and the expansion through construction and purchase. Thus the operational managers were thrust aside and control gravitated to financiers who were chiefly responsible for administrative structures that evolved between 1865 and 1900."

In the development of our space systems we are now at that same point. "Non-operational" problems are already our limiting factor. What "administrative structures" can we devise to meet these? The answer is not yet in sight.

From its earliest days, the National Aeronautics and Space Administration has relied on the National Academy of Sciences to assist in the formulation of scientific goals, in the continuing examination of projects to accomplish these goals, and in assessing progress. More recently, the formation of the National Academy of Engineering has afforded an opportunity to work with leaders in that profession to develop a different kind of relationship, but one equally important. This takes the form of the Aeronautics and Space Engineering Board which advises NASA on policies and programs related to effective engineering developments and the strengthening of related institutions, such as our engineering schools. Basic research is emphasized in both cases, and we are trying to more clearly understand how a governmental agency and an organized profession can best work together.

Just a few months ago the formation of the National Academy of Public Administration brought a third element to our growing national capability for joining science, engineering, and management. The National Academy of Public Administration is now developing ways and means through which research by competent scholars in the disciplines related to administration can utilize the various installations of NASA as laboratories. Its officials hope to utilize many of the research patterns of the anthropologist to understand how NASA administration actually takes place.

While we know much about the building of the Rockefeller petroleum empire, with its mobilization of widely diverse resources, we know all too little about how it met many complex and relatively unique organizational needs. We can say the same about the establishment of the U.S. Steel complex; the development of Sears Roebuck; General Motors; the DuPont chemical complex; and on through many others.

Our knowledge is inadequate in cases where the Federal government has found it necessary to supplement its regular administrative system with special endeavors aimed at meeting unusual needs. The land-grant operation developed to aid agriculture and its higher education needs is one such example. The building of the Panama Canal is another. And in the era of the Great Depression, large scale efforts were introduced on a variety of fronts, of which perhaps the Tennessee Valley Authority is best known.

During the Second World War large scale endeavors played a critically important role. We found that within the framework of the over-all war effort we had to organize quite large and complex special activities to get difficult and urgent jobs done that could not be accomplished by existing organizations and established methods and procedures.

The Manhattan Engineering District was the most celebrated. President Truman, in his Memoirs, described this as a "vast undertaking" which "had no parallel in history." It brought together in secret establishments around the country large numbers of scientists and engineers drawn from universities, industry, and the government itself, and a tremendous number of support personnel. These were isolated from outside interests and contacts, and assigned the job of developing and testing new scientific concepts, engineering new machines and processes, and marshalling the diverse resources necessary to make a weapon that had never been made before. Sections of great industrial enterprise were, in effect, made component parts of the project. Giant laboratories were built and operated under contract by companies like General Electric and Union Carbide. In other words, we created an integrated "team of teams" and used it with an overriding singleness of purpose to accomplish on a crash basis something never before accomplished. The job was done within a strikingly short period of time.

The Office of Price Administration was the largest, most widely known, and most pervasive of the special wartime endeavors. A National Academy of Public Administration summary describes the unprecedented nature of the task undertaken by the OPA as "to wage war and make peace without at the same time suffering the ills of large-scale inflation and deflation . . . ." There were many who thought that the task of substituting conscious governmental controls for the relatively mechanical functioning of the market place was beyond the power of human endeavor; but on balance the war record is astonishingly good. Price stabilization was achieved in the face of inflationary potentialities unequalled in the country's modern experience. More than this, it was achieved while new production records were being made in almost every field of manufacturing and production.

Petroleum was a different problem. Submarine warfare had played havoc with the flow of oil to our major industrial centers while our requirements were sharply rising. We had to produce more oil and move it quickly to points of critical need. Massive new activities and resources were necessary. Efforts to meet the situation through improvisations utilizing existing organizations and regular methods failed. A single authority, the Petroleum Administration for War, was established and met the need.

A similar operation was necessary for rubber; for building the massive fleet of commercial ships; for meeting critical housing and construction requirements; for increasing the manpower resources necessary for new and greatly expanded industries; and so on down a surprisingly long list.

As the war drew to an end, a strong movement developed to force the Federal government to abandon these large scale endeavors and to liquidate the various extraordinary activities in which it had become engaged. The thought was that the old-line agencies and departments, and the old methods, would be adequate to meet peacetime problems. It was soon apparent, however, that the peacetime problems of the late 1940's required many of the same specialized organizational efforts and approaches as wartime problems. For the first time in our history we had to establish a centralized intelligence agency. We came to recognize the need for a "Voice of America" and the Atomic Energy Commission was set up.

As to the old-line departments and pre-war agencies during the war, they were enormously expanded, both in personnel and in responsibilities. The Departments of Commerce, State, Interior, Agriculture, Treasury, the Veterans Administration, the Justice Department, specialized agencies dealing with housing and transportation, and even the regulatory agencies, took on complex new functions.

The separation of the Air Force from the Army, and then the combination of the three military services within a single Department of Defense, was a monumental undertaking. Establishment of the National Security Council marked a step forward.

In 1948, with a Republican Congress and a Democratic Administration, the first Hoover Commission on Government Reorganization was established. Former President Hoover was made Chairman and Mr. Dean Acheson Vice Chairman. As Director of the Bureau of the Budget, it was my responsibility to serve as liaison between President Truman and President Hoover. We in the Truman Administration were able, on the basis of a mutual willingness of all participants to be realistic, to work well with Mr. Hoover and the Commission. A large number of the ideas and concepts that had been developed from experience were incorporated in the Commission's recommendations.

The Hoover Commission devoted much attention to the Department of State. It emphasized the incongruity between the organizational structure and the methods and procedures of the department, on the one hand, and the requirements raised by the rapidly changing environment in which our foreign policy was being conducted.

The Department of State had become after the war a giant conglomerate. New functions and personnel were piled on its very small base. Moreover, as U.S. world responsibilities grew, new units and new groups of personnel were added to do special jobs. The organizational structure of State and its methods of doing business were completely inadequate to absorb, much less utilize, the resources that were heaped upon it--and this at a time when we needed all the means we could command to increase our effectiveness in foreign affairs.

The organizational heart of the department--that is, the "inner" department of operating bureaus--remained much as it had developed during the 1920's and 1930's. Resting on a base of "country desk officers," it reported to the Secretary through a pyramidal command structure. This inner department prided itself on its self-containment, with little knowledge or understanding of what was going on elsewhere in the department or in other agencies. It was this inner department which commanded most of the time of the Secretary and on which he largely depended for the information and judgments needed in the decision-making process, and for the development of strategy and tactics. There were few systematized means whereby many areas of the Department could be drawn into the day-to-day councils and deliberations of the Secretary.

The Hoover Commission recommended sweeping changes to bring the Department up to date. The Vice Chairman of the Commission, Mr. Acheson, was appointed Secretary of State. I soon joined him as Under Secretary and we set as a major goal the reorganization of the Department along the lines recommended by the Hoover Commission.

The pyramidal system was "flattened out." The organizational structure just below the Secretary/Under Secretary level was greatly broadened in order to delegate responsibilities downward. Assistant Secretaries were appointed for each of the main geographical areas of the world--that is, for Europe and the British Commonwealth, for the Near and Middle East and Africa, for Latin America, for the Far East, and for South and Southeast Asia. Two new senior officials, a new Deputy Under Secretary for Political Affairs, and another for Administrative Affairs, were appointed. The Heads of functional divisions such as Intelligence Research, Legal Affairs, Policy Planning, and others who were previously outside the mainstream of departmental operations, were brought into the senior group with status equivalent to that of the Assistant Secretaries. Each Assistant Secretary was charged with overall direction of operations within his area; insuring coordination between his bureau and other bureaus, and effectively utilizing all available resources in and outside the Department in carrying out his responsibilities. Each Assistant Secretary was charged with administrative as well as substantive leadership.

A communications network was so structured as to insure open lines of communications hierarchically and laterally and to provide a continuing feedback of information on performance against policies, decisions, and instructions. Much of this was accomplished through the Executive Secretariat.

Mechanisms were established whereby all intelligence information available either in the Department or in other agencies could be introduced on a real time basis into deliberations of The President and the Secretary as well as in the day-to-day work at lower levels. The research resources available in the Department were reordered so as to bring them directly to bear on problems and missions of immediate and continuing importance. Among other things, a system was established whereby needs could be anticipated and research and other preparatory work done in advance so as to be readily available on need. We established an inter-agency "Watch Committee" to serve as a centralized point for pooling all intelligence information that might give early indications of developments adverse to our interests. We also joined in the development of systematized national intelligence estimates on both a regular and special need basis.

I point to these experiences in the organization and reorganization of our government during the early post-war years because the effort represented a successful endeavor not just to improve governmental operations, but to achieve a better and more effective governmental system. There was then no wartime emergency. The aim was more than to work our way through trying times and difficult situations. It was to equip ourselves with the tools and to find an organizational pattern through which we could cope, on a world-wide basis, with the complex, the unusual, and the uncertain. We were seeking to adjust to a new and demanding national and international environment, and to do this in a way that would prepare us to cope with further changes. We wanted a system of administration that would bring to the fore the essential ingredients required for good judgment at critical points of decision and effective action in the handling of complex and difficult matters. Our aim was to work toward the use of what we now call "feedback" in a "closed loop" system. Our aim, if you will, was good government.

This brings me to a concern I feel needs emphasis.

We often talk about what is bad in government. My observations and experiences lead me to feel that there is much that is good in government. For a long time many responsible officials have sought with much earnestness and persistence to adapt the administrative processes with which we have lived so long, and which are so central to our institutional structure, to the requirements of a new age, and to do this without damage to the essential features and basic values of our society.

Few seem now to recall how well our government met the first post-war challenge--the Greece and Turkey aid program. This proved a most complex enterprise, requiring a combined military, economic, diplomatic, morale-building, training and educational program. It involved both a variety of government agencies and private enterprises and establishments. Moreover, it depended for success on getting action and decisions from the divided, confused, and dispirited Greek and Turkish leaders. And we had constantly to take into account the wishes and activities of our allies, as well as the maneuvers of a relentless adversary. Later we were to have many rounds with similar situations, but in 1947 we were little experienced and were ill equipped to measure up to the commitments we felt we had to assume. We had virtually no time in which to prepare ourselves. We had to do everything under the pressure of imminent disaster. We had the resources, and this was not the problem. The problem was organizing the use of the resources. And for this a whole set of new rules and procedures in management had to be developed and put into operation.

Hardly had the Greek-Turkish aid program gotten under way when a crisis in Western Europe caused the United States to embark on an even larger endeavor, the Marshall Plan. In the words of President Truman: "Never before in history has one nation faced so vast an undertaking as that confronting the United States of repairing and salvaging the victors as well as the vanquished." What was needed and what the Marshall Plan provided was a comprehensive program for a large population in many nations to salvage their economic program based upon U.S. material assistance. The Europeans needed technological and managerial guidance coupled with a means for disciplined self-help. They were, of course, highly developed and educated people living in nations with long traditions. They had the base and the capability necessary for reestablishing viable conditions. But they lacked many of the components required for getting industrial and other establishments going again, or achieving political and social stability. Most of all, they lacked the spirit and the will to dig themselves out of the economic, political, and psychological debris left by the ravages of war. Also, ominous threats were always in the background.

When the Marshall Plan was launched in the summer of 1947, it called for an outlay of $20 billion over a four-year period. This was revised down to $16 billion in the budget requests to Congress. There were committees and task forces in a variety of agencies, and inter-agency groups operating within the Executive Office of the President. We organized to do this job as we had seldom organized in peacetime before, and it turned out to be a magnificent success. With it we proved much about what could be done through skillful and purposeful organizing on a large scale.

In the 1950's, when Soviet rocket power threatened to make our air power obsolete, we undertook a vast program to give us an intercontinental missile capability. This was a $50 billion endeavor spread over most of a decade. Like the Manhattan District, it centered primarily on the use and development of advanced technology. Its complexities were so great that it required a whole range of new administrative concepts. It involved the systems approach to management on a grand scale. And alongside this special enterprise, we worked toward a general overhaul of our entire weapons complex, including entirely new aeronautical systems. We also successfully carried out the Polaris nuclear submarine missile launcher program, a large scale endeavor within the larger U.S. Navy.

The accomplishments of the ballistic missile and related endeavors formed a solid foundation of know-how which we used when we embarked on the latest--and the most complex--of the large scale endeavors we have undertaken: our national space program.

All of us well remember the impact of Sputnik and the consequential traumatic circumstances that led us to move out in space. There was the shocked realization that Russia had become a first class technological power, capable of successfully challenging us in an area where we had felt secure; the deep concern that the balance of strategic power may have been tilted against us; the awed world-wide response to the Soviet success; the new stridency of claims regarding the superiority of the Soviet-Communist system; and even deeply troubled questioning within our own ranks as to whether our ways and our values could measure up to the demands of a new age. Many felt trapped by forces beyond their control; desperate to prove to themselves and others that what they feared was not true.

Actually, we were better off than most of us thought. We had a number of valuable things going for us. We had nearly all of the resources, nearly all of the means needed to do the space job. And what we did not have, we could bring into being. The big problem--the big task--was to organize the use of what we had and to do this in such a way as to bid for continued support over the long time required to demonstrate results. The matter came down to management, the organization and administration of the most complex of the large scale endeavors our nation has undertaken, and to do this in close association with four Congressional committees which included 124 members whose confidence we must get and retain.

In these lectures I will say more about how we proceeded with this task of organizing, managing, and reporting on the space program. I will try to show why we did some things and not others. I will point out some failures as well as some successes.

It will be my purpose to develop these matters not entirely in the context of the NASA operation itself. I will try to set them within the context of our nation's general experiences with large scale endeavors, and to show their usefulness for future tasks.

In speaking of large scale endeavors you will note that I have avoided attempts at definition. Such endeavors quite clearly do not conform to uniform patterns.

They may be public or private, or essentially a mixture of the two. They may be socially motivated or profit motivated. They may have to do with either a civilian or a military situation.

They may be designed to meet a critical problem, or to capitalize on a unique opportunity. They may involve a complex of tasks or aim at getting a single major job done.

They may be more or less self-contained, or extend over a variety of organizations and institutions. They may be of relatively short duration, or continuing. They may involve hundreds of thousands of production workers and highly specialized teams of scientists and engineers. They may be principally concerned with the utilization and development of advanced technology or with new applications of old technology. They may be vested with great authority and power to marshall the human and material resources needed, or they may be dependent upon self-generated energies and skills.

But however great the diversity among such large scale endeavors, there are important common threads that run through them. Seven of these come to mind:

First: They are ordinarily undertaken as a result of a significant change in the environment--social, political, technological, military, or others--which raise a new and urgent need, or present a significant new opportunity.

Second: Interaction between the environmental situation and the endeavor is a continuous process. As changes in the environment produce the endeavor, so do subsequent changes work for continuing modifications in the nature of the job being done and in the tools needed and available to do it. Pressures may arise from what happens in the endeavor itself. Or they may have other sources as, for example, the rise of new competing demands on scarce resources; growing effectiveness of a dissenting minority; a change in popular attitudes; a change in the political balance.

A third very important common feature of large scale endeavors is that organizing, administering, reorganizing, and the administration of the reorganized structure, is the key to their effectiveness and usefulness rather than inventing an entirely new machine or process. For most large scale endeavors the knowledge and technology and the human and material resources necessary for the job were already in being. The requirement has been to effectively organize the use of what was at hand. This has been true even for endeavors like NASA and the Manhattan District which might appear singularly dependent upon invention or "new" knowledge and technology.

Fourth: Large scale endeavors also do not generally require new organizational and administrative forms but the more effective utilization of existing forms. Some endeavors have not even required new organizational structures, or at least not all-encompassing structures. NASA, for example, has made use of a wide variety of pre-existing structures. The Corps of Engineers has used much the same organizational structure while carrying out, over time, a variety of large scale endeavors. The Marshall Plan was largely managed on the U.S. side through utilizing the resources of existing governmental agencies and commercial practices.

Fifth: All large scale endeavors do have a number of special requirements. They depend on men with special, often unique, skills; men of high intelligence and creativity; men trained in a variety of of disciplines; men who by their very nature raise special problems for management. Communications are of unusual importance; and particularly communications related to the collection and use of feedback. Enormous quantities of data are indispensable, but this in its turn creates a special problem of unwanted data or "noise" and possibilities of confusion. The need is for a sure means to select what is needed when it is needed and put it where it is needed. A large scale endeavor is so complex that the chief executive and his senior associates cannot have detailed knowledge and expertise for every facet. They must delegate important responsibilities to lower echelons and then find ways to make sure the delegations accomplish their purpose without harmful compartmentation.

<u>Sixth</u>: Another common denominator of large scale endeavors is the necessity of a continuing "critical mass" of support. There must be enough support and continuity of support to retain and keep directly engaged on the critical problems the highly talented people required to do the job, as well as to keep viable the entire organizational structure. As with an airplane, the initial support must be adequate to attain the equivalent of "flying speed" and continued support must be adequate to maintain the equivalent of an efficient flight path. Any uncertainty or shortfall in the support factor is apt to have large effects on the result and force the endeavor into serious difficulties.

<u>Seventh</u>: A number of intangibles also mark large scale endeavors. All have important secondary and tertiary effects other than those associated with the prime objective. These alter the environment and

significantly impact events generally. All tend to have a high degree of uncertainty regarding precise end results. The costs of inadequacy or failure are invariably high. Finally, the large scale endeavor has a very high potential for participants, which helps to attract the creative individual.

Can we now ask how a nation like the U.S. should approach future projects of the complexity just described: Should we proceed as with any other job, applying the same methods and procedures, only on a larger scale? Should we despair of any help from existing doctrine and practice and try to build an entirely new element? Or should we try for a successful mix of the old and the new through careful planning and new experimental approaches?

One thing is obvious. The first essential for success is to operate as efficiently and productively as possible. Whoever is responsible must employ workable management tools. These tools may be old or new. That is not important. The important thing is that they work, that they be used, and that available tools not be overlooked.

Men have been searching for good management tools throughout the ages. Texts on management have a way of going back to the ancient Sumarians, or Chinese, or Hebrews for a point of departure. Historically, each society has made its contributions. Machiavelli had a good grasp of the basic rules and principles in the early sixteenth century. So did Pope Gregory the Great in the late sixth. And for some types of management problems, it would be difficult to improve on the Benedictine Rule, also of the sixth century.

The systematization of these traditional rules and principles by the so-called "Scientific School" of management at the turn of the century resulted in a body of doctrine which, for all of its publicized faults, provides building blocks from which parts of a large scale endeavor can be constructed. An hierarchical system of authority, the hallmark of the traditionalists, is in one form or another essential. Basic principles covering "delegation of authority" and "division of labor" must be applied. The span of control must have some limit, and tasks must be structured so that there is a logical and consistent relationship between functions.

Yet as a system of management, the traditional doctrine constructed by Taylor, Weber, Fayol, and others, is not suited to the very large, complex undertaking. A slavish application of the "Fourteen Principles" which Fayol used in 1916 (which sums up the essence of the traditional doctrine and which still provide the backbone of much of the management training of today) would almost certainly guarantee the failure of any complex large endeavor. The fundamental shortcoming is the assumption of a highly rigid and inflexible structure. Fayol and Taylor were engineers who applied engineering design concepts to organization; they assumed it would then operate in much the same way as an internal combustion engine. The participants in the organization were viewed as multi-purpose, poorly designed machines. These concepts apply quite well to routine, repetitive, and stable operations. But they are self-defeating for the highly complex endeavor making its way in a turbulent environment, where rapid change and adjustment are of the essence.

Just as we can use some but not all of the doctrinal principles of the traditional school, we can also use parts of the newer doctrine of the behavioral or participative school. Developed through a synthesis of social science theories about man and "tested" in a limited number of highly controlled experiments, this doctrine argues that the traditional organization is in conflict with the needs of the mature individual and that the organizational atmosphere must permit all individuals to interact freely through all levels of the structure. It further argues that the goals of an organization can be efficiently achieved only if there is a fusion between them and the goals of the individual.

There is certainly validity and usefulness in such concepts. They include interdependency of human relationships, self-motivation, self-actualization, and recognition of the informal group structure within a formal organization.

On the other hand, the complexity and enormous scale, and the actual and potential side effects, of the large scale endeavor cannot allow the degree of participation in goal setting and operation envisaged by the behavioralists.

Others have, of course, noted the inadequacies of the doctrines of both the traditionalists and the behavioralists. An entirely new school, one that advocates an "evolutionary" or "systems" doctrine appears to be emerging. A main concern of this school is the concern I have expressed--the increasing size and complexity of corporations and government operations. Its thinking has opened broad new vistas and introduced a variety of tools that are particularly useful. It has given us a new approach based on both a "general systems theory" and a "situational" concept. It has helped to transform practice from a compartmented mode of operation to a highly integrated one, which is, of course, of great importance. It has also pointed up the necessity for managers to base their actions not on a rigid set of principles, as was the case with the traditionalists and to some extent with the behavioralists, but instead to recognize that these actions must be adapted to particular situations, organizational levels, and the human beings involved. Above all else perhaps, the "systems" school has emphasized the importance of quantitative methods of analysis in the use of the ever-increasing quantities of data generated by the computer. Operations Research is prominent among the new techniques.

Even a casual reading of the literature of the "systems" school will reveal, however, that it too is inadequate to the aggregate of the requirements of the large scale endeavor. It is given to generalizations based upon special and often artificial situations. Sophisticated mathematics and conceptual model building, without the essential foundations of observation and first-hand study, sometimes seem to be the sources of its development.

As a general matter, all this indicates our need to recognize a significant lag in management doctrine. There is an urgent need to research our experiences with complex activities and to systematize our findings so that better doctrine can be developed into the workable guide it ought to be.

The essence of the problem, it seems to me, is more emphasis on research. In actual practice where do doctrinal principles work and where do they fail? What additions or changes are necessary to update and strengthen doctrine? These are the things we need to find out more about, and this means thorough and systematic examinations of concrete experiences. Professor Leonard Sayles, of Columbia University Graduate School of Business, has entitled a forthcoming article "Whatever Happened to Management?" He points out that management as a field of study has been seriously lacking in down-to-earth research; that in the past those who achieved greatness in the social and behavioral sciences did so because they "immersed themselves in the affairs of man and built their powerful abstractions on the basis of prolonged first-hand experience." Pointing out that this methodology has become less fashionable, Dr. Sayles adds, "given the absence of an accepted research tradition, the field of management and all its branches (human relations, organization theory, organization behavior) often rests on proselytizing."

There are any number of instances in the conduct of large scale public and private endeavors where established doctrine--even the latest "systems" doctrine--has proved deficient. There had to be exceptions, and innovations with few guides from doctrine.

It is to these instances that research should be directed. Important findings may be uncovered there.

In the next of these McKinsey lectures I plan to touch upon two broad areas where exceptions have been particularly necessary in the large scale endeavor. The first I have called Goal Setting and Feedback; and the second, Executive Performance and its Evaluation.

Perhaps, then, I can conclude this lecture with a thought from the period before World War I, when technology and industrialization were forcing new social adaptations.

In about 1910 Woodrow Wilson began to change his views on how America would meet the future. He stated that this nation was no longer content, as he had previously believed, with the progress that could come through an orderly development of our legal system. He wrote: "The transition we are witnessing is no equitable transition of growth and normal alteration, no silent, unconscious unfolding of one age into another, its natural heir and successor. Society is looking itself over in our day from top to bottom, is making a fresh and critical analysis of its every element, is questioning its oldest practices as freely as its newest, scrutinizing every arrangement and motive of its life and stands ready to attempt nothing less than a radical reconstruction."

Wilson came to believe that our nation's vitality, its strength and its needs, made obsolete patterns based on a slowly evolving "common law" concept.

Out of this new line of thought came the quick but sweeping reforms of Wilson's first years as President and much that followed later.

I believe we are in a similar age. There is great need for new concepts to take hold. Just as "common law" concepts had to give way to "statutory law" in Wilson's time, it is advocated today that needed reforms cannot wait for normal legislative periods of gestation but must be forced. On the other hand, we do now have the tools to free our society of many of its burdens and to carry it to new levels of achievement. What we lack is a dependable operating concept acceptable to our elected representatives of how we can deliberately and purposefully use those tools to shape our own destiny, to choose attainable goals, and to insure continuing progress toward those goals.

An April 1968 issue of <u>Science</u> gives an interesting account of recent experiments to test the efficiency of Stone Age tools. These tests revealed that the tools made of stone were generally as effective for their purposes as the later tools made of metal. The conclusion was that: "Stone Age man may have been better equipped than we suppose; his tools and weapons were cheap, sharp, and very enduring." *

Why then did the Stone Age last so long? Why did it change so little over its long life?

Many believe it was the failure, or inability, of Stone Age man to develop concepts that would demand and make possible the fuller use of his tools for broader and greater purposes than the accepted and the traditional. In the <u>Science</u> issue of July 31, 1964, V. Edwin Bixenstine expressed this idea: "The great advances of science are

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* A. C. Custance, "Stone Tools and Woodworking," in <u>Science</u>, April 5, 1968, p. 101.

associated with its grand conceptions even more than with its discoveries." ** Perhaps we should broaden Bixenstine's thought to the great advances of man himself. This is what we ought to have in the back of our minds as we consider the past and the future of societies' use of large scale endeavors.

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** V. Edwin Bixenstine, "Empiricism in Latter-day Behavioral Science," in Science, July 31, 1964, p. 464.