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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON 25, D.C.

OFFICE OF THE ADMINISTRATOR

MAY 10 1963

MEMORANDUM FOR THE VICE PRESIDENT

This memorandum refines and reduces, in volume, the information provided in my memorandum of May 3 with respect to the national space program. The information is organized into five paragraphs corresponding to the five questions raised in the President's memorandum of April 9, 1963.

1. COMPARISON OF PROGRAMS. The only definitive way we have found to compare the program of the last administration with that of the present one is to compare the last long range plan prepared by NASA under the Eisenhower Administration (January 1961), and the first long range plan prepared by NASA under the present administration (January 1962). Comparisons of the Major Mission Target Dates (Enclosure 1) and of the Budget Projections (Enclosure 2) of these two plans are attached.

Neither of these plans had Presidential approval, and there is doubt that President Eisenhower ever fully approved more of NASA's long range plan than a run-out of the items included in his FY 1962 budget request for $1.159 billion.

A comparison of accomplishments under the 1961 and 1962 plans, based on the assumption that both plans were successful, would not be meaningful in the light of current knowledge. For example, NASA's studies in February and March 1961 showed that the Apollo vehicle and the related boosters, as previously planned, could not meet the technical requirements of the manned lunar landing. Furthermore, by the time the 1962 plan was formulated, there had been delays in achieving milestones under the 1961 plan which necessitated a later scheduling under the 1962 plan of certain milestones common to both plans.

In general, the principal advances under the 1962 plan are as follows:

a. The advancement of the manned lunar landing from some time after 1970 to the 1967-1970 period is, of course, the major forward step, and is responsible for the principal increase in the expenditure forecast.

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Authority NLJ 85-11
By mg, NARS, Date 9-11-85

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b. A new launch vehicle, the Saturn 5, was introduced in the 1962 plan. This booster will have five times the payload capacity of the largest booster in the 1961 plan. It will be capable of supporting manned lunar landings whereas the largest booster previously planned, the Saturn 2, would not.

c. The introduction of the Gemini program will significantly advance the country's experience with manned orbital operations. It introduces the concept of orbital rendezvous, not envisioned by the previous plan.

d. In the area of Space Sciences, the 1962 plan activated the program for large orbital observatories: the geophysical, solar, and astronomical observatories. Some of these were only in the planning stage, and others were envisioned on a reduced scale in the 1961 program.

e. In order to assure pre-eminence in space over an extended period, it is considered essential to invest in research and advanced technology looking toward the future. The augmented and more carefully planned program now in being gives the nation a significantly greater thrust toward a sound technological base on which to proceed with difficult space exploration missions.

f. In the program of Applications, the low orbit communications and weather satellites would have been achieved under either plan. The 1962 plan, however, introduced the synchronous satellite which holds great promise for the ultimate communications system.

The NASA long range plan of January 1962 not only provided for an acceleration of the lunar landing and booster development programs, but also for substantial increases in the space science and applications activities and flights. The supplemental requests sent to the Congress in May of 1961 started many of the projects which were reflected in that plan.

Enclosure 2 is a comparative tabulation showing: (1) originally projected funding requirements of the January 1961 program, (2) upward revision of these funding requirements prepared in April 1961, and (3) originally projected funding requirements of the January 1962 plan.

In the spring of 1961, Congress was informed that the cost of the manned lunar program (up to the first landing) would range between \$20 billion and \$40 billion. Current (May 1963) estimates show that this program will be accomplished at or near the \$20 billion figure. This amount includes approximately \$2.5 billion in capital facilities such as large test stands, launching facilities, and investment items that will be required to build, test, and fly the large boosters and spacecraft for manned space operations. These will have value over a long period of time as a major national capability to operate in space.

Enclosure 3 tabulates by years the currently estimated run-out of NASA's 1964 budget plus funding estimates for possible new programs at an annual $6 billion budget level. The Appendix to Enclosure 3 is a detailed report comparing accomplishments, both planned and actual, under the 1961 and 1962 programs in the major areas of: Manned Space Flight, Space Sciences, Advanced Research and Technology, and Applications.

2. BENEFITS TO ACCRUE TO THE NATIONAL ECONOMY

a. APPLICATIONS

The capability of meteorological satellite systems to prevent millions of dollars of property damage and loss of life by providing advance warning of severe storms has been demonstrated.

In addition to providing information immediately useful in weather forecasting, the increased understanding of weather processes will make possible better and longer range forecasting to permit better planning in many areas of the nation's economy and perhaps may ultimately lead to methods of weather control or modification.

Communication satellites provide another immediate application. Intercontinental communications are growing so rapidly that the present planned transoceanic facilities will not be capable of satisfying the need by 1965 or 1966. Communication satellites to provide increased worldwide communications will not only establish a new industry in itself, but will result in new economies and patterns in trade throughout the world.

We can look forward to navigation satellite systems which will provide substantial benefits and economies to the various transportation industries.

We can also look forward to the use of satellites for the collection of data on a global basis. Such satellites could provide for the collection of data from weather balloons, oceanographic buoys, tidal warning stations, and perhaps even chart the courses of wildlife.

These applications will result in immediate economic benefit to the nation but they are only made possible because of the present understanding of basic science and technology which was painstakingly accumulated in the past.

b. SCIENTIFIC KNOWLEDGE

Recent history shows clearly that advances in fundamental understanding of natural phenomena--as in the understanding of the atom--produce major effects in the economic sphere, though these effects are not initially foreseen.

Space exploration by means of space probes and satellites offers the opportunity to obtain fundamental understanding in four broad areas of current scientific interest:

(1) the sun and its influence on the earth, including the nature of the interplanetary space environment,

(2) origin and nature of the solar system,

(3) astronomy, and

(4) the origin of life.

Scientific advance on the scale of the current space program must inevitably open new advances in technology and thus new avenues of economic use. It is in terms of the broad, basic, scientific advance and the accompanying technological advance that the science of space will have its greatest economic impact.

Earth and Sun

The sun is one of the most important objects for man to study. The sun is the major source of energy in the solar system. It controls the weather on earth; supports or disrupts communications depending upon solar activity; and determines the interplanetary environment. A major portion of the NASA effort is directed toward a better understanding of the sun and its influence on the earth.

Observatories above the earth's atmosphere make it possible to investigate the sun and its activity with a thoroughness not possible from the ground. The ultraviolet, X-ray, radio, and infrared radiations are absorbed in the upper atmosphere and control the properties of that region. They do not reach the ground but can be observed and measured from space platforms. They provide a great deal of new and very valuable information on the properties of the solar chromosphere and the corona; on the nature of sunspots; and on the processes which take place in solar flares.

Satellites and sounding rockets have shown that the upper atmosphere and ionosphere are exceedingly complex regions, subject to gross and sudden changes dependent on activity on the sun. Large temperature changes occur between day and night, and between sunspot maximum and sunspot minimum. The composition, ionization, temperature and the density are controlled by solar electromagnetic and particle radiations. The atmosphere is important because it comprises the source and substance of our everyday weather. The ionosphere is important because it furnishes the means by which radio waves may be reflected beyond the horizon, thereby making it possible to communicate around the world. Correlated measurements with sounding rockets and satellites of solar activity, the properties of the upper atmosphere, and conditions on the surface should determine the mechanism by which solar activity affects the surface weather on earth.

Beyond the sensible atmosphere of the earth, above about 500 Km, is a region of space whose properties are controlled by the earth's magnetic field. This region is called the magnetosphere. The Van Allen belts are contained within the magnetosphere.

Satellite-borne instruments plot out the earth's magnetic field; measure the radiation levels in the Van Allen belts; and record the particles which create the auroras in the far North and South. The radiation levels in the Van Allen belts determine the regions of space within which Mercury, Gemini, Apollo, and Manned Space Stations can fly.

One can also use satellites to study the earth itself. Observations on the influence of the earth's shape and mass distribution on the orbit of the satellite enable the scientist to determine the density of the earth's interior and to measure the distribution of matter within the earth. This data is required for accurate trajectory calculations.

Surrounding the sun and extending out to some distance beyond the orbit of the earth is an interplanetary medium through which there is a continual flow of plasma, the solar wind, whose density and velocity fluctuates with solar activity. This flow of plasma determines the configuration of the weak interplanetary magnetic fields. These weak fields, acting over large distances, determine the trajectories of cosmic rays. Occasionally, during a large solar flare, large numbers of solar cosmic rays are ejected into space, thereby increasing the radiation levels. The magnitude and duration of such an increased radiation level is also determined by the configuration of these weak fields. All of this is new information which we have obtained from satellites Pioneers and Mariner II. All of it is information which we need to define the environment in space and to determine the influence of the sun on the earth.

Moon and Planets

In the field of science, the moon is of particular interest because it may furnish one of the most significant clues to the question of how the earth and the other planets of the solar system originated. The lunar surface is likely to have preserved the record of past events going back billions of years, perhaps nearly to the time of its origin 4½ billion years ago. This record has remained unmarred by the erosion of atmospheres and oceans, and by mountain-building processes. On the earth, the surface record is lost because of these atmospheric and mountain-building processes.

The opportunities that lie ahead will be of interest to many disciplines but should be especially attractive to the geophysicist. Most of the techniques that will be required to observe and make measurements on these bodies will be of those of the geophysicist.

These forthcoming opportunities not only broaden the horizons of the geophysicist by extending the range of his investigations to other planets, but also broaden the perspective in which the geophysicist can view the earth. Comparative investigations of earth, moon, and planets will contribute greatly to the understanding of each one, and also to the understanding of the solar system.

Measurements of lunar surface characteristics will provide data of fundamental value to the design of the Apollo spacecraft.

Stars and Galaxies

In the past ground-based observations have been limited to the very narrow range of wave lengths in the visible portion of the spectrum. From these observations the astronomer has put together a truly remarkable body of astronomical knowledge and theory.

Nevertheless, this limitation to the visible spectrum is a very serious limitation indeed. The most fundamental processes in the birth of stars can be observed only in the infrared, while the most exciting portions of the evolution of the star are observable only in the ultraviolet. For this reason, the satellite orbiting above the earth's atmosphere opens up valuable new opportunities to the astronomer.

One of the most important programs in NASA, the Orbiting Astronomical Observatory, is designed to exploit these new opportunities in astronomy. Carrying instruments and telescopes above the earth's atmosphere, OAO will permit observations in all parts of the spectrum.

The lunar and planetary probes provide an opportunity for astronomers to observe the planets of the solar system at close range.

The astronomer and cosmologist use spacecraft in satellite orbits about the earth or on escape trajectories from the earth to perform experiments in relativity; gravity; celestial mechanics; galactic cosmic rays; and magnetodynamics on a scale utterly unobtainable on the surface of the earth.

Life in Space

Certainly one of the most exciting possibilities in space exploration is that indigenous life may be found outside the earth. For this reason, preparations are going forward with various types of instruments to search for living forms on other planets, particularly Mars. These will be carried in fly-bys and landers as soon as the necessary transportation is available. All data available at present would indicate that there is little likelihood of life on Venus. Various radio astronomical and the Mariner II observations of the planet indicate that the surface temperatures are in the vicinity of 800°K, well over the boiling point of water. If life has formed on these planets, it must be both similar to, and yet different from, that which exists on the earth. A knowledge of these life forms would provide us deep insight into the basic dynamics of life formation and life processes.

Advanced Research and Technology

In addition to the scientific knowledge obtained from actual flights in space, NASA's advanced research and technology program produces scientific knowledge on a broad front, covering many branches of physics, chemistry, mathematics, engineering science, and physiological and biological science. As history amply demonstrates, discoveries in one field profoundly affect others, and we can, therefore, expect widespread influence in other scientific and technical endeavors.

c. INDUSTRIAL PRODUCTIVITY

The space effort is extending the industrial capability of the United States in a major way for four main reasons:

(1) The exploration of space involves large net additions to the industrial base in the form of engineering teams and capital facilities which constitute continuing national resources.

(2) The exploration of space involves virtually all fields of science and engineering; from anatomy to electronics systems to the effects of zero gravity on both the animate and inanimate.

(3) The harsh environment of space typically requires a fundamental advance in the state-of-the-art in many areas. A high proportion of NASA researeh and development funds are spent in

extending the existing technology to new, more rigorous and efficient uses; and in finding new materials, new systems, operating at higher levels of reliability over long periods of time in a radically different environment.

(4) The exploration of space on the scale involved requires a major contribution to the technique of managing large research and development efforts. In World War II, the Manhattan Project was the largest effort of this type that the United States had carried out to date. In the 1950's, we increased our national capability with the help of the experience gained in the ballistic missile programs. In Project Apollo, we are engaged in another large enterprise, which involves thousands of persons working in many locations throughout the United States in accordance with a single, overall schedule. Completing this endeavor successfully will provide the ability and competence to go on to still more ambitious national undertakings, when required.

Some examples of actual and potential increased industrial capability and efficiency brought on by the space program are set forth in the following paragraphs:

(1) An infrared horizon sensing device used in the Mercury spacecraft has been adapted to use by steel makers in measuring rods of hot steel before these rods are cooled, thus not only insuring accuracy but achieving a savings in cost.

(2) Through NASA's use of fiberglas refractory welding tape, it is possible to obtain a smooth seam with a single pass outside weld, thus cutting welding costs in half.

(3) Fluoroethylene propylene has been used to release the aluminum star-shaped insert from the sticky solid rocket propellant after casting. This appears to have application to plywood laminating presses, furniture gluing clamps or rubber gasket molds.

(4) The need for new sources of power for spacecraft has concentrated work on the long-time goal of developing a fuel cell which will transform chemical energy from fuel directly into electrical energy, with high efficiency. NASA requirements for the use of solar cells are advancing the state-of-the-art in this area, and this again has implications for widespread use.

(5) In aeronautics, NASA is making significant contributions to the supersonic transport program. Research on vertical and short take-off and landing aircraft is expected to produce benefits in air transportation.

(6) A membrane being developed for a spacecraft life support system has the prospect of becoming an effective filter against detergents.

(7) To simulate the heating conditions under which a space vehicle re-enters the atmosphere, the Langley Research Center developed an arc gas heater which employs a radial magnetic field to rotate an electric arc at high velocity between two circular water-cooled electrodes. Midwest Research Institute, in its translation of this item to industrial use, estimates that the use of this arc heater to convert natural gas into acetylene may result in a considerable reduction in the cost of producing acetylene.

d. EDUCATION

During this decade, NASA will expend nearly one billion dollars in space related research and development at universities and other institutions of higher learning. Two thirds of this amount will be for research and technology in direct support of program and project goals. This university participation is carried on by highly trained and capable groups of faculty and graduate students working in three major areas:

(1) Sponsored university research programs on a broad front covering many branches of physics, chemistry, mathematics, engineering sciences, and physiological and biological sciences.

(2) Development of new, improved, or more sophisticated spacecraft instrumentation generally for scientific data acquisition but also including engineering technology.

(3) Analysis and interpretation of scientific and engineering data acquired through execution of NASA flight missions.

This essential participation on the part of American colleges and universities produces not only a continuous stream of trained scientists and engineers with some experience in space research, but also yields the major share of new knowledge in space sciences. In Fiscal Year 1963 universities will conduct about $35 million on research, development, and data analysis directly related to NASA missions.

In addition, NASA has instituted a sustaining university program designed to meet NASA's needs while at the same time strengthening the colleges and universities, increasing the supply of technical manpower, and encouraging close relations between education and industry to advance the space program while stimulating economic growth.

In order to increase the nation's supply of scientific and technical manpower, NASA has instituted a graduate training program, begun in 1962 with the award of ten training grants to each of ten universities for a total of 100 students for a period of three years. In 1963, $15 million of additional grants were made, bringing the total to 886 students in 88 different universities. It is intended to make additional grants in Fiscal Year 1964 with the total number of institutions rising to about 110. Ultimately the intention is to start some 1350 students annually, at which time NASA will be supporting about 4000 trainees with an expected output rate of about 1000 PhD's per year.

An essential aspect of this program is that the grants are made to the institution. Candidates are selected by the institution for work at that university. The resulting wide geographical distribution provides a basis for encouraging and increasing scientific strength in places where additional strength is needed.

Also in Fiscal Year 1963, $10 million are being used for the construction of space related research facilities in universities.

The NASA program in secondary education is small but designed to encourage capable young people to embark on careers in science, mathematics and engineering, develop in all children a higher level of scientific literacy, and improve the teaching of science and mathematics by updating courses to include information arising from space research. Much of it is accomplished through spacemobile demonstrations at schools.

Less tangible, but not to be overlooked, is the impact of space activity as a stimulus to educational interest on the part of American youth, and on the improvement of American schools. Dr. Lee DuBridge has said the latter "alone may be worth the cost of all our space rockets."

e. The table at Enclosure 4 provides an estimate in dollars of the contribution that NASA fund authorizations for FY 1962 and 1963 and fund projections for FY 1964 through 1970 makes to scientific knowledge, industrial productivity, education, and military technology. Estimates are included for both the January 1961 plan and for NASA's present long range planning.

D. NATIONAL PROBLEMS. There is little evidence to indicate that significant national problems are likely to be made critical or require radical solutions as a result of the continuation of the space program. In fact, new approaches being tried in NASA may open the way to new and more effective attacks on such problems as shortages in engineering and technical manpower, and the shortening up of the time lag now associated with the utilization of the results of government research by industry.

Concern has been expressed over NASA requirements for scientists and engineers, which will increase substantially during 1964 and 1965, leveling out at a little above 100,000 after that year, based on an assumed stability of present ratios of personnel to procurement expenditures.

The nation's total employment of scientists and engineers is estimated at 1,400,000 as of January 1963 and is estimated to rise to 1,900,000 in January of 1970. NASA's records and government data indicate that on January 1, 1963, about 42,000 scientists and engineers were at work for NASA, 9,200 employed under Civil Service by NASA, and an estimated 32,800 employed by industry, universities, and other government agencies. This is three percent of the 1963 national pool. The estimated number required in 1965 will rise to 97,000 (an increase of 55,000 in two years), and the estimated percentage will rise to slightly more than six percent of projected total national requirements, based on an assumed stability of present ratios of personnel to procurement expenditures.

However, the aerospace industry, with an annual volume of $16 billion, performs the greater part of NASA industrial research, development, and fabrication. NASA's level of expenditures in this category, and hence mostly in this industry, follows:

NASA's major procurement is projected as:

	Launch Vehicle Procurement	Industrial Research and Development	Total
1963	$200 million	$1.210 million	$1.410 million
1964	$375 million	$2.400 million	$2.775 million
1965	$485 million	$3.300 million	$3.785 million
1966	$480 million	$3.560 million	$4.040 million

In the last few years, industry has used large numbers of scientists and engineers on important new research and development projects without a correspondingly large recruitment of scientists and engineers. For 1962 Aerospace Industry requirements, based on NASA estimated procurement expenditures, indicated a requirement for 10,000 additional scientists and engineers. However, the actual total added by the Aerospace Industry for all work was only 6,000 scientists and engineers. Industry leaders indicate this is being accomplished by increased productivity, internal reassignments, on-the-job training and up-grading through work experience and formal off-the-job training. For example, in the case of one aerospace company, 12 percent of the new engineers required were produced from within the company's existing work force.

On January 1, 1963, of the total 32,800 scientists and engineers working in non-governmental corporations and institutions on the NASA program, some 3,000 faculty and graduate assistant man-year equivalents were in universities. Such faculty members are doing research, training graduate assistants in the research process and teaching graduate and undergraduate courses, thus contributing substantially to an increase in the national supply. Over and above this, the NASA graduate training program is designed to increase rapidly until it will add 1,000 Ph.D.'s per year to the national supply.

During 1962 over 1,700 NASA employees were enrolled in graduate level training in science and engineering, thus also adding an important increment to the national supply.

NASA's in-house recruitment of scientists and engineers has had no significant adverse effects on industry or on the ability of universities to produce scientific and engineering graduates. Only 30 of the approximately 3,700 scientists and engineers recruited during the period July 1, 1961 through September 1962 were teaching professors at universities.

There are a number of problems before the nation that are related to science and technology quite apart from the space program. These include the effect of changing technology upon employment and upon the regional economies; the transfer of the results of government research and development to civilian use; the administration of large, complex research and development undertakings; the encouragement of the individual scientist; the dissemination of scientific information; the necessity of strengthening the universities; and the need to increase the potential source of scientific manpower among the underdeveloped areas and population groups of the nation. NASA is actively working to so execute its program as to assist in meeting these needs.

4. REDUCTIONS OR ADDITIONS

a. Any program reductions not jeopardizing the manned lunar landing target date would have to occur in areas that would affect our capability to understand the composition of space, to improve our future space capabilities, or to utilize space for early beneficial applications. As now programmed, these areas represent NASA's best judgment of a desirable balance of activities. Funding reductions would require a detailed restudy to establish the best alternative program. The projects listed below illustrate missions which would have to be curtailed or deferred.

(1) SPACE SCIENCES

Project ANNA - A geodetic satellite to evaluate gravitational anomalies of the earth and to improve the location of geodetic tie-points for military and civil purposes.

Funding: FY 1964, $6 M; FY 1965, $9 M; FY 1966, $1 M

Orbiting Geophysical Observatories - A series of satellites capable of carrying a large number of experiments to measure the properties of space near the earth.

Funding: FY 1964, $62 M; FY 1965, $59 M; FY 1966, $36 M

Mariner - A family of spacecraft to give close-up scientific observations of Mars and Venus during fly-by.

Funding: FY 1964, $100 M; FY 1965, $102 M; FY 1966, $128 M

Pioneer - A series of interplanetary spacecraft to measure the properties of space at great distances from the earth.

Funding: FY 1964, $15 M; FY 1965, $17 M; FY 1966, $19 M

Biosatellite - Recoverable satellites to determine the effects of space conditions on living organisms.

Funding: FY 1964, $28 M; FY 1965, $19 M; FY 1966, $4 M

International Satellites - U.S expenses for projects using foreign-built spacecraft or incorporating selected experiments built by cooperating nations.

Funding: FY 1964, $10 M; FY 1965, $17 M; FY 1966, $17 M

(2) ADVANCED TECHNOLOGY

General supporting research and technology - Advanced research in technical areas currently limiting space utilization and exploration.

Funding: FY 1964, $172 M; FY 1965, $193 M; FY 1966, $212 M

Technology flight projects - Space flight evaluations of promising technical concepts and developments.

Funding: FY 1964, $33 M; FY 1965, $63 M; FY 1966, $78 M

M-1 Engine - Development of a 1.5 million lb. thrust hydrogen-oxygen engine for upper stage application.

Funding: FY 1964, $45 M; FY 1965, $50 M; FY 1966, $50 M

(3) SPACE APPLICATIONS

Advanced Syncom - High capacity, electronically stabilized communication satellite for flight at 23,000-mile altitude to explore technological concepts useful to military and civil communication satellite systems.

Funding: FY 1964, $40 M; FY 1965, $32 M; FY 1966, $13 M

Nimbus - NASA funded portion of prototype for an operational weather-observation satellite system.

Funding: FY 1964, $44 M; FY 1965, $42 M; FY 1966, $48 M

b. In NASA's judgment the following categories of programs should receive strong consideration for initiation within the next several years. Each proposal should, however, be considered on its own merits at the proper time. Although specific recommendations are not being made in the present context, it should be observed that the programs outlined could be conducted within this decade at total program funding levels not appreciably exceeding FY 1964 requirements.

Space Sciences - Follow-on projects should be initiated to maintain the current level of activity in the determination of the properties of space. Larger planetary spacecraft should be developed for more significant exploration of Venus and Mars. A suitable injection stage should be developed for the Saturn launch vehicle to perform these planetary missions.

Advanced Technology - Additional satellites should be incorporated in this program to permit flight evaluation of promising concepts and devices emerging from laboratory research.

Space Applications - Additional satellites for data collection or navigation should be incorporated as required for research and development on currently foreseen and future satellite applications.

Manned Flight Systems - The technological capabilities being developed in the current manned lunar landing program are opening the avenues for other missions. The end uses of earth orbiting space stations and their potential application for military as well as non-military missions should receive thorough and constant evaluation. Possibilities for extended and expanded exploration of the lunar terrain should be thoroughly evaluated together with the requirements for logistic support of such operations.

5. NASA-DOD COOPERATION. Effective measures do exist to insure coordination and cooperation between NASA and the DOD. While these measures have been progressively expanded as the objectives of the civilian and military defense segments of the national space program have tended to converge, efforts further to strengthen coordination among NASA, DOD, and other executive agencies will continue.

Relationships currently exist for coordination and for mutual assistance and support by NASA and the DOD at all levels. Examples:

a. The Aeronautics and Astronautics Coordinating Board, responsible for insuring coordination at the highest managerial levels. Under the aegis of the Board, the annual construction of facilities budgets of NASA and the DOD are coordinated. For Fiscal Year 1964, a total of 217 items were jointly reviewed. It was agreed that no unwarranted duplication existed in the FY 1964 facility plans of NASA and DOD.

b. The Gemini Program Planning Board, instituted at the executive level to insure the maximum practicable DOD participation in the manned flight phase of NASA's Gemini Project.

c. Panels of an operating nature, which deal with programs in advanced research and technology such as the X-15, Dyna Soar, hypersonic research, and the Supersonic Transport. DOD participates in many other panels sponsored by NASA, such as the NASA Research Advisory Committees, or by NASA in combination with other agencies such as AEC. These close working relationships between individual scientists and engineers are an effective means of coordinating scientific progress and understanding.

d. In the area of manned space flight, close coordination between the U. S. Air Force, as executive agent of the DOD, and NASA has been effected through the establishment of the Office of Deputy Commander for Manned Space Flight, Air Force Systems Command, physically located within NASA's Office of Manned Space Flight.

e. DOD local representatives act for NASA with the majority of the Agency's contractors in matters of audit, quality control, and contract administration. During FY 64, NASA plans to purchase more than 4,000 man years from the DOD for this work.

f. More than fifty joint agreements, consummated to effect coordination and eliminate unwarranted duplication in specific areas, are in effect. Some are:

(1) The National Launch Vehicle Program Agreement, which provides for concurrence by both agencies before the development of a new launch vehicle is undertaken.

(2) Agreements which cover NASA's utilization of the Atlantic, Pacific, and White Sands National Ranges.

(3) Agreements on the inter-agency use of boosters. NASA uses the DOD's Atlas, Atlas Agena, Thor Agena, Titan II; the DOD uses NASA's Scout.

(4) Agreements for the non-military applications of DOD developed systems; e.g., TRANSIT.

(5) Agreements between NASA and the Corps of Engineers (Army) and the Bureau of Yards and Docks (Navy), under which approximately 70 per cent of NASA facilities funds are expended.

g. More than 200 active duty military personnel are detailed to duty with NASA. The more senior officers so assigned hold important line positions in the NASA organization.

h. Through NASA participation in meetings of the Armed Services Procurement Regulation Committee when items of joint interest are discussed, NASA and the DOD coordinate the development of the procurement policies under which both agencies operate.

NASA established on December 1, 1962, the Office of the Deputy Associate Administrator for Defense Affairs. Functions: to improve working relationships between NASA and the DOD; to expedite the flow of information; and to promote coordination on matters of mutual interest.

Although cooperation between NASA and the DOD is good, some areas for further improvement are:

a. Earlier coordination in the study phase of advanced projects to eliminate unwarranted duplication between NASA and the DOD when these projects are ready for initial development;

b. Further strengthening of cross-fertilization in the areas of research and technology to reveal additional applications of NASA discoveries and advancements to some of the more critical military problems, while at the same time serving to focus or channel NASA research efforts into those areas holding additional promise of solutions to military problems.

c. Greater participation by the DOD in NASA projects to enhance the knowledge and capability of the services in space and space-oriented applications.

James E. Webb

James E. Webb
Administrator

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COMPARISON OF MAJOR MISSIONS

Calendar Year	1961 PLAN	1962 PLAN
1961	Suborbital flight of an astronaut Launching of Atlas-Centaur γ-ray astronomy experiment Orbiting solar observatory Launching of a Ranger lunar spacecraft Orbital flight of an astronaut Launching of the Saturn first stage	
1962	Impact landing of instruments on the moon (Ranger) Topside ionospheric sounding Launching of a planetary spacecraft Launching of Nimbus meteorological satellite Real time active communications satellite leading to civil application	Orbital flight of an astronaut Orbiting solar observatory Flight past Venus (Mariner R) Nimbus meteorological satellite Developmental launching of Atlas-Centaur (Ce) Launching of a lunar impact spacecraft (Ranger) Active communications satellites (Relay, Telstar) Ionospheric Topside Sounder
1963	Launching of a 2-stage Saturn C-1 Soft landing of instruments on the moon Launching of a complete 3-stage Saturn C-1	Active communications satellite (Syncom) Two-man earth orbit flight Orbiting astronomical observatory Eccentric geophysical observatory Initiation of Nimbus meteorological satellite system Developmental flight of two-stage Saturn C-1 (Sa-I)
1964	Launching of an orbiting astronomical observatory Qualification of 200,000 lb. thrust hydrogen-oxygen rocket engine for flight Reconnaissance of Mars and/or Venus by an unmanned vehicle	Flight past Venus and Mars (Mariner B) Lunar orbiting and soft landing of instruments (Surveyor) Initiation of operational low orbit communications satellite system Flight qualification of 1,500,000 lb. thrust rocket engine (F-1) Rendezvous in earth orbit (Gemini) Three-man earth orbit (Apollo)

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COMPARISON OF MAJOR MISSIONS

Calendar Year	1961 PLAN	1962 PLAN
1965	Qualification of a 1,500,000 lb. thrust rocket engine for flight Apollo prototype capsule test	Aeros stationary orbit meteorological satellite Developmental flight of C-5 first stage launch vehicle (S-Ib) Developmental flight of three-stage Saturn C-1 (Sa III) Flight qualification of 1 to 1.5 million lb. thrust hydrogen-oxygen engine (M-1) Initiation of stationary orbit meteorological satellite system
1966-67	Flight of a complete 3-stage Saturn C-2 Flight test of a nuclear-thermal rocket Attempt to land mobile instruments on the moon Attempt to put spacecraft in orbit about another planet	Radio astronomy satellite Artificial comet Nuclear turboelectric power generation flight test (Snap-8) Recoverable geophysical observatory Sun orbiting solar observatory Launch of a Mars orbiter and/or lander Operational stationary orbit communication satellite system Manned circumlunar flight Three-man orbiting laboratory Developmental flight of Nova first stage (N-I) Nuclear rocket flight test (Rift) (1966-67 period)
8-70	Apollo manned orbiting laboratory and circumlunar flights	Developmental flight of 2-stage Nova (N-I plus N-II) Initiation of experiments in weather modification Manned lunar landing and return High power stationary orbit communications satellite Orbiting astronomical observatory with recoverable data package Flight test with 1500 kilowatt electric rocket engine
Post 1970	Manned landing on the moon	Cosmological probe Twelve-man orbiting laboratory Solar scientific probe Operational lunar scientific base Probe out of the ecliptic Developmental flight of Nova with nuclear second stage Manned interplanetary flight (Mars)
		First manned planetary landing

Enclosure 1

SECRET

PROJECTION OF NASA FUNDING FROM LRP 62, RUN-OUT OF 1964 BUDGET AND POSSIBLE NEW PROGRAMS AT $6 BILLION LEVEL

(Millions of Dollars)

	PROJECTIONS* / YEARS	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
NASA TOTAL	LONG-RANGE PLAN 1962	964	1672	3943	5431	5324	4705	4540	5210	5255	5470
	RUN OUT OF 1964 BUDGET	964	1822	3688	5712	5546	4490	3340	2760	2070	1660
	POSSIBLE NEW PROGRAMS AT $6 BILLION LEVEL					454	1510	2660	3240	3930	4340
MANNED SPACE FLIGHT PROGRAM	LONG-RANGE PLAN 1962	429	806	2512	3612	3443	2885	2765	3450	3505	3710
	RUN-OUT OF 1964 BUDGET	429	923	2242	3758	3493	2740	1760	1380	900	500
	POSSIBLE NEW PROGRAMS AT $6 BILLION LEVEL					204	790	1690	2230	2860	3260
SPACE SCIENCES PROGRAM	LONG-RANGE PLAN 1962	259	406	565	695	674	705	680	705	660	665
	RUN-OUT OF 1964 BUDGET	259	443	635	837	918	740	600	460	330	320
	POSSIBLE NEW PROGRAMS AT $6 BILLION LEVEL					80	290	560	600	620	630
ADVANCED RESEARCH AND TECHNOLOGY PROGRAM	LONG-RANGE PLAN 1962	165	229	513	771	760	730	730	730	730	730
	RUN-OUT OF 1964 BUDGET	165	261	497	597	638	660	680	660	600	600
	POSSIBLE NEW PROGRAMS AT $6 BILLION LEVEL					95	170	200	260	290	290
APPLICATIONS PROGRAM	LONG-RANGE PLAN 1962	57	107	140	134	195	150	155	125	140	160
	RUN-OUT OF 1964 BUDGET	57	76	118	141	126	50	50	50	40	40
	POSSIBLE NEW PROGRAMS AT $6 BILLION LEVEL					40	100	100	100	110	110
TRACKING AND DATA ACQUISITION PROGRAM	LONG-RANGE PLAN 1962	54	125	213	219	252	235	210	200	220	205
	RUN OUT OF 1964 BUDGET	54	119	196	379	371	300	250	210	200	200
	POSSIBLE NEW PROGRAMS AT $6 BILLION LEVEL					35	160	110	50	50	50

Funding projections for each program in the above chart include funds for its contribution to the Manned Lunar Landing Program

*The "Run-out of 1964 Budget" figures are, for 1961, 1962, and 1963, the actual appropriations for those years and, for 1964, are the current values contained in the President's budget

SUMMARY OF BUDGET PROJECTIONS
(IN MILLIONS)

FY	(1) 1961 1961 Plan	(2) 1961 Plan Adj.	(1) 1962 1961 Plan	1962 1962 Plan	(1) 1963 1961 Plan	1963 1962 Plan	(1) 1964 1961 Plan	1964 1962 Plan
Manned Space Flight 1	390 (390)	429	443 (507)	806	623 (944)	2512	698 (1096)	3612
Space Sciences 2	283 (283)	259	346 (350)	406	466 (620)	565	451 (600)	695
Advanced Research and Technology 3	33 (33)	165	231 (235)	228	313 (360)	513	358 (400)	771
Applications 4	163 (163)	57	86 (88)	107	82 (165)	140	70 (125)	134
Tracking and Data Acquisition 5	46 (46)	54	54 (55)	125	93 (100)	213	97 (105)	219
NASA Total 6	915 (915)	964	1160 (1235)	1672	1577 (2189)	3943	1674 (2326)	5431

FY	(1) 1965 1961 Plan	1965 1962 Plan	(1) 1966 1961 Plan	1966 1962 Plan	(1) 1967 1961 Plan	1967 1962 Plan	(1) 1968 1961 Plan	1968 1962 Plan	(1) 1969 1961 Plan	1969 1962 Plan
Manned Space Flight 1	742 (1312)	3441	880 (1274)	2885	1008 (1198)	2765	1210 (1410)	3450	1242 (1324)	3505
Space Sciences 2	504 (740)	674	502 (760)	705	482 (710)	680	480 (680)	705	476 (620)	660
Advanced Research and Technology 3	393 (440)	760	368 (400)	730	395 (450)	730	400 (420)	730	355 (365)	730
Applications 4	88 (133)	195	83 (123)	150	67 (102)	155	61 (76)	125	60 (75)	140
Tracking and Data Acquisition 5	98 (110)	252	98 (108)	235	104 (110)	210	107 (112)	200	106 (110)	220
NASA Total 6	1825 (2735)	5324	1931 (2665)	4705	2056 (2570)	4540	2258 (2698)	5210	2239 (2494)	5255

	(1) 1970 1961 Plan	1970 1962 Plan	(1) Total 1961 Plan	Total 1962 Plan
1	1312 (1334)	3710	8,548 (10,789)	27,117
2	476 (500)	665	4,466 (5,863)	6,014
3	322 (324)	730	3,168 (3,427)	6,087
4	60 (75)	160	820 (1,125)	1,363
5	106 (107)	205	909 (963)	1,933
6	2276 (2340)	547[illegible]	17,910 (22,167)	42,514

APPENDIX TO ENCLOSURE 3

1. COMPARISON OF MANNED SPACE FLIGHT PROGRAMS

The fundamental difference between the two space programs involves the decision of the present Administration to extend the program of manned space flight beyond Project Mercury, and to do so on a time scale leading to a manned lunar landing in this decade.

The 1961 long range plan included the development of a three-man Apollo type spacecraft for earth-orbital and circumlunar flights and the development of a three-stage Saturn launch vehicle. However, the projected funding for these programs was inadequate.

The plans adopted by the present Administration include the following:

a. Extension of the Mercury program.

b. Project Gemini, which will produce an operational two-man spacecraft capable of flights lasting up to two weeks, and space flight trajectory changes that will make rendezvous maneuvers possible.

c. Development of the Saturn IB launch vehicle for boosting payloads weighing up to 32,000 pounds into earth orbit.

d. Development of the Saturn V launch vehicle to boost 240,000 pounds into earth orbit, or to launch 90,000 pounds into a lunar trajectory. Its earth-orbital payload will be the equivalent of 80 Mercury spacecraft. The first stage of this vehicle will be five times as powerful as that of the Saturn I.

e. Development of the Apollo spacecraft, consisting of three separate modules, and thereafter, operational flights carried out in the following manner:

(1) Manned earth-orbital flights to test rendezvous and docking techniques in preparation for similar maneuvers in orbit about the moon.

(2) Manned flights into orbit about the moon and lunar landing. In the latter flights, the Saturn V will launch a lunar excursion module for the lunar landings, in addition to the Apollo command module that houses the astronauts during launch and reentry.

f. Establishment of a complex of fabrication, assembly, test, and launch facilities omitted entirely from the 1961 Plan, but essential to the manned lunar exploration and sustained space flight operations. These facilities include: the Manned Spacecraft Center with responsibility for spacecraft development, astronaut training, and the operational control of manned space flight missions; the Michoud Plant in New Orleans, in which stages for the Saturn vehicles will be fabricated and assembled; the Mississippi Test Facility at which large launch vehicles stages will be tested; the Merritt Island, Florida, launch area including a Vertical Assembly Building in which four launch vehicles may be checked out simultaneously, and a crawler-transporter to move the vehicles to one of the three launch pads; expansion of production and testing facilities at other locations throughout the country.

2. COMPARISON OF SPACE SCIENCES PROGRAM

The 1962 Space Sciences Plan provides for considerable augmentation over the previous plan, and provides for considerably more comprehensive scientific investigations.

a. Unmanned Lunar Program

The unmanned lunar and space exploration program was expanded in order to provide the fundamental scientific data that are required for the design and successful operation of a safe, reliable system for manned lunar landing and return. The Ranger program was increased from a five to a fifteen spacecraft plan designed to acquire lunar information necessary for determining design constraints of the Apollo spacecraft. Surveyor-lander was increased from seven spacecraft to approximately seventeen, and the lunar orbiter project was modified to provide for twenty, rather than three, spacecraft, in order that more definitive physical characteristics of the lunar surface and potential landing sites can be prescribed for the Apollo program.

More continuous coverage of solar activity and of radiation phenomena was instituted.

b. Geophysics and Astronomy

The revised program provides a considerable augmentation over the previous plan by adding one additional flight per year of each of the major observatories in the latter part of the decade, adding about five flights per year of the Explorer and international satellites with emphasis on monitoring solar and geophysical phenomena, and increasing the rate of sounding rocket firings by 50 per cent.

New programs involving advanced observatory spacecraft and galactic probes were also included. These spacecraft will make possible observations not possible with current ones and will extend our exploration to the outer reaches of the solar system.

c. Bioscience Program

The Bioscience Program has been expanded to provide basic scientific information required for longer manned space flight missions, and backup for Apollo in the event unforeseen physiological problems arise. This expansion has resulted in the initiation of studies for a biosatellite flight project which will obtain fundamental information on important biological phenomena and increased emphasis on experiments related to the search for extraterrestrial life.

d. Propulsion and Launch Vehicle Development

The Launch Vehicle Program has been expanded to provide for increased launch intensity, for the attainment of cost effectiveness in the production of future vehicles, and for additional effort in the Centaur development program.

e. University Program

NASA has used grants and research contracts with universities in support of the space research program. The Sustaining University Program was added in 1962 to support graduate level training, to provide facilities to house on-going space research, and to give long term support to university research projects.

3. COMPARISON OF ADVANCED RESEARCH AND TECHNOLOGY

The history of science and technology has shown that a sharp cutting edge of research is an essential ingredient for pre-eminence in any branch of technology. In order to assure pre-eminence in space over an extended period, it is considered essential to maintain a balanced space program in which adequate resources are invested in research and advanced technology looking toward the future. The augmented and more carefully planned program now in being gives the nation a significantly greater thrust toward providing a sound technological base on which to proceed with difficult space exploration missions.

A salient difference between the two programs lies in the substantial increases in effort in several research and advanced technology areas, including that of nuclear rocket research and development.

The following programs are illustrative of those in which new or expanded activities have been initiated: space radiation effects on spacecraft materials and structures, biotechnology and human research, meteoroid hazards in spacecraft, reentry heating at lunar return speeds, new electronic components and techniques, nuclear electric power generation, fuel cells, solar cells, chemical rocket combustion stability, high energy chemical rocket fuels and engine concepts. Since electronic devices absorb substantial sums (e.g., 70% of the cost of spacecraft) and are of such fundamental importance to the success of any space mission, a new Electronics Research Center has been recommended.

The direct effects of the increase in the depth and breadth of the research effort will be:

a. to make flight accomplishments and missions more assured and reliable, and

b. to improve the efficiency with which space flight is carried out, thereby permitting more to be accomplished with a given effort.

Several flight programs of critical importance have been undertaken which were not funded under the 1961 plan. Among these are Project Fire, which is to provide vital data in flight on reentry heating at, and beyond Apollo speeds; an augmented flight program to obtain data on the meteoroid collision hazard; and a series of flight experiments to study the problems and performance of experimental ion engines in space.

Specialized ground research facilities are indispensable to the accomplishment of the research program in the most economic and efficient manner possible. The augmented program has permitted the construction of such facilities.

4. COMPARISON OF APPLICATIONS PROGRAMS

At the beginning of 1961, in the area of satellite applications, two successful Tiros Meteorological Satellites had been launched, a third was being readied for launch, but no more were planned. One of the first decisions of the new Administration was to expand the Tiros program in order that at least one might be kept in orbit at all times to provide a semi-operational system that would give valuable weather data and stimulate a substantial number of other nations to work with the U. S. in the early steps toward a world-wide meteorological system based on satellites.

The Nimbus development effort was substantially increased to provide for a world-wide meteorological system. The decision was made that the Weather Bureau should operate this system. The number of Nimbus satellites has been increased from the four research and development satellites planned for in January 1961, to nine in the present program, with the funding to be provided by both NASA and the Weather Bureau.

Only low altitude communication satellites were funded in the early program, and no early initiation of a synchronous orbit satellite was contemplated. A cooperative NASA/DOD project, SYNCOM, has now been underway for nearly two years.

SECRET

ESTIMATED PORTIONS OF NASA AUTHORIZATIONS (1962-3) AND PROJECTIONS (1964-70) WHICH CONTRIBUTE TO SCIENTIFIC KNOWLEDGE, INDUSTRIAL PRODUCTIVITY, EDUCATION AND MILITARY TECHNOLOGY
(IN MILLIONS OF DOLLARS)

	1962	1963	1964	1965	1966	1967	1968	1969	1970
Scientific Knowledge									
January 1961 Long Range Plan	420	540	560	730	810	1100	1100	1100	1100
Present Long Range Planning	610	1030	1460	1600	1600	1600	1600	1600	1600
Industrial Productivity									
January 1961 Long Range Plan	750	1140	1240	1360	1450	1600	1600	1600	1600
Present Long Range Planning	1180	2760	4370	4400	4400	4400	4400	4400	4400
Education									
January 1961 Long Range Plan	40	50	60	90	115	160	160	160	160
Present Long Range Planning	50	110	160	200	250	250	250	250	250
Mi' 'ary Technology									
January 1961 Long Range Plan	210	190	160	200	200	200	200	200	200
Present Long Range Planning	290	620	1150	1500	1500	1500	1500	1500	1500

NOTES: 1. Inasmuch as the areas specified are not mutually exclusive, i.e., certain money expended may benefit two or more areas simultaneously, the yearly totals of the above figures exceed the actual or planned expenditures.

2. The values stated for the "Present Long Range Planning" are based on a continuation at a $6 Billion level beyond 1964.

SECRET

ENCLOSURE 4