PRELIMINARY HISTORY

OF

NASA

1963 - 1968

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P A R T B - S U P P O R T I N G A P P E N D I C E S

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APPENDIX TO CHAPTER I

CHALLENGE AND RESPONSE, 1947-1963

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ROCKET DEVELOPMENTS BEFORE 1955

The rocket, like gunpower, originated in China. The name of the inventor is lost to history. The earliest recorded use was to propel flaming arrows against the Mongol besiegers of the city of Kai-fung-fu in 1232 A.D.[1]

But the early rocket lacked reliability. Thus despite occasional military use, seven centuries were to pass before it was taken seriously as a potential major weapon. One brief period of ascendency resulted from improvements made in India in the late Eighteenth Century and by William Congreve, a British colonel, in the early 1800s. Thus the rockets' red glare over Fort McHenry, Baltimore, in the war of 1812 were immortalized in The Star Spangled Banner. But rapid advances in the artillery far outstripped the rocket in the Nineteenth Century.[2]

With the birth of aviation in the early 1900s, imaginations throughout the world were stimulated to ponder the possibilities of space flight. This in turn revived interest in the rocket because it, unlike other means of propulsion, does not depend on the atmosphere. Among those who investigated the possibilities were Hermann Ganswindt (1856-1922) in Germany and Konstantin Tsiolkovski (1857-1935) in Russia, Robert H. Goddard (1882-1945) in the United States, Robert Esnault - Pelterie (1881-1957) in France, and Hermann Oberth (1894-   ), a Rumanian living in Germany.

Goddard proved by experiment that a rocket will generate thrust in a vacuum. On March 16, 1926, he flew the world's first liquid-fueled rocket to an altitude of 184 feet over Auburn, Massachusetts. Charles A. Lindbergh helped Goddard receive support from the Guggenheim Foundation. He patented many of his ideas, including inertial guidance (with use of gyroscopes), which made it possible to steer rockets with high accuracy.[3]

But Goddard was fanatically secretive; he published little. Thus his ideas had relatively little impact during his lifetime. Others who were more extroverted were more influential. However, copies of his early papers and reports reached Germany, where Hermann Oberth wrote prolifically, both for technical and for popular readers. The writings and other public activities of Oberth and his friends stimulated nationwide interest in rocketry and space flight. By 1929, a motion picture on space travel, Frau im Mond (The Girl in the Moon),[4] was produced successfully by Fritz Lang.

With all of this public interest, it is probably no coincidence that Germany became the first country to invest substantial funds in rocket development. But there was also another consideration. Almost every form of military research was forbidden to Germany by the Treaty of Versailles, which concluded the first World War. Rockets, however, were not mentioned in the treaty. Thus the German Army high command was not in violation of the treaty when it authorized rocket studies on December 13, 1930, more than two years before Adolf Hitler came to power. When the rocket program entered the development stage in 1932, a young graduate student at the University of Berlin, Wernher von Braun was hired as its first employee.[5]

Under von Braun's technical direction, the German army group established a rocket test station at Peenemuende on the Baltic Sea and developed a liquid-fueled rocket missile that propelled a 2200-pound warhead above the atmosphere and down again on a ballistic flight of 160 miles, twice the range of "Big Bertha," the longest-range artillery piece of World War I. Hitler's propaganda ministry named the rocket Vengeance (Vergeltung) Weapon Number 2--V-2 for short. Altogether, 1,027 V-2s were launched, mostly against London, in 1944 and 1945.[6] Von Braun and about 100 senior members of the Peenemuende staff fled westward in 1945 in advance of the Red Army and eventually surrendered to American forces in Bavaria. They were brought to the United States late in 1945 in an Army operation called "Paperclip". The Germans were stationed at Fort Bliss, Texas, until April, 1950, when they were moved to Redstone Arsenal, Huntsville, Alabama.[7]

In the United States, meanwhile, a number of organizations were working with rockets for military use. Mostly solid-fueled, they were of various sizes, but none approached that of the V-2. The best-known U. S. rocket of World War II was the bazooka, a recoilless antitank missile weighing 3.4 pounds, fired from a 13.3-pound launcher on an infantryman's shoulder. Also produced by the end of the war were somewhat larger JATO (jet assisted takeoff) rockets that enabled military aircraft to use shorter runways.[8]

After the war, rocket development was accelerated in the United States. The example of the V-2 and its companion, the winged V-1, stimulated work on both air-breathing and ballistic missiles, as well as "sounding" rockets to obtain weather information and scientific data from the upper atmosphere. Rockets were also used to accelerate aircraft models to supersonic speed in outdoor experiments that preceded the availability of supersonic wind tunnels. The studies and experiments were sponsored by the Army, the Navy, the Air Force and the National Advisory Committee for Aeronautics, a federal civilian agency that operated laboratories for aeronautical research in support of the country's military and civil needs.[9]

Meanwhile, interest had been developing in the scientific community for several years, stimulated by the V-2 demonstrations of rocket feasibility. The Briton, Arthur C. Clarke, published in 1945 a paper that proposed the use of satellites for worldwide radio communications.[10] A lecture delivered in June 1946 at the Infantry School, Fort Benning, Georgia, speculated on earth satellites and found its way into the public prints a few months later.[11] Willy Ley, who had participated in the early rocket experiments in Germany in the 1920s and who had emigrated to the United States before World War II, published some technical speculations in December 1949.[12] Rocket and astronautical societies in a number of countries formed an international federation, which beginning in 1950 provided a forum for the discussion of technical questions and potential applications of space flight.[13]

But conservative scientists did not take the rocket's potential very seriously. Accordingly, studies were continued and captured V-2 rockets were flown for research and familiarization with the process. But no authorization was given in the immediate post-war years for the development of larger rockets.

The Armed Services Unification Act of 1947 became a milestone in the development of U. S. policy dealing with the rocket and its implications. In establishing a separate Air Force as a third military service and putting the three services under the single roof of a Department of Defense, this act opened the way toward a more aggressive approach to the development and exploitation of technology for the purposes of national security. However, the implementation of armed services unification was achieved only very slowly, over a long period of time. Coincidentally, this process was just getting under way, with consideration of the legislation by Congressional committees at the time that Premier Stalin was deciding to make the major commitment of Soviet resources to develop rocket technology. Thus some of the causes of the much-debated missile and space "gap" were inherent in the differences between the two systems of government and can be traced to 1947, if not earlier.[14]

The first annual report of the first Secretary of Defense, James Forrestal, said on December 29, 1948, that earth satellite studies and component designs, which had been carried out independently by each military service, were assigned to a Committee on Guided Missiles for coordination. The statement was contained in an appendix prepared by the Executive Secretary of the Research and Development Board.[15]

One source reports that the disclosure "evoked a public outcry at such a wasteful squandering of taxpayers' money," which did not encourage the loosening of military pursestrings for space exploration.[16]

Work on long-range missiles also proceeded slowly. The Air Force engaged a contractor to study rocket capabilities with the idea of developing an intercontinental missile, but cancelled the contract during an economy wave in 1947. The project was revived with limited funding 1951.[17] In May, 1949, however, President Harry S. Truman had approved legislation providing for a test range for guided missiles, which was established at Cape Canaveral, Florida.[18]

The 1949 explosion of the first Soviet atomic bomb and the 1950-53 Korean War sharply intensified concern in the United States about technological leadership and the development of advanced weapons. The response to this concern included the beginning of the development of the thermonuclear (hydrogen) bomb and higher priority for work on both air-cruising and ballistic missiles. In the final years of the Truman Administration, a high-level study effort, Project Lincoln, reported that the Soviets were threatening to draw ahead of the United States in development and perhaps production of advanced weapons. This report and related papers were before the President for action when Dwight D. Eisenhower assumed office in January, 1953.[19]

But in the transition to a new Administration, more than a year was to pass before a program was developed to deal with this problem. On February 1, 1954, a special scientific committee headed by Dr. John von Neumann recommended the development of an inter-continental ballistic missile (ICBM) that would carry a nuclear warhead. The technical question that had caused the most difficulty was the weight of the nuclear warhead, since it was calculated that about 200 pounds of launching weight would be required for each pound of warhead delivered to a target several thousand miles away. The first atomic warheads weighed 9,000 pounds. Evidently it was considered that the development of a rocket large enough for this task would be too difficult or too expensive.

But the von Neumann group reported that a major breakthrough in reducing the size of missile warheads had resulted from the research of the Atomic Energy Commission. Consequently, acceleration of the ICBM program was authorized and it was expanding rapidly by 1955. In May, 1955, these findings were confirmed by bomb tests in the Pacific. Funding for the year ended June 30, 1955, was $161 million, more than ten times that of the previous year.

In February, 1955, another scientific committee, headed by Dr. James R. Killian, recommended the development of an intermediate range ballistic missile (IRBM) with a range of 1,500 miles. In the summer of 1955, the ICBM program was assigned the highest national priority and by the following December this highest priority was broadened to cover two ICBMs, the Atlas and the Titan, and two IRBMs, the Jupiter and the Thor. Atlas, Titan, and Thor were developed by the Air Force; Jupiter by the Army. Also in 1955, the Navy was authorized to develop the Polaris missile for launching from a nuclear submarine while under the surface of the ocean.[20]

Soviet Activity -- Like other great powers, the Soviet Union had sponsored rocket research for possible military use before and during World War II. When the Red Army overran Peenemuende in 1945, it captured V-2 rockets, production facilities, and several hundred persons who had been engaged in the V-2 program. But the Soviets did not capture any of the leading V-2 engineers or administrators.

Stalin was quite annoyed. "This is intolerable," he is reported to have said to Colonel-General I.A. Serov on one occasion. "We defeated Nazi armies; we occupied Berlin and Peenemuende; but the Americans got the rocket engineers. What could be more revolting and more inexcusable?"

The Soviets worked with the people and information they did capture and learned to produce the V-2 in fairly short order. In September 1949, Soviet rocket engineers began the production of an improved V-2, which they called Pobeda, with a maximum range of about 550 miles and a fairly reliable guidance system.[21]

Chief among the Soviet engineers was Sergei P. Korolev (1906-66), who had been engaged in rocket work since the formation of a group in the early 1930's under the inspiration of Tsiolkovsky. Korolev became a corresponding member of the Soviet Academy of Sciences in 1953. His association with the rocket program was announced by the Soviet government only after his death. Others whose participation traced to the early 1930s were Valentin P. Glushko and L. S. Dushkin. Younger leaders included Yu A. Pobedonostsev, I. A. Merkulov and A. H. Lyul'ko.[22]

The T-2, a 1,500-mile-range Soviet ballistic missile, reached the flight-test stage in the middle 1950s. The development of the first Soviet intercontinental ballistic missile, the T-3, was under way but it had not yet reached flight test. Apparently the Soviets did not delay this work until the weight of the nuclear warhead could be reduced. Instead, they worked on a larger rocket--an action that was to stand them in good stead when it was used for space exploration.[23]

NOTES TO APPENDIX B-I-1

1. Willy Ley, Rockets, Missiles and Space Travel, (second revised edition, Viking, 1961) pp. 50-51. Another writer, however, believes the rocket was invented much earlier, perhaps before the Christian Era. See C. N. Hickman, "Rockets," in Encyclopedia Brittannica (1955 edition) Vol. 19, pp. 366-68).

2. Hickman, op. cit.

3. Milton Lehman, This High Man (Farrar, Strauss, 1963) is the definitive biography of Goddard. Also see Eugene M. Emme, "Yesterday's Dream...Today's Reality," The Aerospace Historian, October 1960, pp. 217-21.

4. Ley, op. cit., p. 124. On p. 284 (footnote) Ley reports that the countdown, the reverse count of the final seconds before a rocket launch, was originated by Lang as a dramatic device for the film Frau im Mond.

5. Erik Bergaust, Reaching for the Stars (Doubleday, 1960). Despite its evident limitations, this is an authoritative account of von Braun's early life and career in Germany.

6. Ley, op. cit., pp. 197-237.

7. David Akens, Historical Origins of Marshall Space Flight Center (NASA Marshall Space Flight Center, 1960) pp. 24-28.

8. Hickman, op. cit.

9. Emme, Aeronautics and Astronautics, pp. 50, 61.

10. Arthur C. Clarke, Wireless World, October 1945. See also letter to the editor, Wireless World, February 1945, p. 58.

11. Ley, op. cit., p. 328.

12. Willy Ley, "The Satellite Rocket," The Technology Review, Massachusetts Institute of Technology, Vol. 52, No. 2, December 1949, p. 93.

13. Notable papers at early meetings of the federation included "Minimum Satellite Vehicles" by K. W. Gatland, A. M. Kunesch and A. E. Dixon of the British Interplanetary Society at the London meeting in 1951 and "A Minimum Orbital Unmanned Satellite of the Earth (MOUSE)" by S. Fred Singer of the United States at the Zurich meeting in 1953.

14. See James E. Webb, Reflections on Government Service: I. Doctrine and Practice in Large Scale Endeavors, Lecture at the Graduate School of Business, Columbia University, May 2, 1968, for a commentary on the approach to government organization followed in the immediate postwar period.

15. National Military Establishment, First Report of the Secretary of Defense, 1948, p. 129.

16. Constance M. Green and Milton Lomask, Vanguard, A History, (in press) Chapter I.

17. John L. Chapman, Atlas: The Story of a Missile (Harper, 1960), pp. 25-35.

18. Emme, op. cit., p. 62.

19. Joseph and Stewart Alsop, The Reporter's Trade, (Reynal & Co., 1958), pp. 59-63, 197-200. The existence of the Lincoln Report was first disclosed by the Alsops in their syndicated newspaper column on May 5, 1953. Former President Harry S. Truman did not discuss rockets or missiles in his two-volume memoirs, published by Doubleday in 1955 and 1956.

20. Dwight D. Eisenhower, Mandate for Change (Doubleday, 1963), pp. 455-58; Waging Peace, Doubleday, 1965, pp. 206-08. Also Chapman, op. cit., pp. 62-77. G. A. Tokaty, "Soviet Rocket Technology," in Eugene M. Emme (ed.) The History of Rocket Technology, (Wayne University Press, 1964) pp. 280-81.

21. Tokaty, op. cit., pp. 275-78.

22. Reliable documentation for this stage of Soviet missile development is sparse in the open literature. Tokaty fled the Soviet Union in late 1947. Thus his information on the subsequent period is only sketchy. The careful scholar can peruse the U. S. trade magazines, keeping in mind that much of what was printed was self-serving and therefore suspect. See also the Senate Space Committee report, Soviet Space Programs: Organization, Plans, Goals and International Implications, May 31, 1962, and Ley, op. cit., pp. 49-91.

STATEMENT BY THE PRESIDENT OF THE UNITED STATES; SCIENCE ADVISORY COMMITTEE: INTRODUCTION TO OUTER SPACE

THE WHITE HOUSE, *March 26, 1958.*

STATEMENT BY THE PRESIDENT

In connection with a study of space science and technology made at my request, the President's Science Advisory Committee, of which Dr. James R. Killian is Chairman, has prepared a brief introduction to outer space for the nontechnical reader. This is not science fiction. This is a sober, realistic presentation prepared by leading scientists.

I have found this statement so informative and interesting that I wish to share it with all the people of America and, indeed, with all the people of the earth. I hope that it can be widely disseminated by all news mediums, for it clarifies many aspects of space and space technology in a way which can be helpful to all people as the United States proceeds with its peaceful program in space science and exploration. Every person has the opportunity to share, through understanding, in the adventures which lie ahead.

This statement of the Science Advisory Committee makes clear the opportunities which a developing space technology can provide to extend man's knowledge of the earth, the solar system, and the universe. These opportunities reinforce my conviction that we and other nations have a great responsibility to promote the peaceful use of space and to utilize the new knowledge obtainable from space science and technology for the benefit of all mankind.

INTRODUCTION TO OUTER SPACE

An explanatory statement prepared by the President's Science Advisory Committee

What are the principal reasons for undertaking a national space program? What can we expect to gain from space science and exploration? What are the scientific laws and facts and the technological means which it would be helpful to know and understand in reaching sound policy decisions for a United States space program and its management by the Federal Government? This statement seeks to provide brief and introductory answers to these questions.

It is useful to distinguish among four factors which give importance, urgency, and inevitability to the advancement of space technology.

The first of these factors is the compelling urge of man to explore and to discover, the thrust of curiosity that leads men to try to go where no one has gone before. Most of the surface of the earth has now been explored, and men now turn to the exploration of outer space as their next objective.

Second, there is the defense objective for the development of space technology. We wish to be sure that space is not used to endanger our security. If space is to be used for military purposes, we must be prepared to use space to defend ourselves.

Third, there is the factor of national prestige. To be strong and bold in space technology will enhance the prestige of the United States among the peoples of the world and create added confidence in our scientific, technological, industrial, and military strength.

Fourth, space technology affords new opportunities for scientific observation and experiment which will add to our knowledge and understanding of the earth, the solar system, and the universe.

The determination of what our space program should be must take into consideration all four of these objectives. While this statement deals mainly with the use of space for scientific inquiry, we fully recognize the importance of the other three objectives.

In fact, it has been the military quest for ultra-long-range rockets that has provided man with new machinery so powerful that it can readily put satellites in orbit, and, before long, send instruments out to explore the moon and nearby planets. In this way, what was at first a purely military enterprise has opened up an exciting era of exploration that few men, even a decade ago, dreamed would come in this century.

Why satellites stay up

The basic laws governing satellites and space flight are fascinating in their own right. And, while they have been well known to scientists ever since Newton, they may still seem a little puzzling and unreal to many of us. Our children, however, will understand them quite well.

We all know that the harder you throw a stone the farther it will travel before falling to earth. If you could imagine your strength so fantastically multiplied that you could throw a stone at a speed of 15,000 miles per hour, it would travel a great distance. It would, in fact, easily cross the Atlantic Ocean before the earth's gravity pulled it down. Now, imagine being able to throw the stone just a little faster, say about 18,000 miles per hour; what would happen then?

The stone would again cross the ocean, but this time it would travel much farther than it did before. It would travel so far that it would overshoot the earth, so to speak, and keep falling until it was back where it started. Since, in this imaginary example, there is no atmospheric resistance to slow the stone down, it would still be traveling at its original speed, 18,000 miles per hour, when it had got back to its starting point. So, around the earth it goes again. From the stone's point of view, it is continuously falling, except that its very slight downward arc exactly matches the curvature of the earth, and so it stays aloft, or, as the scientist would say, "in orbit," indefinitely.

Since the earth has an atmosphere, of course, neither stones nor satellites can be sent whizzing around the earth at treetop level. Satellites must first be lifted beyond the reach of atmospheric resistance. It is absence of atmospheric resistance, plus speed, that makes the satellite possible. It may seem odd that weight or mass has nothing to do with a satellite's orbit. If a feather were released from a 10-ton satellite, the 2 would stay together, following the same path in the airless void. There is, however, a slight vestige of atmosphere even a few hundred miles above the earth, and its resistance will cause the feather to spiral inward toward the earth sooner than the satellite. It is atmospheric resistance, however slight, that has set limits on the life of all satellites launched to date. Beyond a few hundred miles the remaining trace of atmosphere fades away so rapidly that tomorrow's satellites should stay aloft thousands of years, and perhaps indefinitely. The higher the satellite, incidentally, the less speed it needs to stay in orbit once it gets there (thus the moon's speed is only a little more than 2,000 miles per hour), but to launch a satellite toward a more distant orbit requires a higher initial speed and greater expenditure of energy.

The thrust into space

Rocket engineers rate rockets not in horsepower, but in thrust. Thrust is just another name for push, and it is expressed in pounds of force. The rocket gets its thrust or push by exhausting material backward. It is this thrust that lifts the rocket off the earth and accelerates it, making it move faster and faster.

As everyone knows, it is more difficult to accelerate an automobile than a baby carriage. To place satellites weighing 1,000 to 2,000 pounds in orbit requires a first-stage rocket engine or engines having a thrust in the neighborhood of 200,000 to 400,000 pounds. Rocket engines able to supply this thrust have been under development for some time. For launching a satellite, or other space vehicle, the rocket engineer divides his rockets into 2, 3, or more stages, which can be dropped one after the other in flight, thus reducing the total weight that must be accelerated to the final velocity desired. (In other words, it is a great waste of energy to lift one huge fuel tank into orbit when the tank can be divided into smaller tanks—each packaged in its own stage with its own rocket motor—that can be left behind as they become empty.)

To launch some of the present satellites has required rockets weighing up to 1,000 times the weight of the satellite itself. But it will be possible to reduce takeoff weights until they are only 50 to 100 times that of the satellite. The rocket's high ratio of gross weight to payload follows from a fundamental limitation in the exhaust velocities that can be achieved by chemical propellents.

If we want to send up not a satellite but a device that will reach the moon, we need a larger rocket relative to its payload in order that the final stage can be accelerated to about 25,000 miles per hour. This speed, called the escape velocity, is the speed with which a projectile must be thrown to escape altogether from the gravitational pull of the earth. If a rocket fired at the moon is to use as little fuel as possible, it must attain the escape velocity very near the beginning of its trip. After this peak speed is reached, the rocket will be gradually slowed by the earth's pull, but it will still move fast enough to reach the moon in 2 or 3 days.

The moon as a goal

Moon exploration will involve three distinct levels of difficulty. The first would be a simple shot at the moon, ending either in a hard landing or a circling of the moon. Next in difficulty would be a soft landing. And most difficult of all would be a soft landing followed by a safe return to earth.

The payload for a simple moon shot might be a small instrument carrier similar to a satellite. For the more difficult soft landing, the carrier would have to include, as part of its payload, a "retrorocket" (a decelerating rocket) to provide braking action, since the moon has no atmosphere that could serve as a cushion.

To carry out the most difficult feat, a round trip to the moon, will require that the initial payload include not only retrorockets but rockets to take off again from the moon. Equipment will also be required aboard to get the payload through the atmosphere and safely back to earth. To land a man on the moon and get him home safely again will require a very big rocket engine, indeed—one with a thrust in the neighborhood of 1 million or 2 million pounds. While nuclear power may prove superior to chemical fuels in engines of multi-million-pound thrust, even the atom will provide no shortcut to space exploration.

Sending a small instrument carrier to Mars, although not requiring much more initial propulsion than a simple moon shot, would take a much longer travel time (8 months or more), and the problems of navigation and final guidance are formidable.

A message from Mars

Fortunately, the exploration of the moon and nearby planets need not be held up for lack of rocket engines big enough to send men and instrument carriers out into space and home again. Much that scientists wish to learn from satellites and space voyages into the solar system can be gathered by instruments and transmitted back to earth. This transmission, it turns out, is relatively easy with today's rugged and tiny electronic equipment.

For example, a transmitter with a power of just 1 or 2 watts can easily radio information from the moon to the earth. And messages from Mars, on the average some 50 million to 100 million miles away at the time the rocket would arrive, can be transmitted to earth with less power than that used by most commercial broadcasting stations. In some ways, indeed, it appears that it will be easier to send a clear radio message between Mars and Earth than between New York and Tokyo.

This all leads up to an important point about space exploration. The cost of transporting men and material through space will be extremely high, but the cost and difficulty of sending information through space will be comparatively low.

Will the results justify the costs?

Since the rocket powerplants for space exploration are already in existence or being developed for military need, the cost of additional scientific research, using these rockets, need not be exorbitant. Still, the cost will not be small, either. This raises an important question that scientists and the general public (which will pay the bill) both must face: Since there are still so many unanswered scientific questions and problems all around us on earth, why should we start asking new questions and seeking out new problems in space? How can the results possibly justify the cost?

Scientific research, of course, has never been amenable to rigorous cost accounting in advance. Nor, for that matter, has exploration of any sort. But if we have learned one lesson, it is that research and exploration have a remarkable way of paying off—quite apart from the fact that they demonstrate that man is alive and insatiably curious. And we all feel richer for knowing what explorers and scientists have learned about the universe in which we live.

It is in these terms that we must measure the value of launching satellites and sending rockets into space. These ventures may have practical utility, some of which will be noted later. But the scientific questions come first.

The view from a satellite

Here are some of the things that scientists say can be done with the new satellites and other space mechanisms. A satellite in orbit can do three things: (1) It can sample the strange new environment through which it moves; (2) it can look down and see the earth as it has never been seen before; and (3) it can look out into the universe and record information that can never reach the earth's surface because of the intervening atmosphere.

The satellite's immediate environment at the edge of space is empty only by earthly standards. Actually, empty space is rich in energy, radiation, and fast-moving particles of great variety. Here we will be exploring the active medium, a kind of electrified plasma, dominated by the sun, through which our earth moves. Scientists have indirect evidence that there are vast systems of magnetic fields and electric currents that are connected somehow with the outward flow of charged material from the sun. These fields and currents the satellites will be able to measure for the first time. Also, for the first time, the satellites will give us a detailed three-dimensional picture of the earth's gravity and its magnetic field.

Physicists are anxious to run one crucial and fairly simple gravity experiment as soon as possible. This experiment will test an important prediction made by Einstein's general theory of relativity, namely, that a clock will run faster as the gravitational field around it is reduced. If one of the fantastically accurate clocks, using atomic frequencies, were placed in a satellite and should run faster than its counterpart on earth, another of Einstein's great and daring predictions would be confirmed. (This is not the same as the prediction that any moving clock will appear to a stationary observer to lose time—a prediction that physicists already regard as well confirmed.)

There are also some special questions about cosmic rays which can be settled only by detecting the rays before they shatter themselves against the earth's atmosphere. And, of course, animals carried in satellites will begin to answer the question: What is the effect of weightlessness on physiological and psychological functions? (Gravity is not felt inside a satellite because the earth's pull is precisely balanced by centrifugal force. This is just another way of saying that bodies inside a satellite behave exactly as they would inside a freely falling elevator.)

The satellite that will turn its attention downward holds great promise for meteorology and the eventual improvement of weather forecasting. Present weather stations on land and sea can keep only about 10 percent of the atmosphere under surveillance. Two or three weather satellites could make a cloud inventory of the whole globe every few hours. From this inventory, meteorologists believe they could spot large storms (including hurricanes) in their early stages and chart their direction of movement with much more accuracy than at present. Other instruments in the satellites will measure for the first time how much solar energy is falling upon the earth's atmosphere and how much is reflected and radiated back into space by clouds, oceans, the continents, and by the great polar icefields.

It is not generally appreciated that the earth has to send back into space, over the long run, exactly as much heat energy as it receives from the sun. If this were not so, the earth would either heat up or cool off. But there is an excess of income over outgo in the tropical regions, and an excess of outgo over income in the polar regions. This imbalance has to be continuously rectified by the activity of the earth's atmosphere which we call weather.

By looking at the atmosphere from the outside, satellites will provide the first real accounting of the energy imbalances, and their consequent tensions, all around the globe. With the insight gained from such studies, meteorologists hope they may improve long-range forecasting of world weather trends.

Finally, there are the satellites that will look not just around or down, but out into space. Carrying ordinary telescopes, as well as special instruments for recording X-rays, ultraviolet, and other radiations, these satellites cannot fail to reveal new sights forever hidden from observers who are bound to the earth. What these sights will be, no one can tell. But scientists know that a large part of all stellar radiation lies in the ultraviolet region of the spectrum, and this is totally blocked by the earth's atmosphere. Also blocked are other very long wavelengths of light of the kind usually referred to as radio waves. Some of these get through the so-called radio window in the atmosphere and can be detected by radio telescopes, but scientists would like a look at the still longer waves that cannot penetrate to earth.

Even those light signals that now reach the earth can be recorded with brilliant new clarity by satellite telescopes. All existing photographs of the moon and nearby planets are smeared by the same turbulence of the atmosphere that makes the stars twinkle. Up above the atmosphere the twinkling will stop, and we should be able to see for the first time what Mars really looks like. And we shall want a really sharp view before launching the first rocket to Mars.

A closeup of the moon

While these satellite observations are in progress, other rockets will be striking out for the moon with other kinds of instruments. Photographs of the back or hidden side of the moon may prove quite unexciting, or they may reveal some spectucular new feature now unguessed. Of greater scientific interest is the question whether or not the moon has a magentic field. Since no one knows for sure why the earth has such a field, the presence or absence of one on the moon should throw some light on the mystery.

But what scientists would most like to learn from a closeup study of the moon is something of its origin and history. Was it originally molten? Does it now have a fluid core, similar to the earth's? And just what is the nature of the lunar surface? The answer to these and many other questions should shed light, directly or indirectly, on the origin and history of the earth and the surrounding solar system.

While the moon is believed to be devoid of life, even the simplest and most primitive, this cannot be taken for granted. Some scientists have suggested that small particles with the properties of life—germs or spores—could exist in space and could have drifted onto the moon. If we are to test this intriguing hypothesis we must be careful not to contaminate the moon's surface, in the biological sense, beforehand.

There are strong scientific reasons, too, for avoiding radioactive contamination of the moon until its naturally acquired radioactivity can be measured.

** * * and on to Mars*

The nearest planets to earth are Mars and Venus. We know quite enough about Mars to suspect that it may support some form of life. To land instrument carriers on Mars and Venus will be easier, in one respect, than achieving a "soft" landing on the moon. The reason is that both planets have atmospheres that can be used to cushion the final approach. These atmospheres might also be used to support balloons equipped to carry out both meteorological soundings and a general photo survey of surface features. The Venusian atmosphere, of course, consists of what appears to be a dense layer of clouds so that its surface has never been seen at all from earth.

Remotely controlled scientific expeditions to the moon and nearby planets could absorb the energies of scientists for many decades. Since man is such an adventurous creature, there will undoubtedly come a time when he can no longer resist going out and seeing for himself. It would be foolish to try to predict today just when this moment will arrive. It might not arrive in this century, or it might come within 1 or 2 decades. So much will depend on how rapidly we want to expand and accelerate our program. According to one rough estimate it might require a total investment of about a couple of billion dollars, spent over a number of years to equip ourselves to land a man on the moon and to return him safely to earth.

The satellite radio network

Meanwhile, back at earth, satellites will be entering into the everyday affairs of men. Not only will they be aiding the meteorologists, but they could surely—and rather quickly—be pressed into service for expanding worldwide communications, including intercontinental television.

At present all transoceanic communication is by cable (which is costly to install) or by shortwave radio (which is easily disrupted by solar storms). Television cannot practically be beamed more than a few hundred miles because the wavelengths needed to carry it will not bend around the earth and will not bounce off the region of the atmosphere known as the ionosphere. To solve this knotty problem, satellites may be the thing, for they can serve as high-flying radio relay stations. Several suitably equipped and properly spaced satellites would be able to receive TV signals from any point on the globe and to relay them directly—or perhaps via a second satellite—to any other point. Powered with solar batteries, these relay stations in space should be able to keep working for many years.

Military applications of space technology

The development of military rockets has provided the technological base for space exploration. It will probably continue to do so, because of the commanding military importance of the ballistic missile. The subject of ballistic missiles lies outside our present discussion. We ask instead, putting missiles aside, what other military applications of space technology can we see ahead?

There are important, foreseeable, military uses for space vehicles. These lie, broadly speaking, in the fields of communication and reconnaissance. To this we could add meteorology, for the possible advances in meteorological science which have already been described would have military implications. The use of satellites for radio relay links has also been described, and it does not take much imagination to foresee uses of such techniques in long-range military operations.

The reconnaissance capabilities of a satellite are due, of course, to its position high above the earth and the fact that its orbit carries it in a predictable way over much of the globe. Its disadvantage is its necessarily great distance, 200 miles or more, from the surface. A highly magnifying camera or telescope is needed to picture the earth's surface in even moderate detail. To the human eye, from 200 miles away, a football stadium would be a barely distinguishable speck. A telescopic camera can do a good deal better, depending on its size and complexity. It is certainly feasible to obtain reconnaissance information with a fairly elaborate instrument, information which could be relayed back to the earth by radio.

Much has been written about space as a future theater of war, raising such suggestions as satellite bombers, military bases on the moon, and so on. For the most part, even the more sober proposals do not hold up well on close examination or appear to be achievable at an early date. Granted that they will become technologically possible, most of these schemes, nevertheless, appear to be clumsy and ineffective ways of doing a job. Take one example, the satellite as a bomb carrier. A satellite cannot simply drop a bomb. An object released from a satellite doesn't fall. So there is no special advantage in being over the target. Indeed, the only way to "drop" a bomb directly down from a satellite is to carry out aboard the satellite a rocket launching of the magnitude required for an intercontinental missile. A better scheme is to give the weapon to be launched from the satellite a small push, after which it will spiral in gradually. But that means launching it from a moving platform halfway around the world, with every disadvantage compared to a missile base on the ground. In short, the earth would appear to be, after all, the best weapons carrier.

This is only one example; each idea has to be judged on its own merits. There may well be important military applications for space vehicles which we cannot now foresee, and developments in space technology which open up quite novel possibilities. The history of science and technology reminds us sharply of the limitations of our vision. Our road to future strength is the achievement of scientific insight and technical skill by vigorous participation in these new explorations. In this setting, our appropriate military strength will grow naturally and surely.

A space timetable

Thus we see that satellites and space vehicles can carry out a great variety of scientific missions, and a number of military ones as well.

Indeed, the scientific opportunities are so numerous and so inviting that scientists from many countries will certainly want to participate. Perhaps the International Geophysical Year will suggest a model for the international exploration of space in the years and decades to come.

The timetable on the following page suggests the approximate order in which some of the scientific and technical objectives mentioned in this review may be attained.

The timetable is not broken down into years, since there is yet too much uncertainty about the scale of the effort that will be made. The timetable simply lists various types of space investigations and goals under three broad headings: "Early," "Later," "Still Later."

Scientific objectives

Early	Later	Still later
1. Physics	1. Astronomy	1. Automated lunar exploration.
2. Geophysics	2. Extensive communications	2. Automated planetary exploration.
3. Meteorology	3. Biology	3. Human lunar exploration and return.
4. Minimal Moon contract	4. Scientific lunar investigation	And much later still:
5. Experimental communications.	5. Minimal planetary contact	Human planetary exploration.
6. Space physiology	6. Human flight in orbit	

In conclusion, we venture two observations. Research in outer space affords new opportunities in science, but it does not diminish the importance of science on earth. Many of the secrets of the universe will be fathomed in laboratories on earth, and the progress of our science and technology and the welfare of the Nation require that our regular scientific programs go forward without loss of pace, in fact at an increased pace. It would not be in the national interest to exploit space science at the cost of weakening our efforts in other scientific endeavors. This need not happen if we plan our national program for space science and technology as part of a balanced national effort in all science and technology.

Our second observation is prompted by technical considerations. For the present, the rocketry and other equipment used in space technology must usually be employed at the very limit of its capacity. This means that failures of equipment and uncertainities of schedule are to be expected. It therefore appears wise to be cautious and modest in our predictions and pronouncements about future space activities—and quietly bold in our execution.

Dr. James R. Killian, Jr., *Chairman.*
Dr. Robert F. Bacher.
Dr. William O. Baker.
Dr. Lloyd V. Berkner.
Dr. Hans A. Bethe.
Dr. Detlev W. Bronk.
Dr. James H. Doolittle.
Dr. James B. Fisk.
Dr. Caryl P. Haskins.
Dr. George B. Kistiakowsky.
Dr. Edwin H. Land.
Dr. Edward M. Purcell.
Dr. Isidor I. Rabi.
Dr. H. P. Robertson.
Dr. Paul A. Weiss.
Dr. Jerome B. Wiesner.
Dr. Herbert York.
Dr. Jerrold R. Zacharias.

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March 27, 1958, pp. 45-53.

B-I-3

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II. BASIC LEGISLATION

(a) National Aeronautics and Space Act of 1958, as Amended

AN ACT To provide for research into problems of flight within and outside the earth's atmosphere, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Public Law 85-568, 85th Congress, H.R. 12575, July 29, 1958, 72 Stat. 426.

TITLE I—SHORT TITLE, DECLARATION OF POLICY, AND DEFINITIONS

SHORT TITLE

SEC. 101. This Act may be cited as the "National Aeronautics and Space Act of 1958".

DECLARATION OF POLICY AND PURPOSE

42 U.S.C. 2451

SEC. 102. (a) The Congress hereby declares 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.

(b) The Congress declares that the general welfare and security of the United States require that adequate provision be made for aeronautical and space activities. The Congress further declares that such activities shall be the responsibility of, and shall be directed by, a civilian agency exercising control over aeronautical and space activities sponsored by the United States, except that activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States (including the research and development necessary to make effective provision for the defense of the United States) shall be the responsibility of, and shall be directd by, the Department of Defense; and that determination as to which such agency has responsibility for and direction of any such activity shall be made by the President in conformity with section 201(e).

(c) The aeronautical and space activities of the United States shall be conducted so as to contribute materially to one or more of the following objectives:

(1) The expansion of human knowledge of phenomena in the atmosphere and space;

(2) The improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical and space vehicles;

(3) The development and operation of vehicles capable of carrying instruments, equipment, supplies, and living organisms through space;

(4) The establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes;

(5) The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere;

(6) The making available to agencies directly concerned with national defense of discoveries that have military value or significance, and the furnishing by such agencies, to the civilian agency established to direct and control nonmilitary aeronautical and space activities, of information as to discoveries which have value or significance to that agency;

(7) Cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof; and

(8) The most effective utilization of the scientific and engineering resources of the United States, with close cooperation among all interested agencies of the United States in order to avoid unnecessary duplication of effort, facilities, and equipment.

(d) It is the purpose of this Act to carry out and effectuate the policies declared in subsections (a), (b), and (c).

DEFINITIONS

42 U.S.C. 2452.

SEC. 103. As used in this Act—

(1) the term "aeronautical and space activities" means (A) research into, and the solution of, problems of flight within and outside the earth's atmosphere, (B) the development, construction, testing, and operation for research purposes of aeronautical and space vehicles, and (C) such other activities as may be required for the exploration of space; and

(2) the term "aeronautical and space vehicles" means aircraft, missiles, satellites, and other space vehicles, manned and unmanned, together with related equipment, devices, components, and parts.

42 U.S.C. 2471. Establishment; membership.

TITLE II—COORDINATION OF AERONAUTICAL AND SPACE ACTIVITIES

NATIONAL AERONAUTICS AND SPACE COUNCIL

SEC. 201 [1] (a) There is hereby established, in the Exec-

[1] Subsecs. (a), (b), (c), (d), and (e) of sec. 201 of the National Aeronautics and Space Act of 1958 (72 Stat. 427; 42 U.S.C. 2471) were amended April 25, 1961, by Public Law 87-26 (75 Stat. 46) to place the National Aeronautics and Space Council within the Executive Office of the President; to remove the President from the Council and from the chairmanship thereof and replace him with the Vice President; to provide that the Council shall be composed of the members designated above; to remove from the Council the additional Government member and the three private scientific members appointed by the President under the previous law; to authorize the President to designate other Council members to act as Chairman when the Vice President is absent or otherwise unavailable; to enlarge the role of the Council by removing the language which made it the specific duty of the President to formulate the national space

program and to add language requiring the Council to advise and assist the President in the "performance of functions in the aeronautics and space field"; and to broaden the duty of the Council to provide for cooperation between the National Aeronautics and Space Administration and the Department of Defense to include cooperation "among all departments and agencies of the United States engaged in aeronautical and space activities". Subsection (g) of sec. 201 authorizing per diem compensation to members of the Council appointed from private life was repealed by Public Law 87–26 (75 Stat. 47).

utive Office of the President, the National Aeronautics and Space Council (hereinafter called the "Council") which shall be composed of—

(1) the Vice President, who shall be Chairman of the Council;

(2) the Secretary of State;

(3) the Secretary of Defense;

(4) the Administrator of the National Aeronautics and Space Administration; and

(5) the Chairman of the Atomic Energy Commission.

Alternate presiding officer. (b) The President shall from time to time designate one of the members of the Council to preside over meetings of the Council during the absence, disability, or unavailability of the Chairman.

Alternate members. (c) Each member of the Council may designate another officer of his department or agency to serve on the Council as his alternate in his unavoidable absence.

(d) Each alternate member designated under subsection (c) of this section shall be designated to serve as such by and with the advice and consent of the Senate unless at the time of his designation he holds an office in the Federal Government to which he was appointted by and with the advice and consent of the Senate.

Functions. (e) It shall be the function of the Council to advise and assist the President, as he may request, with respect to the performance of functions in the aeronautics and space field, including the following functions:

(1) survey all significant aeronautical and space activities, including the policies, plans, programs, and accomplishments of all departments and agencies of the United States engaged in such activities;

(2) develop a comprehensive program of aeronautical and space activities to be conducted by departments and agencies of the United States;

(3) designate and fix responsibility for the direction of major aeronautical and space activities;

(4) provide for effective cooperation among all departments and agencies of the United States engaged in aeronautical and space activities, and specify, in any case in which primary responsibility for any category of aeronautical and space activities has been assigned to any department or agency, which of those activities may be carried on concurrently by other departments or agencies; and

(5) resolve differences arising among departments and agencies of the United States with respect to aeronautical and space activities under this Act, including differences as to whether a particular project is an aeronautical and space activity.

Executive secretary. Appointment and compensation of staff.

(f) The Council may employ a staff to be headed by a civilian executive secretary who shall be appointed by the President by and with the advice and consent of the Senate.[2] The executive secretary, subject to the direction of the Council, is authorized to appoint and fix the compensation of such personnel, including not more than seven[3] persons who may be appointed without regard to the civil service laws or the Classification Act of 1949 and compensated at not to exceed the highest rate of grade 18 of the General Schedule of the Classification Act of 1949, as amended,[4] as may be necessary to perform such duties as may be prescribed by the Council in connection with the performance of its functions.

Security check.

Each appointment under the subsection shall be subject to the same security requirements as those established for personnel of the National Aeronautics and Space Administration appointed under section 203(b)(2) of this Act. Other provisions of law or regulations relating to Government employment (except those relating to pay and retirement) shall apply to council employees reporting directly to the chairman to the extent that such provisions are applicable to employees in the office of the Vice President.[5]

[(g)] Repealed.[6]

[2] Sec. 201(f), 72 Stat. 428, was amended August 14, 1964, by the Federal Executive Salary Act of 1964, Public Law 88-426, title III, sec. 305(13)(A) (78 Stat. 423), which repealed the provision fixing the compensation of the Executive Secretary at the rate of $20,000 a year. In its place, Public Law 88-426 (sec. 304(b), 78 Stat. 422), amended 3 U.S.C. 105 to authorize the President to fix the compensation of the executive secretary at a rate of basic compensation not to exceed that of level II ($30,000) of the Federal Executive Salary Schedule ~~5 U.S.C., Government Organization and Employees, Public Law 89-554, September 6, 1966, codified this provision as 5 U.S.C. 581 [illegible]~~.

was passed

Level II of the Executive Salary schedule has been codified as 5 U.S.C. 5313.

[3] The number of such persons to be appointed by the executive secretary was increased from three to seven by Public Law 87-367, title II, sec. 207, October 4, 1961 (75 Stat. 792).

[4] Sec. 201(f) was further amended by sec. 306(e) of Public Law 88-426 (78 Stat. 428), which repealed the provision fixing the compensation of the seven persons appointed thereunder at not more than $19,000 a year and inserted in its place the provision for compensation at not to exceed the highest rate of GS 18.

[5] Final sentence of sec. 201(f) added August 14, 1962, by Public Law 87-584, sec. 7 (76 Stat. 385).

[6] Public Law 87-26, sec. 1(b), April 25, 1961 (75 Stat. 47) repealed sec. 201(g), 72 Stat. 429, which had provided for per diem compensation to the members appointed from private life.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

42 U.S.C. 2472. Establishment; Administrator.

SEC. 202.[7] (a) There is hereby established the National Aeronautics and Space Administration (hereinafter called the "Administration"). The Administration shall be headed by an Administrator, who shall be appointed from civilian life by the President by and with the advice and consent of the Senate. Under the supervision and direction of the President, the Administrator shall be responsible for the exercise of all powers and the discharge of all duties of the Administration, and shall have authority and control over all personnel and activities thereof.

Deputy Administrator.

(b) There shall be in the Administration a Deputy Administrator, who shall be appointed from civilian life by the President by and with the advice and consent of the Senate and shall perform such duties and exercise such powers as the Administrator may prescribe. The Deputy Administrator shall act for, and exercise the powers of, the Administrator during his absence or disability.

Restriction.

(c) The Administrator and the Deputy Administrator shall not engage in any other business, vocation, or employment while serving as such.

[7] The Federal Executive Salary Act of 1964, supra (sec. 305(12), 78 Stat. 423), repealed the language in sec. 202, 72 Stat. 429, fixing the compensation of the Administrator and Deputy Administrator at per annum rates of $22,500 and $21,500, respectively. In lieu thereof, the positions of Administrator and Deputy Administrator were placed in level II ($30,000) and level III ($28,500), respectively, of the Federal Executive Salary Schedule by sec. 303 of that Act (78 Stat. 416, 5 U.S.C. 2211). In addition, sec. 303 places seven other NASA positions in designated levels of the Federal Executive Salary Schedule. (See appendix A hereto.) Title 5, U.S.C., Government Organization and Employees, Public Law 89-554, September 6, 1966, codified The Federal Executive Salary Schedule as 5 U.S.C. 5311. (See Part III.)

per attachment

FUNCTIONS OF THE ADMINISTRATION

42 U.S.C. 2473. Functions.

SEC. 203. (a) The Administration, in order to carry out the purpose of this Act, shall—

(1) plan, direct, and conduct aeronautical and space activities;

(2) arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautical and space vehicles, and conduct or arrange for the conduct of such measurements and observations; and

(3) provide for the widest ~~practical~~ practicable and appropriate dissemination of information concerning its activities and the results thereof.

(b) In the performance of its functions the Administration is authorized—

Rules and regulations.

(1) to make, promulgate, issue, rescind, and amend rules and regulations governing the manner of its operations and the exercise of the powers vested in it by law;

Employees: appointment and compensation.

(2) to appoint and fix the compensation of such officers and employees as may be necessary to carry out such functions. Such officers and employees shall be appointed in accordance with the civil-service laws and their compensation fixed in accordance with the Classification Act of 1949, except that (A) to the extent the Administrator deems such action necessary to the discharge of his responsibilities, he may appoint not more than four hundred and twenty-five of the scientific, engineering, and administrative personnel of the Administration without regard to such laws, and may fix the compensation of such personnel not in excess of the highest rate of grade 18 of the General Schedule of the Classification Act of 1949, as amended, and [8] (B) to the extent the Administrator deems such action necessary to recruit specially qualified scientific and engineering talent, he may establish the entrance grade for scientific and engineering personnel without previous service in the

Excepted positions.

Entrance grades; scientific and engineering personnel.

[8] Clause (A) of sec. 203(b)(2), as amended, was further amended August 14, 1964, to read as above by sec. 306(d) (78 Stat. 429) of the Federal Executive Salary Act of 1964, supra. Original language of clause (A) appeared at 72 Stat. 429, and previous amendments thereto appear in Public Law 86-481 (74 Stat. 153); Public Law 87-367 (75 Stat. 791); Public Law 87-793, (76 Stat. 864). For annual report to Congress, see appendix A.

(Attachment to Galley 27)

7/ The Federal Executive Salary Act of 1964, supra (sec. 305(12), 78 Stat.423), repealed the language in sec. 202, 72 Stat. 429, fixing the compensation of the Administrator and Deputy Administrator at per annum rates of $22,500 and $21,500, respectively. In lieu thereof, the positions of Administrator and Deputy Administrator were placed in level II ($30,000) and level III ($29,500), respectively, of the Federal Executive Salary Schedule. In addition, the Federal Executive Salary Act of 1964 placed seven other NASA positions in designated levels of the Federal Executive Salary Schedule (78 Stat. 416 as amended, 5 U.S.C. 5311-5317).

Section 303 of the Federal Executive Salary Act of 1964, Public Law 88-426, title III, August 14, 1964, 78 Stat. 416 ~~(5 U.S.C. 2211)~~, ~~provides~~ provided that the Administrator and Deputy Administrator and seven other designated offices and positions in NASA shall be compensated under the Federal Executive Salary Schedule. ~~at the following levels and annual rates of basic compensation:~~

The Federal Executive Salary Schedule, 5 U.S.C. 5311-5317 as amended, provides the following levels and annual rates of basic compensation:

Level II ($30,000)
- Administrator ~~(see sec. 202(a), supra)~~

Level III ~~($28,500)~~ ($29,500)
- Deputy Administrator ~~(see sec. 202(b), supra)~~

Level IV ~~($27,000)~~ ($28,750)
- Associate Administrator

Level V ~~($26,000)~~ ($28,000)
- Associate Administrator for Advanced Research and Technology
- Associate Administrator for Space Science and Applications
- Associate Administrator for Manned Space Flight
- Associate Deputy Administrator
- Deputy Associate Administrator
- General Counsel

Federal Government at a level up to two grades higher than the grade provided for such personnel under the General Schedule established by the Classification Act of 1949, and fix their compensation accordingly;

Acquisition, construction, maintenance, etc., of property.

(3) to acquire (by purchase, lease, condemnation, or otherwise), construct, improve, repair, operate, and maintain laboratories, research and testing sites and facilities, aeronautical and space vehicles, quarters and related accommodations for employees and dependents of employees of the Administration, and such other real and personal property (including patents), or any interest therein, as the Administration deems necessary within and outside the continental United States; to acquire by lease or otherwise, through the Administrator of General Services, buildings or parts of buildings in the District of Columbia for the use of the Administration for a period not to exceed ten years without regard to the Act of March 3, 1877 (40 U.S.C. 34); * to lease to others such real and personal property; to sell and otherwise dispose of real and personal property (including patents and rights thereunder) in accordance with the provisions of the Federal Property and Administrative Services Act of 1949, as amended (40 U.S.C. 471 et seq.); and to provide by contract or otherwise for cafeterias and other necessary facilities for the welfare of employees of the Administration at its installations and purchase and maintain equipment therefor;

Lease of buildings.

/S/

* Authority to lease buildings in the District of Columbia was added to sec. 203(b)(3), 72 Stat. 430, by Public Law 86-20, May 13, 1959 (73 Stat. 21).

Disposal of property.

Cafeterias and other facilities for employees.

Gifts.

(4) to accept unconditional gifts or donations of services, money, or property, real, personal, or mixed, tangible or intangible;

Contracts, leases, and other transactions.

(5) without regard to section 3648 of the Revised Statutes, as amended (31 U.S.C. 529), to enter into and perform such contracts, leases, cooperative agreements, or other transactions as may be necessary in the conduct of its work and on such terms as it may deem appropriate, with any agency or instrumentality of the United States, or with any State, Territory, or possession, or with any political subdivision thereof, or with any person, firm, association, corporation, or educational institution. To the maximum extent practicable and consistent with the accomplishment of the purpose of this Act, such contracts, leases, agreements, and other transactions shall be allocated by the Administrator in a manner which will enable small-business concerns to participate equitably and proportionately in the conduct of the work of the Administration;

Small-business participation.

Agency cooperation in use of services, equipment, etc.

(6) to use, with their consent, the service, equipment, personnel, and facilities of Federal and other agencies with or without reimbursement, and on a similar basis to cooperate with other public and pri-

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vate agencies and instrumentalities in the use of services, equipment, and facilities. Each department and agency of the Federal Government shall cooperate fully with the Administration in making its services, equipment, personnel, and facilities available to the Administration, and any such department or agency is authorized, notwithstanding any other provision of law, to transfer to or to receive from the Administration, without reimbursement, aeronautical and space vehicles, and supplies and equipment other than administrative supplies or equipment;

Advisory committees.

(7) to appoint such advisory committees as may be appropriate for purposes of consultation and advice to the Administration in the performance of its functions;

Coordination with related activities.

(8) to establish within the Administration such offices and procedures as may be appropriate to provide for the greatest possible coordination of its activities under this Act with related scientific and other activities being carried on by other public and private agencies and organizations;

Experts and consultants.

(9) to obtain services as authorized by section 15 of the Act of August 2, 1946 ~~(5 U.S.C. 55a)~~, at rates not to exceed $100 per diem for individuals; (5 U.S.C. 3109(b))

\|3\|

Employment of aliens.

(10 when determined by the Administrator to be necessary, and subject to such security investigations as he may determine to be appropriate, to employ aliens without regard to statutory provisions prohibiting payment of compensation to aliens;

Retired officers.

[(11)] Repealed.[10]

[10] Sec. 402(a)(34) of the Dual Compensation Act (Public Law 88-448, August 19, 1964, 78 Stat. 495) repealed sec. 203(b)(11), 72 Stat. 431, which formerly authorized NASA "to employ retired commissioned officers of the armed forces of the United States and compensate them at the rate established for the positions occupied by them within the Administration, subject only to the limitations in pay set forth in sec. 212 of the Act of June 30, 1932, as amended (5 U.S.C. 59a)." The Dual Compensation Act ~~(5 U.S.C. 3101-3108)~~ (5 USC. 3326, 3501, 3502, 3531-3533, 6303), effective Dec. 1, 1964, was designed "to simplify, modernize and consolidate * * * the laws concerning the civilian employment of retired members of the uniformed services. * * *" Pertinent portions of the Dual Compensation Act are set forth in part 11(b) of this document.

Agreements for detail of military personnel.

(12) with the approval of the President, to enter into cooperative agreements under which members of the Army, Navy, Air Force, and Marine Corps may be detailed by the appropriate Secretary for services in the performance of functions under this Act to the same extent as that to which they might be lawfully assigned in the Department of Defense;

Claims against United States.

(13)(A) to consider, ascertain, adjust, determine, settle, and pay, on behalf of the United States, in full satisfaction thereof, any claim for $5,000 or less against the United States for bodily injury, death, or damage to or loss of real or personal property resulting fom the conduct of the Administration's functions as specified in subsection (a) of this section, where such claim is presented to the Administration in writing within two years after the accident or incident out of which the claim arises; and

(B) if the Administration considers that a claim in excess of $5,000 is meritorious and would otherwise be covered by this paragraph, to report the facts and circumstances thereof to the Congress for its consideration;[11] and e

[11] NASA, like other Federal agencies, can settle claims under the Federal Tort Claims Act. Public Law 89-506, July 18, 1966, (80 Stat. 306) ~~amending the~~ Federal Tort Claims Act, expanded the authority of Federal agencies to ~~settle claims.~~

#

Reimbursement to owners and tenants of land.

(14) to reimburse, to the extent determined by the Administrator or his designee to be fair and reasonable, the owners and tenants of land and interests in land acquired on or after November 1, 1961, by the United States for use by the Administration by purchase, condemnation, or otherwise for expenses and losses and damages incurred by such owners and tenants as a direct result of moving themselves, their families, and their possessions because of said acquisition. Such reimbursement shall be in addition to, but not in duplication of, any payments that may otherwise be authorized by law to be made to such owners and tenants. The total of any such reimbursement to any owner or tenant shall in no event exceed 25 per centum of the fair value, as determined by the Administrator, of the parcel of land or interest in land to which the reimbursement is related. No payment under this paragraph shall be made unless application therefor, supported by an itemized statement of the expenses, losses, and damages incurred, is submitted to the Administrator within one year from (a) the date upon which the parcel of land or interest in land is to be vacated under agreement with the Government by the owner or tenant or pursuant to law, including but not limited to, an order of a court, or (b) the date upon which the parcel of land or interest in the land involved is vacated, whichever first occurs. The Administrator may perform any and all acts and make such rules and regulations as he deems necessary and proper for the purpose of carrying out this paragraph. All functions performed under this paragraph shall be exempt from the operation of the Act of June 11, 1946, as amended ~~(5 U.S.C. 1001-1011)~~ (5 U.S.C. 551-559, 701-706) except as to the requirements of section 3 of said Act. Funds available to the Administration for the acquisition of real property or interests therein shall also be available for carrying out this paragraph.[12]

(3) Application; one year limit.

Rules and regulations.

Exemption from Administrative Procedure Act.

[12] Sec. 203(b)(14) added by Public Law 87-584, sec. 6, August 14, 1962 (76 Stat. 384). 9

CIVILIAN-MILITARY LIAISON COMMITTEE

42 U.S.C. 2474. Establishment; membership.

Sec. 204.[13] (a) There shall be a Civilian-Military Liaison Committee consisting of—

[13] The Committee was abolished by Reorganization Plan No. 4 of 1965, effective July 27, 1965 (30 Federal Register 9353, July 28, 1965, 79 Stat. 1319), and its functions were transferred to the President.

#

(1) a Chairman, who shall be the head thereof and who shall be appointed by the President, shall serve at the pleasure of the President.[14]

[14] Previous language in sec. 204(a)(1), 72 Stat. 431, providing for compensation of the Chairman at the rate of $20,000 per annum was repealed on August 14, 1964, by the Federal Executive Salary Act of 1964, supra, sec. 305(13)(B), 78 Stat. 423. No substitute provision was made to replace the language repealed. ~~See 5 U.S.C. [illegible]~~

(2) one or more representatives from the Department of Defense and one or more representatives from each of the Departments of the Army, Navy, and Air Force, to be assigned by the Secretary of Defense to serve on the Committee without additional compensation; and

(3) representatives from the Administration, to be assigned by the Administrator to serve on the Committee without additional compensation, equal in number to the number of representatives assigned to serve on the Committee under paragraph (2).

Functions.

(b) The Administration and the Department of Defense, through the Liaison Committee, shall advise and consult with each other on all matters within their respective jurisdictions relating to aeronautical and space activities and shall keep each other fully and currently informed with respect to such activities.

Resolution of differences by President.

(c) If the Secretary of Defense concludes that any request, action, proposed action, or failure to act on the part of the Administrator is adverse to the responsibilities of the Department of Defense, or the Administrator concludes that any request, action, proposed action, or failure to act on the part of the Department of Defense is adverse to the responsibilities of the Administration, and the Administrator and the Secretary of Defense are unable to reach an agreement with respect thereto, either the Administrator or the Secretary of Defense may refer the matter to the President for his decision (which shall be final) as provided in section 201(e).

Chairman, service of active or retired officer.

(d) Notwithstanding the provisions of any other law, any active or retired officer of the Army, Navy, or Air Force may serve as Chairman of the Liaison Committee without prejudice to his active or retired status as such officer. Any such active officer serving as Chairman of the Liaison Committee shall receive, in addition to his pay and allowances, including special and incentive pays, an amount equal to the difference between such pay and allowances, including special and incentive pays, and the compensation fixed by subsection (a)(1) for such chairman. Any such retired officer serving as Chairman of the Liaison Committee shall receive the compensation fixed by subsection (a)(1) for such Chairman and his retired pay, subject to section 201 of the Dual Compensation Act.[15]

[15] Sec. 204(d), 72 Stat. 432, was amended to read as above by the Dual Compensation Act, sec. 401(g), August 19, 1964 (78 Stat. 490). That part of sec. 204(d) which had referred to the compensation "fixed by subsec. (a)(1)" was repealed by sec. 305(13)(B) of the Federal Executive Salary Act of 1964, supra (78 Stat. 423), but it was reenacted by sec. 401(g) of the Dual Compensation Act. As noted above in footnote ~~15~~, there now is no provision fixing compensation in sec. 204(a)(1).

INTERNATIONAL COOPERATION

42 U.S.C. 2475.

SEC. 205. The Administration, under the foreign policy guidance of the President, may engage in a program of international cooperation in work done pursuant to this Act, and in the peaceful application of the results thereof, pursuant to agreements made by the President with the advice and consent of the Senate.

REPORTS TO THE CONGRESS

42 U.S.C. 2476. Semi-annual report of NASA activities.

SEC. 206. (a) The Administration shall submit to the President for transmittal to the Congress, semiannually and at such other times as it deems desirable, a report of its activities and accomplishments.

President's annual report of activities of all agencies.

(b) The President shall transmit to the Congress in January of each year a report, which shall include (1) a comprehensive description of the programmed activities and the accomplishments of all agencies of the United States in the field of aeronautics and space activities during the preceding calendar year, and (2) an evaluation of such activities and accomplishments in terms of the attainment of, or the failure to attain, the objectives described in section 102(c) of this Act.

(c) Any report made under this section shall contain such recommendations for additional legislation as the Administrator or the President may consider necessary or desirable for the attainment of the objectives described in section 102(c) of this Act.

(d) No information which has been classified for reasons of national security shall be included in any report made under this section, unless such information has been declassified by, or pursuant to authorization given by, the President.

TITLE III—MISCELLANEOUS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

Note under 42 U.S.C. 2472. Termination. Transfer of functions.

SEC. 301. (a) The National Advisory Committee for Aeronautics, on the effective date of this section, shall cease to exist. On such date all functions, powers, duties, and obligations, and all real and personal property, personnel (other than members of the Committee), funds, and records of that organization, shall be transferred to the Administration.

cease

Procurement.

(b) Section 2302 of title 10 of the United States Code is amended by striking out "or the Executive Secretary of the National Advisory Committee for Aeronautics." and inserting in lieu thereof "or the Administrator of the National Aeronautics and Space Administration."; and section 2303 of such title 10 is amended by striking out "The National Advisory Committee for Aeronautics." and inserting in lieu thereof "The National Aeronautics and Space Administration."

National security: suspension of employees.

(c) The first section of the Act of August 26, 1950 (5 [redacted]), is amended by striking out "the Director, National Advisory Committee for Aeronautics" and inserting in lieu thereof "the Administrator of the

(5 U.S.C. 3571, 5594, 7312, 7501(c), 7512(c), 2)),

National Aeronautics and Space Administration", and by striking out "or National Advisory Committee for Aeronautics" and inserting in lieu thereof "or National Aeronautics and Space Administration".

Unitary Wind Tunnel Plan Act of 1949.

(d) The Unitary Wind Tunnel Plan Act of 1949 (50 U.S.C. 511-515) is amended (1) by striking out "The National Advisory Committee for Aeronautics (hereinafter referred to as the 'Committee')" and inserting in lieu thereof "The Administrator of the National Aeronautics and Space Administration (hereinafter referred to as the 'Administrator')"; (2) by striking out "Committee" or "Committee's" wherever they appear and inserting in lieu thereof "Administrator" and "Administrator's", respectively; and (3) by striking out "its" wherever it appears and inserting in lieu thereof "his".

Effective date.

(e)[16] This section shall take effect ninety days after the date of the enactment of this Act, or on any earlier date on which the Administrator shall determine, and announce by proclamation published in the Federal Register, that the Administration has been organized and is prepared to discharge the duties and exercise the powers conferred upon it by this Act.

Publication in F.R.

[16] Effective September 30, 1958, by virtue of proclamation published in the Federal Register on September 25, 1958.

TRANSFER OF RELATED FUNCTIONS

42 U.S.C. 2453. Transfers to NASA.

SEC. 302. (a) Subject to the provisions of this section, the President, for a period of four years after the date of enactment of this Act, may transfer to the Administration any functions (including powers, duties, activities, facilities, and parts of functions) of any other department or agency of the United States, or of any officer or organizational entity thereof, which relate primarily to the functions, powers, and duties of the Administration as prescribed by section 203 of this Act. In connection with any such transfer, the President may, under this section or other applicable authority, provide for appropriate transfers of records, property, civilian personnel, and funds.

Reports to Congress.

(b) Whenever any such transfer is made before January 1, 1959, the President shall transmit to the Speaker of the House of Representatives and the President pro tempore of the Senate a full and complete report concerning the nature and effect of such transfer.

(c) After December 31, 1958, no transfer shall be made under this section until (1) a full and complete report concerning the nature and effect of such proposed transfer has been transmitted by the President to the Congress, and (2) the first period of sixty calendar days of regular session of the Congress following the date of receipt of such report by the Congress has expired without the adoption by the Congress of a concurrent resolution stating that the Congress does not favor such transfer.

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ACCESS TO INFORMATION

42 U.S.C. 2454. Public inspection; exceptions.

SEC. 303. Information obtained or developed by the Administrator in the performance of his functions under this Act shall be made available for public inspection, except (A) information authorized or required by Federal statute to be withheld, and (B) information classified to protect the national security: Provided, That nothing in this Act shall authorize the withholding of information by the Administrator from the duly authorized committees of the Congress.

SECURITY

42 U.S.C. 2455. Requirements.

SEC. 304. (a) The Administrator shall establish such security requirements, restrictions, and safeguards as he deems necessary in the interest of the national security.

Investigations.

The Administrator may arrange with the Civil Service Commission for the conduct of such security or other personnel investigations of the Administration's officers, employees, and consultants, and its contractors and subcontractors and their officers and employees, actual or prospective, as he deems appropriate; and if any such investigation develops any data reflecting that the individual who is the subject thereof is of questionable loyalty the matter shal be referred to the Federal Bureau of Investigation for the conduct of a full field investigation, the results of which shall be furnished to the Administrator.

Referral to F.B.I.

Access to AEC restricted data.

(b) The Atomic Energy Commission may authorize any of its employees, or employees of any contractor, prospective contractor, licensee, or prospective licensee of the ~~Atom~~ Energy Commission or any other person authorized to have access to Restricted Data by the Atomic Energy Commission under subsection 145b. of the Atomic Energy Act of 1954 (42 U.S.C. 2165(b)), to permit any member, officer, or employee of the Council, or the Administrator, or any officer, employee, member of an advisory committee, contractor, subcontractor, or officer or employee of a contractor or subcontractor of the Administration, to have access to Restricted Data relating to aeronautical and space activities which is required in the performance of his duties and so certified by the Council or the Administrator, as the case may be, but only if (1) the Council or Administrator or designee thereof has determined, in accordance with the established personnel security procedures and standards of the Council or Administration, that permitting such individual to have access to such Restricted Data will not endanger the common defense and security, and (2) the Council or Administrator or designee thereof finds that the established personnel and other security procedures and standards of the Council or Administration are adequate and in reasonable conformity to the standards established by the Atomic Energy Commission under section 145 of the Atomic Energy Act of 1954 (42 U.S.C 2165). Any individual granted access to such Restricted Data pursuant to this subsection may ex-

Atomic

change such Data with any individual who (A) is an officer or employee of the Department of Defense, or any department or agency thereof, or a member of the armed forces, or a contractor or subcontractor of any such department, agency, or armed force, or an officer or employee of any such contractor or subcontractor, and (B) has been authorized to have access to Restricted Data under the provisions of section 143 of the Atomic Energy Act of 1954 (42 U.S.C. 2163).

Espionage and Censorship. Violation of regulations. ~~Penalty.~~

(c) Chapter 37 of title 18 of the United States Code (entitled Espionage and Censorship) is amended by—

(1) adding at the end thereof the following new section:

"§ 799. Violation of regulations of National Aeronautics and Space Administration

Penalty.

"Whoever willfully shall violate, attempt to violate, or conspire to violate any regulation or order promulgated by the Administrator of the National Aeronautics and Space Administration for the protection or security of any laboratory, station, base or other facility, or part thereof, or any aircraft, missile, spacecraft, or similar vehicle, or part thereof, or other property or equipment in the custody of the Administration, or any real or personal property or equipment in the custody of any contractor under any contract with the Administration or any subcontractor of any such contractor, shall be fined not more than $5,000, or imprisoned not more than one year, or both."

(2) adding at the end of the sectional analysis thereof the following new item:

"§ 799. Violation of regulations of National Aeronautics and Space Administration."

Protection of NASA officers and employees.

(d) Section 1114 of title 18 of the United States Code is amended by inserting immediately before "while engaged in the performance of his official duties" the following: "or any officer or employee of the National Aeronautics and Space Administration directed to guard and protect property of the United States under the administration and control of the National Aeronautics and Space Administration,".

42 U.S.C. 2456. Permission to use firearms.

(e) The Administrator may direct such of the officers and employees of the Administration as he deems necessary in the public interest to carry firearms while in the conduct of their official duties. The Administrator may also authorize such of those employees of the contractors and subcontractors of the Administration engaged in the protection of property owned by the United States and located at facilities owned by or contracted to the United States as he deems necessary in the public interest, to carry firearms while in the conduct of their official duties.

PROPERTY RIGHTS IN INVENTIONS

42 U.S.C. 2457. Inventions made in performance of work under contract.

SEC. 305. (a) Whenever any invention is made in the performance of any work under any contract of the Administration, and the Administrator determines that—

(1) the person who made the invention was employed or assigned to perform research, development, or exploration work and the invention is related to the work he was employed or assigned to perform, or that it was within the scope of his employment duties, whether or not it was made during working hours, or with a contribution by the Government of the use of Government facilities, equipment, materials, allocated funds, information proprietary to the Government, or services of Government employees during working hours; or

(2) the person who made the invention was not employed or assigned to perform research, development, or exploration work, but the invention is nevertheless related to the contract, or to the work or duties he was employed or assigned to perform, and was made during working hours, or with a contribution from the Government of the sort referred to in clause (1),

Exclusive property of United States: issuance of patent.

such invention shall be the exclusive property of the United States, and if such invention is patentable a patent therefor shall be issued to the United States upon application made by the Administrator, unless the Administrator waives all or any part of the rights of the United States to such invention in conformity with the provisions of subsection (f) of this section.

Contract provisions for reporting inventions, etc.

(b) Each contract entered into by the Administrator with any party for the performance of any work shall contain effective provisions under which such party shall furnish promptly to the Administrator a written report containing full and complete technical information concerning any invention, discovery, improvement, or innovation which may be made in the performance of any such work.

Patent application.

(c) No patent may be issued to any applicant other than the Administrator for any invention which appears to the Commissioner of Patents to have significant utility in the conduct of aeronautical and space activities unless the applicant files with the Commissioner, with the application or within thirty days after request therefor by the Commissioner, a written statement executed under oath seting forth the full facts concerning the circumstances under which such invention was made and stating the relationship (if any) of such invention to the performance of any work under any contract of the Administration. Copies of each such statement and the application to which it relates shall be transmitted forthwith by the Commissioner to the Administrator.

Patent issuance to applicant.

(d) Upon any application as to which any such statement has been transmitted to the Administrator, the Commissioner may, if the invention is patentable, issue a patent to the applicant unless the Administrator, within ninety days after receipt of such application and statement, requests that such patent be issued to him on behalf of the United States. If, within such time, the Administrator files such a request with the Commissioner, the Commissioner shall transmit notice thereof to the applicant, and shall issue such patent to the Administrator

Board of Patent Interferences.

unless the applicant within thirty days after receipt of such notice requests a hearing before a Board of Patent Interferences on the question whether the Administrator is entitled under this section to receive such patent. The Board may hear and determine, in accordance with rules and procedures established for interference cases, the question so presented, and its determination shall be subject to appeal by the applicant or by the Administrator to the Court of Customs and Patent Appeals in accordance with procedures governing appeals from decisions of the Board of Patent Interferences in other proceedings.

False representations, request for transfer of title to patent.

(e) Whenever any patent has been issued to any applicant in conformity with subsection (d), and the Administrator thereafter has reason to believe that the statement filed by the applicant in connection therewith contained any false representation of any material fact, the Administrator within five years after the date of issuance of such patent may file with the Commissioner a request for the transfer to the Administrator of title to such patent on the records of the Commisisoner. Notice of any such request shall be transmitted by the Commissioner to the owner of record of such patent, and title to such patent shall be so transferred to the Administrator unless within thirty days after receipt of such notice such owner of record requests a hearing before a Board of Patent Interferences on the question whether any such false representation was contained in such statement. Such question shall be heard and determined, and determination thereof shall be subject to review, in the manner prescribed by subsection (d) for questions arising thereunder. No request made by the Administrator under this subsection for the transfer of title to any patent, and no prosecution for the violation of any criminal statute, shall be barred by any failure of the Administrator to make a request under subsection (d) for the issuance of such patent to him, or by any notice previously given by the Administrator stating that he had no objection to the issuance of such patent to the applicant therefor.

Waiver of right to inventions.

(f) Under such regulations in conformity with this subsection as the Administrator shall prescribe, he may waive all or any part of the rights of the United States under this section with respect to any invention or class of inventions made or which may be made by any person or class of persons in the performance of any work required by any contract of the Administration if the Administrator determines that the interests of the United States will be served thereby. Any such waiver may be made upon such terms and under such conditions as the Administrator shall determine to be required for the protection of the interests of the United States. Each such waiver made with respect to any invention shall be subject to the reservation by the Administrator of an irrevocable, nonexclusive, nontransferable, royalty-free license for the practice of such invention throughout the world by or on behalf of the United States or any foreign government pursuant to any treaty or agreement with the United States. Each proposal for any waiver under this subsection shall be referred to an Inventions and Contributions Board which shall be established by the Administrator within the Administration. Such Board shall accord to each interested party an opportunity for hearing, and shall transmit to the Administrator its findings of fact with respect to such proposal and its recommendations for action to be taken with respect thereto.

Inventions and Contributions Board.

License regulations.

(g) The Administrator shall determine, and promulgate regulations specifying the terms and conditions upon which licenses will be granted by the Administration for the practice by any person (other than an agency of the United States) of any invention for which the Administrator holds a patent on behalf of the United States.

Protection of Title.

~~Referral to Inventions and Contributions Board; hearing and recommendation.~~

(h) The Administrator is authorized to take all suitable and necessary steps to protect any invention or discovery to which he has title, and to require that contractors or persons who retain title to inventions or discoveries under this section protect the inventions or discoveries to which the Administration has or may acquire a license of use.

Defense Agency.

~~Determination by Administrator.~~

(i) The Administration shall be considered a defense agency of the United States for the purpose of chapter 17 of title 35 of the United States Code.

Definitions.

~~Protection of title.~~

(j) As used in this section—

(1) the term "person" means any individual, partnership, corporation, association, institution, or other entity.

(2) the term "contract" means any actual or proposed contract, agreement, understanding, or other arrangement, and includes any assignment, substitution of parties, or subcontract executed or entered into thereunder; and

(3) the term "made", when used in relation to any invention, means the conception or first actual reduction to practice of such invention.

42 U.S.C. 2458.

CONTRIBUTIONS AWARDS

~~Defense agency.~~

Application.

~~Definitions.~~

Referral to Inventions and Contributions Board; hearing and recommendation.

~~42 U.S.C. 2458.~~

Determination by Administrator.

~~Application.~~

SEC. 306. (a) Subject to the provisions of this section, the Administrator is authorized, upon his own initiative or upon application of any person, to make a monetary award, in such amount and upon such terms as he shall determine to be warranted, to any person (as defined by section 305) for any scientific or technical contribution to the Administration which is determined by the Administrator to have significant value in the conduct of aeronautical and space activities. Each application made for any such award shall be referred to the Inventions and Contributions Board established under section 305 of this Act. Such Board shall accord to each such ~~applic-can~~ /applicant/ an opportunity for hearing upon such application, and shall transmit to the Administrator its recommendation as to the terms of the award, if any, to be made to such applicant for such contribution. In determining the terms and conditions of any award the Administrator shall take into account—

(1) the value of the contribution to the United States;

(2) the aggregate amount of any sums which have been expended by the applicant for the development of such contribution;

(3) the amount of any compensation (other than salary received for services rendered as an officer or employee of the Government) previously received by the applicant for or on account of the use of such contribution by the United States; and

(4) such other factors as the Administrator shall determine to be material.

Apportionment of award.

(b) If more than one applicant under subsection (a) claims an interest in the same contribution, the Administrator shall ascertain and determine the respective interest of such applicants, and shall apportion any award to be made with respect to such contribution among such applicants in such proportions as he shall determine to be equitable. No award may be made under subsection (a) with respect to any contribution—

Surrender of claims to compensation.

(1) unless the applicant surrenders, by such means as the Administrator shall determine to be effective, all claims which such applicant may have to receive any compensation (other than the award made under this section) for the use of such contribution or any element thereof at any time by or on behalf of the United States or by or on behalf of any foreign government pursuant to any treaty or agreement with the United States, within the United States or at any other place;

Limitation of amount; report to Congress.

(2) in any amount exceeding $100,000, unless the Administrator has transmitted to the appropriate committees of the Congress a full and complete report concerning the amount and terms of, and the basis for, such proposed award, and thirty calendar days of regular session of the Congress have expired after receipt of such report by such committees.

APPROPRIATIONS[17]

[17] For requirement of prior authorizing legislation, ~~see appendix B,~~ /see — hereto,/ Public Law 86-45.

42 U.S.C. 2459. Authorization of appropriations.

Sec. 307. (a) There are hereby authorized to be appropriated such sums as may be necessary to carry out this Act, except that nothing in this Act shall authorize the appropriation of any amount for (1) the acquisition or condemnation of any real property, or (2) any other item of a capital nature (such as plant or facility acquisition, construction, or expansion) which exceeds $250,000. Sums appropriated pursuant to this subsection for the construction of facilities, or for research and development activities, shall remain available until expended.

Funds for emergency repairs.

(b) Any funds appropriated for the construction of facilities may be used for emergency repairs of existing facilities when such existing facilities are made inoperative by major breakdown, accident, or other circumstances and such repairs are deemed by the Administrator to be of greater urgency than the construction of new facilities.

Expiration of authorizations.

(c) Notwithstanding any other provision of law, the authorization of any appropriation to the Administration shall expire (unless an earlier expiration is specifically provided) at the close of the third fiscal year following the fiscal year in which the authorization was enacted, to the extent that such appropriation has not heretofore ~~therefore~~ actually been made.[18] July 29, 1958.

421 ¶ Farewell Radio and Television Address to the American People. *January 17, 1961*

[Delivered from the President's Office at 8:30 p.m.]

My fellow Americans:

Three days from now, after half a century in the service of our country, I shall lay down the responsibilities of office as, in traditional and solemn ceremony, the authority of the Presidency is vested in my successor.

This evening I come to you with a message of leave-taking and farewell, and to share a few final thoughts with you, my countrymen.

Like every other citizen, I wish the new President, and all who will labor with him, Godspeed. I pray that the coming years will be blessed with peace and prosperity for all.

Our people expect their President and the Congress to find essential agreement on issues of great moment, the wise resolution of which will better shape the future of the Nation.

My own relations with the Congress, which began on a remote and tenuous basis when, long ago, a member of the Senate appointed me to West Point, have since ranged to the intimate during the war and immediate post-war period, and, finally, to the mutually interdependent during these past eight years.

In this final relationship, the Congress and the Administration have, on most vital issues, cooperated well, to serve the national good rather than mere partisanship, and so have assured that the business of the Nation should go forward. So, my official relationship with the Congress ends in a feeling, on my part, of gratitude that we have been able to do so much together.

II.

We now stand ten years past the midpoint of a century that has witnessed four major wars among great nations. Three of these involved our own country. Despite these holocausts America is today the strongest, the most influential and most productive nation in the world. Understandably proud of this pre-eminence, we yet realize that America's leadership and prestige depend, not merely upon our unmatched material progress, riches and military strength, but on how we use our power in the interests of world peace and human betterment.

III.

Throughout America's adventure in free government, our basic purposes have been to keep the peace; to foster progress in human achievement, and to enhance liberty, dignity and integrity among people and among nations. To strive for less would be unworthy of a free and religious people. Any failure traceable to arrogance, or our lack of comprehension or readiness to sacrifice would inflict upon us grievous hurt both at home and abroad.

Progress toward these noble goals is persistently threatened by the conflict now engulfing the world. It commands our whole attention, absorbs our very beings. We face a hostile ideology—global in scope, atheistic in character, ruthless in purpose, and insidious in method. Unhappily the danger it poses promises to be of indefinite duration. To meet it successfully, there is called for, not so much the emotional and transitory sacrifices of crisis, but rather those which enable us to carry forward steadily, surely, and without complaint the burdens of a prolonged and complex struggle—with liberty the stake. Only thus shall we remain, despite every provocation, on our charted course toward permanent peace and human betterment.

Crises there will continue to be. In meeting them, whether foreign or domestic, great or small, there is a recurring temptation to feel that some spectacular and costly action could become the miraculous solution to all current difficulties. A huge increase in newer elements of our defense; development of unrealistic programs to cure every ill in agriculture; a dramatic expansion in basic and applied research—these and many other possibilities, each possibly promising in itself, may be suggested as the only way to the road we wish to travel.

But each proposal must be weighed in the light of a broader consideration: the need to maintain balance in and among national programs—balance between the private and the public economy, balance between cost and hoped for advantage—balance between the clearly necessary and the comfortably desirable; balance between our essential requirements as a nation and the duties imposed by the nation upon the individual; balance between actions of the moment and the national welfare of the future. Good judgment seeks balance and progress; lack of it eventually finds imbalance and frustration.

The record of many decades stands as proof that our people and their government have, in the main, understood these truths and have responded to them well, in the face of stress and threat. But threats, new in kind or degree, constantly arise. I mention two only.

IV.

A vital element in keeping the peace is our military establishment. Our arms must be mighty, ready for instant action, so that no potential aggressor may be tempted to risk his own destruction.

Our military organization today bears little relation to that known by any of my predecessors in peacetime, or indeed by the fighting men of World War II or Korea.

Until the latest of our world conflicts, the United States had no armaments industry. American makers of plowshares could, with time and as required, make swords as well. But now we can no longer risk emergency improvisation of national defense; we have been compelled to create a permanent armaments industry of vast proportions. Added to this, three and a half million men and women are directly engaged in the defense establishment. We annually spend on military security more than the net income of all United States corporations.

This conjunction of an immense military establishment and a large arms industry is new in the American experience. The total influence—economic, political, even spiritual—is felt in every city, every State house, every office of the Federal government. We recognize the imperative need for this development. Yet we must not fail to comprehend its grave implications. Our toil, resources and livelihood are all involved; so is the very structure of our society.

In the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex. The potential for the disastrous rise of misplaced power exists and will persist.

We must never let the weight of this combination endanger our liberties or democratic processes. We should take nothing for granted. Only an alert and knowledgeable citizenry can compel the proper meshing of the huge industrial and military machinery of defense with our peaceful methods and goals, so that security and liberty may prosper together.

Akin to, and largely responsible for the sweeping changes in our industrial-military posture, has been the technological revolution during recent decades.

In this revolution, research has become central; it also becomes more formalized, complex, and costly. A steadily increasing share is conducted for, by, or at the direction of, the Federal government.

Today, the solitary inventor, tinkering in his shop, has been overshadowed by task forces of scientists in laboratories and testing fields. In the same fashion, the free university, historically the fountainhead of free ideas and scientific discovery, has experienced a revolution in the conduct of research. Partly because of the huge costs involved, a government contract becomes virtually a substitute for intellectual curiosity. For every old blackboard there are now hundreds of new electronic computers.

The prospect of domination of the nation's scholars by Federal employment, project allocations, and the power of money is ever present—and is gravely to be regarded.

Yet, in holding scientific research and discovery in respect, as we should, we must also be alert to the equal and opposite danger that public policy could itself become the captive of a scientific-technological elite.

It is the task of statesmanship to mold, to balance, and to integrate these and other forces, new and old, within the principles of our democratic system—ever aiming toward the supreme goals of our free society.

V.

Another factor in maintaining balance involves the element of time. As we peer into society's future, we—you and I, and our government—must avoid the impulse to live only for today, plundering, for our own ease and convenience, the precious resources of tomorrow. We cannot mortgage the material assets of our grandchildren without risking the loss also of their political and spiritual heritage. We want democracy to survive for all generations to come, not to become the insolvent phantom of tomorrow.

VI.

Down the long lane of the history yet to be written America knows that this world of ours, ever growing smaller, must avoid becoming a community of dreadful fear and hate, and be, instead, a proud confederation of mutual trust and respect.

Such a confederation must be one of equals. The weakest must come to the conference table with the same confidence as do we, protected as we are by our moral, economic, and military strength. That table, though scarred by many past frustrations, cannot be abandoned for the certain agony of the battlefield.

Disarmament, with mutual honor and confidence, is a continuing imperative. Together we must learn how to compose differences, not with arms, but with intellect and decent purpose. Because this need is so sharp and apparent I confess that I lay down my official responsibilities in this field with a definite sense of disappointment. As one who has witnessed the horror and the lingering sadness of war—as one who knows that another war could utterly destroy this civilization which has been so slowly and painfully built over thousands of years—I wish I could say tonight that a lasting peace is in sight.

Happily, I can say that war has been avoided. Steady progress toward our ultimate goal has been made. But, so much remains to be done. As a private citizen, I shall never cease to do what little I can to help the world advance along that road.

VII.

So—in this my last good night to you as your President—I thank you for the many opportunities you have given me for public service in war and peace. I trust that in that service you find some things worthy; as for the rest of it, I know you will find ways to improve performance in the future.

You and I—my fellow citizens—need to be strong in our faith that all nations, under God, will reach the goal of peace with justice. May we be ever unswerving in devotion to principle, confident but humble with power, diligent in pursuit of the Nation's great goals.

To all the peoples of the world, I once more give expression to America's prayerful and continuing aspiration:

We pray that peoples of all faiths, all races, all nations, may have their great human needs satisfied; that those now denied opportunity shall come to enjoy it to the full; that all who yearn for freedom may experience its spiritual blessings; that those who have freedom will understand, also, its heavy responsibilities; that all who are insensitive to the needs of others will learn charity; that the scourges of poverty, disease and ignorance will be made to disappear from the earth, and that, in the goodness of time, all peoples will come to live together in a peace guaranteed by the binding force of mutual respect and love.

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COPY

THE WHITE HOUSE

April 20, 1961

MEMORANDUM FOR

VICE PRESIDENT

In accordance with our conversation I would like for you as Chairman of the Space Council to be in charge of making an overall survey of where we stand in space.

1. Do we have a chance of beating the Soviets by putting a laboratory in space, or by a trip around the moon, or by a rocket to land on the moon, or by a rocket to go to the moon and back with a man. Is there any other space program which promises dramatic results in which we could win?

2. How much additional would it cost?

3. Are we working 24 hours a day on existing programs. If not, why not? If not, will you make recommendations to me as to how work can be speeded up.

4. In building large boosters should we put our emphasis on nuclear, chemical or liquid fuel, or a combination of these three?

5. Are we making maximum effort? Are we achieving necessary results?

I have asked Jim Webb, Dr. Weisner, Secretary McNamara and other responsible officials to cooperate with you fully. I would appreciate a report on this at the earliest possible moment.

(John F. Kennedy)

COPY

Extract from

SPECIAL MESSAGE BY THE PRESIDENT ON URGENT NATIONAL NEEDS TO A JOINT SESSION OF THE CONGRESS (as actually delivered)

May 25, 1961

Finally, if we are to win the battle that is now going on around the world between freedom and tyranny, the dramatic achievements in space which occurred in recent weeks should have made clear to us all, as did the Sputnik in 1957, the impact of this adventure on the minds of men everywhere, who are attempting to make a determination of which road they should take. Since early in my term, our efforts in space have been under review. With the advice of the Vice President, who is Chairman of the National Space Council, we have examined where we are strong and where we are not, where we may succeed and where we may not. Now it is time to take longer strides -- time for a great new American enterprise -- time for this nation to take a clearly leading role in space achievement, which in many ways may hold the key to our future on earth.

I believe we possess all the resources and talents necessary. But the facts of the matter are that we have never made the national decisions or marshalled the national resources required for such leadership. We have never specified long-range goals on an urgent time schedule, or managed our resources and our time so as to insure their fulfillment.

Recognizing the head start obtained by the Soviets with their large rocket engines, which gives them many months of lead-time, and recognizing the likelihood that they will exploit this lead for some time to come in still more impressive successes, we nevertheless are required to make new efforts on our own. For while we cannot guarantee that we shall one day be first, we can guarantee that any failure to make this effort will make us last. We take an additional risk by making it in full view of the world -- but as shown by the feat of astronaut Shepard, this very risk enhances our stature when we are successful. But this is not merely a race. Space is open to - us now; and our eagerness to share its meaning is not governed by the efforts of others. We go into space because whatever mankind must undertake, free men must fully share.

I therefore ask the Congress, above and beyond the increases I have earlier requested for space activities, to provide the funds which are needed to meet the following national goals:

First, I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth. No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish. We propose to accerlate development of the appropriate lunar space craft. We propose to develop alternate liquid and solid fuel boosters, much larger than any now being developed, until certain which is superior. We propose additional funds for other engine development and for unmanned explorations -- explorations which are particularly important for one purpose which this nation will never overlook: the survival of the man who first makes this daring flight. But in a very real sense, it will not be one man going to the moon -- if we make this judgment affirmatively, it will be an entire nation. For all of us must work to put him there.

Secondly, an additional 23 million dollars, together with 7 million dollars already available, to accelerate development of the ROVER nuclear rocket. This gives promise of some day providing a means for even more exciting and ambitious exploration of space, perhaps beyond the moon, perhaps to the very end of the solar system itself.

Third, an additional 50 million dollars will make the most of our present leadership, by accelerating the use of space satellites for world-wide communications.

Fourth, an additional 75 million dollars -- of which 53 million dollars is for the Weather Bureau -- will help give us at the earliest possible time a satellite system for world-wide weather observation.

Let it be clear -- and this is a judgment which the Members of Congress must finally make -- let it be clear that I am asking the Congress and the country to accept a firm commitment to a new course of action -- a course which will last for many years and carry very heavy costs of 531 million dollars in fiscal 1962 -- an estimated seven to nine billion dollars additional over the next five years. If we are to go only half way, or reduce our sights in the face of difficulty, in my judgment it would be better not to go at all.

Now this is a choice which this country must make, and I am confident that under the leadership of the Space Committees of the Congress, and the Appropriating Committees, that you will consider the matter carefully.

It is a most important decision that we make as a nation. But all of you have lived through the last four years and have seen the significance of space and the adventures in space, and no one can predict with certainty what the ultimate meaning will be of mastery of space.

I believe we should go to the moon. But I think every citizen of this country as well as the Members of the Congress should consider the matter carefully in making their judgment, to which we have given attention over many weeks and months, because it is a heavy burden, and there is no sense in agreeing or desiring that the United States take an affirmative position in outer space, unless we are prepared to do the work and bear the burdens to make it successful. If we are not, we should decide today and this year.

This decision demands a major national commitment of scientific and technical manpower, material and facilities, and the possibility of their diversion from other important activities where they are already thinly spread. It means a degree of dedication, organization and discipline which have not always characterized our research and development efforts. It means we cannot afford undue work stoppages, inflated costs of material or talent, wasteful inter-agency rivalries, or a high turnover of key personnel.

New objectives and new money cannot solve these problems. They could in fact, aggravate them further -- unless every scientist, every engineer, every serviceman, every technician, contractor, and civil servant gives his personal pledge that this nation will move forward, with the full speed of freedom, in the exciting adventure of space.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON 25, D. C.

The Honorable Robert S. Kerr
Chairman, Senate Committee on
Aeronautical and Space Sciences

June 22, 1961

My dear Senator Kerr,

As you suggested during my recent discussion before the Committee, I will attempt to put in writing the remarks I made as to the significance of the program recommended by the President for landing a man on the moon and his safe return by the end of the decade to the present and future welfare of this nation.

The attainment of the goal stated by the President requires extensive research and development in almost every branch of science and technology at the frontiers of knowledge in these various fields. New materials and components must be developed to function in the extreme cold and the extremely low pressures of outer space, at the extreme speeds, and at the extreme temperatures attained in rocket combustion chambers and on the outer surface of bodies reentering the atmosphere at high speed. New developments in propulsion, in electronics, in communications, in guidance and control techniques, in computer techniques, are necessary in order to accomplish the task. New information in the life sciences, including the effects of the radiations encountered in outer space, the effects of long periods of weightlessness, and long exposure to a completely closed environment--all these are required and will provide new basic information about the performance of the human body under adverse conditions. This new knowledge and experience in the space sciences and technologies will provide the sound basis for applying our new-found knowledge to the design of space vehicles for a variety of purposes, some now foreseen, others unthought of at present. These applications include not only space vehicles for scientific research, for communications systems, for meteorological observation, and presently unforeseen civil uses, but also space vehicles for potential applications in the national defense. Space technology, like aeronautical technology, can be applied to military systems, and we must be well advanced in this technology to avoid its possible exploitation against us.

Equally important is the fact that these developments in science and technology are transferable to other applications in our industrial society. We have had repeated evidence in history of the development of the automobile, the airplane, d the nuclear reactor of the transferability of developments these fields to other industrial applications. The develop-nt of space science and technologies strengthens our whole dustrial base and serves as insurance against technological olescence. Education will profit. The discipline of co-eration in a great national effort may well be the instrument great social gain. Many hope that space may be an area ere all the nations of the world may learn to work together r the benefit of all men.

The setting of the difficult goal of landing a man on e moon and return to earth has the highly important role accelerating the development of space science and tech-logy, motivating the scientists and engineers who are engaged this effort to move forward with urgency, and integrating eir efforts in a way that cannot be accomplished by a dis-nnected series of research investigations in the several elds. It is important to realize, however, that the real lues and purposes are not in the mere accomplishment of man etting foot on the moon but rather in the great cooperative tional effort in the development of science and technology ich is stimulated by this goal.

The billions of dollars requred in this effort are not spent on the moon; they are spent in the factories, workshops, nd laboratories of our people for salaries, for new materials, nd supplies, which in turn represent income to others. It s unfortunate that space exploration is still so new that ourneys of man to the moon are synonymous with foolish or isionary enterprises as described in science fiction. Fifty ears ago flying through the air had the same connotations--isky, expensive, useful only as a sport. Our lack of ppreciation of the potentialities of aeronautics extended hrough the early years, forcing the Wright Brothers to go broad. We entered the first World War with no design apability and no manufacturing experience, dependent ompletely on foreign designs. Only after the war did we egin to devote effort to research in the new aeronautical echnology. We must not undergo the same experience in space cience and technology. The national enterprise involved n the goal of manned lunar landing and return within the ecade is an activity of critical impact on the future of his nation as an industrial and military power, and s a leader of a free world.

/s/ Hugh L. Dryden
Deputy Administrator

373 Address at Rice University in Houston on the Nation's Space Effort. *September 12, 1962*

President Pitzer, Mr. Vice President, Governor, Congressman Thomas, Senator Wiley, and Congressman Miller, Mr. Webb, Mr. Bell, scientists, distinguished guests, and ladies and gentlemen:

I appreciate your president having made me an honorary visiting professor, and I will assure you that my first lecture will be very brief.

I am delighted to be here and I'm particularly delighted to be here on this occasion.

We meet at a college noted for knowledge, in a city noted for progress, in a State noted for strength, and we stand in need of all three, for we meet in an hour of change and challenge, in a decade of hope and fear, in an age of both knowledge and ignorance. The greater our knowledge increases, the greater our ignorance unfolds.

Despite the striking fact that most of the scientists that the world has ever known are alive and working today, despite the fact that this Nation's own scientific manpower is doubling every 12 years in a rate of growth more than three times that of our population as a whole, despite that, the vast stretches of the unknown and the unanswered and the unfinished still far outstrip our collective comprehension.

No man can fully grasp how far and how fast we have come, but condense, if you will, the 50,000 years of man's recorded history in a time span of but a half-century. Stated in these terms, we know very little about the first 40 years, except at the end of them advanced man had learned to use the skins of animals to cover them. Then about 10 years ago, under this standard, man emerged from his caves to construct other kinds of shelter. Only 5 years ago man learned to write and use a cart with wheels. Christianity began less than 2 years ago. The printing press came this year, and then less than 2 months ago, during this whole 50-year span of human history, the steam engine provided a new source of power.

Newton explored the meaning of gravity. Last month electric lights and telephones and automobiles and airplanes became available. Only last week did we develop penicillin and television and nuclear power, and now if America's new spacecraft succeeds in reaching Venus, we will have literally reached the stars before midnight tonight.

This is a breathtaking pace, and such a pace cannot help but create new ills as it dispels old, new ignorance, new problems, new dangers. Surely the opening vistas of space promise high costs and hardships, as well as high reward.

So it is not surprising that some would have us stay where we are a little longer to rest, to wait. But this city of Houston, this State of Texas, this country of the United States was not built by those who waited and rested and wished to look behind them. This country was conquered by those who moved forward—and so will space.

William Bradford, speaking in 1630 of the founding of the Plymouth Bay Colony, said that all great and honorable actions are accompanied with great difficulties, and both must be enterprised and overcome with answerable courage.

If this capsule history of our progress teaches us anything, it is that man, in his quest for knowledge and progress, is determined and cannot be deterred. The exploration of space will go ahead, whether we join in it or not, and it is one of the great adventures of all time, and no nation which expects to be the leader of other nations can expect to stay behind in this race for space.

Those who came before us made certain that this country rode the first waves of the industrial revolutions, the first waves of modern invention, and the first wave of nuclear power, and this generation does not intend to founder in the backwash of the coming age of space. We mean to be a part of it—we mean to lead it. For the eyes of the world now look into space, to the moon and to the planets beyond, and we have vowed that we shall not see it governed by a hostile flag of conquest, but by a banner of freedom and peace. We have vowed that we shall not see space filled with weapons of mass destruction, but with instruments of knowledge and understanding.

Yet the vows of this Nation can only be fulfilled if we in this Nation are first, and, therefore, we intend to be first. In short, our leadership in science and in industry, our hopes for peace and security, our obligations to ourselves as well as others, all require us to make this effort, to solve these mysteries, to solve them for the good of all men, and to become the world's leading space-faring nation.

We set sail on this new sea because there is new knowledge to be gained, and new rights to be won, and they must be won and used for the progress of all people. For space science, like nuclear science and all technology, has no conscience of its own. Whether it will become a force for good or ill depends on man, and only if the United States occupies a position of pre-eminence can we help decide whether this new ocean will be a sea of peace or a new terrifying theater of war. I do not say that we should or will go unprotected against the hostile misuse of space any more than we go unprotected against the hostile use of land or sea, but I do say that space can be explored and mastered without feeding the fires of war, without repeating the mistakes that man has made in extending his writ around this globe of ours.

There is no strife, no prejudice, no national conflict in outer space as yet. Its hazards are hostile to us all. Its conquest deserves the best of all mankind, and its opportunity for peaceful cooperation may never come again. But why, some say, the moon? Why choose this as our goal? And they may well ask why climb the highest mountain. Why, 35 years ago, fly the Atlantic? Why does Rice play Texas?

We choose to go to the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too.

It is for these reasons that I regard the decision last year to shift our efforts in space from low to high gear as among the most important decisions that will be made during my incumbency in the Office of the Presidency.

In the last 24 hours we have seen facilities now being created for the greatest and most complex exploration in man's history. We have felt the ground shake and the air shattered by the testing of a Saturn C–1 booster rocket, many times as powerful as the Atlas which launched John Glenn, generating power equivalent to 10,000 automobiles with their accelerators on the floor. We have seen the site where five F–1 rocket engines, each one as powerful as all eight engines of the Saturn combined, will be clustered together to make the advanced Saturn missile, assembled in a new building to be built at Cape Canaveral as tall as a 48-story structure, as wide as a city block, and as long as two lengths of this field.

Within these last 19 months at least 45 satellites have circled the earth. Some 40 of them were "made in the United States of America" and they were far more sophisticated and supplied far more knowledge to the people of the world than those of the Soviet Union.

The Mariner spacecraft now on its way to Venus is the most intricate instrument in the history of space science. The accuracy of that shot is comparable to firing a missile from Cape Canaveral and dropping it in this stadium between the 40-yard lines.

Transit satellites are helping our ships at sea to steer a safer course. Tiros satellites have given us unprecedented warnings of hurricanes and storms, and will do the same for forest fires and icebergs.

We have had our failures, but so have others, even if they do not admit them. And they may be less public.

To be sure, we are behind, and will be behind for some time in manned flight. But we do not intend to stay behind, and in this decade we shall make up and move ahead.

The growth of our science and education will be enriched by new knowledge of our universe and environment, by new techniques of learning and mapping and observation, by new tools and computers for industry, medicine, the home as well as the school. Technical institutions, such as Rice, will reap the harvest of these gains.

And finally, the space effort itself, while still in its infancy, has already created a great number of new companies, and tens of thousands of new jobs. Space and related industries are generating new demands in investment and skilled personnel, and this city and this State, and this region, will share greatly in this growth. What was once the furthest outpost on the old frontier of the West will be the furthest outpost on the new frontier of science and space. Houston, your City of Houston, with its Manned Spacecraft Center, will become the heart of a large scientific and engineering community. During the next 5 years the National Aeronautics and Space Administration expects to double the number of scientists and engineers in this area, to increase its outlays for salaries and expenses to $60 million a year; to invest some $200 million in plant and laboratory facilities; and to direct or contract for new space efforts over $1 billion from this Center in this City.

To be sure, all this costs us all a good deal of money. This year's space budget is three times what it was in January 1961, and it is greater than the space budget of the previous 8 years combined. That budget now stands at $5,400 million a year—a staggering sum, though somewhat less than we pay for cigarettes and cigars every year. Space expenditures will soon rise some more, from 40 cents per person per week to more than 50 cents a week for every man, woman, and child in the United States, for we have given this program a high national priority—even though I realize that this is in some measure an act of faith and vision, for we do not now know what benefits await us. But if I were to say, my fellow citizens, that we shall send to the moon, 240,000 miles away from the control station in Houston, a giant rocket more than 300 feet tall, the length of this football field, made of new metal alloys, some of which have not yet been invented, capable of standing heat and stresses several times more than have ever been experienced,

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fitted together with a precision better than the finest watch, carrying all the equipment needed for propulsion, guidance, control, communications, food and survival, on an untried mission, to an unknown celestial body, and then return it safely to earth, re-entering the atmosphere at speeds of over 25,000 miles per hour, causing heat about half that of the temperature of the sun—almost as hot as it is here today—and do all this, and do it right, and do it first before this decade is out, then we must be bold.

I'm the one who is doing all the work, so we just want you to stay cool for a minute. [*Laughter*]

However, I think we're going to do it, and I think that we must pay what needs to be paid. I don't think we ought to waste any money, but I think we ought to do the job. And this will be done in the decade of the sixties. It may be done while some of you are still here at school at this college and university. It will be done during the terms of office of some of the people who sit here on this platform. But it will be done. And it will be done before the end of this decade.

I am delighted that this university is playing a part in putting a man on the moon as part of a great national effort of the United States of America.

Many years ago the great British explorer George Mallory, who was to die on Mount Everest, was asked why did he want to climb it. He said, "Because it is there."

Well, space is there, and we're going to climb it, and the moon and the planets are there, and new hopes for knowledge and peace are there. And, therefore, as we set sail we ask God's blessing on the most hazardous and dangerous and greatest adventure on which man has ever embarked.

Thank you.

NOTE: The President spoke in the Rice University Stadium at 10 a.m. In his opening words he referred to Dr. K. S. Pitzer, President of the University, Vice President Lyndon B. Johnson, Governor Price Daniel of Texas, Representative Albert Thomas of Texas, Senator Alexander Wiley of Wisconsin, Representative George P. Miller of California, James E. Webb, Administrator, National Aeronautics and Space Administration, and David E. Bell, Director of the Bureau of the Budget.

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November 30, 1962

The President
The White House

Dear Mr. President:

At the close of our meeting on November 21, concerning possible acceleration of the manned lunar landing program, you requested that I describe for you the priority of this program in our over-all civilian space effort. This letter has been prepared by Dr. Dryden, Dr. Seamans, and myself to express our views on this vital question.

The objective of our national space program is to become pre-eminent in all important aspects of this endeavor and to conduct the program in such a manner that our emerging scientific, technological, and operational competence in space is clearly evident.

To be pre-eminent in space, we must conduct scientific investigations on a broad front. We must concurrently investigate geophysical phenomena about the earth, analyze the sun's radiation and its effect on earth, explore the moon and the planets, make measurements in interplanetary space, and conduct astronomical measurements.

To be pre-eminent in space, we must also have an advancing technology that permits increasingly large payloads to orbit the earth and to travel to the moon and the planets. We must substantially improve our propulsion capabilities, must provide methods for delivering large amounts of internal power, must develop instruments and life support systems that operate for extended periods, and must learn to transmit large quantities of data over long distances.

To be pre-eminent in operations in space, we must be able to launch our vehicles at prescribed times. We must develop the capability to place payloads in exact orbits. We must maneuver in space and rendezvous with cooperative spacecraft and, for knowledge of the military potentials, with uncooperative spacecraft. We must develop techniques for landing on the moon and the planets, and for re-entry into the earth's atmosphere at increasingly high velocities. Finally, we must learn the process of fabrication, inspection, assembly, and check-out that will provide vehicles with life expectancies in space measured in years rather than months. Improved reliability is required for astronaut safety, long duration scientific measurements, and for economical meteorological and communications systems.

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In order to carry out this program, we must continually up-rate the competence of Government research and flight centers, industry, and universities, to implement their special assignments and to work together effectively toward common goals. We also must have effective working relationships with many foreign countries in order to track and acquire data from our space vehicles and to carry out research projects of mutual interest and to utilize satellites for weather forecasting and world-wide communications.

Manned Lunar Landing Program

NASA has many flight missions, each directed toward an important aspect of our national objective. The manned lunar landing program requires for its successful completion many, though not all, of these flight missions. Consequently, the manned lunar landing program provides currently a natural focus for the development of national capability in space and, in addition, will provide a clear demonstration to the world of our accomplishments in space. The program is the largest single effort within NASA, constituting three-fourths of our budget, and is being executed with the utmost urgency. All major activities of NASA, both in headquarters and in the field, are involved in this effort, either partially or full time.

In order to reach the moon, we are developing a launch vehicle with a payload capability 65 times that of the present Atlas booster. We are developing flexible manned spacecraft capable of sustaining a crew of three for periods up to 14 days. Technology is being advanced in the areas of guidance and navigation, re-entry, life support, and structures -- in short, almost all elements of booster and spacecraft technology.

The lunar program is an extrapolation of our Mercury experience. The Gemini spacecraft will provide the answers to many important technological problems before the first Apollo flights. The Apollo program will commence with earth orbital maneuvers and culminate with the one-week trip to and from the lunar surface. For the next five to six years there will be many significant events by which the world will judge the competence of the United States in space.

The many diverse elements of the program are now being scheduled in the proper sequence to achieve this objective and to emphasize the major milestones as we pass them. For the years ahead, each of these tasks must be carried out on a priority basis.

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Although the manned lunar landing requires major scientific and technological effort, it does not encompass all space science and technology, nor does it provide funds to support direct applications in meteorological and communications systems. Also, university research and many of our international projects are not phased with the manned lunar program, although they are extremely important to our future competence and posture in the world community.

Space Science

As already indicated, space science includes the following distinct areas: geophysics, solar physics, lunar and planetary science, interplanetary science, astronomy, and space biosciences.

At present, by comparison with the published information from the Soviet Union, the United States clearly leads in geophysics, solar physics, and interplanetary science. Even here, however, it must be recognized that the Russians have within the past year launched a major series of geophysical satellites, the results of which could materially alter the balance. In astronomy, we are in a period of preparation for significant advances, using the Orbiting Astronomical Observatory which is now under development. It is not known how far the Russian plans have progressed in this important area. In space biosciences and lunar and planetary science, the Russians enjoy a definite lead at the present time. It is therefore essential that we push forward with our own programs in each of these important scientific areas in order to retrieve or maintain our lead, and to be able to identify those areas, unknown at this time, where an added push can make a significant breakthrough.

A broad-based space science program provides necessary support to the achievement of manned space flight leading to lunar landing. The successful launch and recovery of manned orbiting spacecraft in Project Mercury depended on knowledge of the pressure, temperature, density, and composition of the high atmosphere obtained from the nation's previous scientific rocket and satellite program. Considerably more space science data are required for the Gemini and Apollo projects. At higher altitudes than Mercury, the spacecraft will approach the radiation belt through which man will travel to reach the moon. Intense radiation in this belt is a major hazard to the crew. Information on the radiation belt will determine the shielding requirements and the parking orbit that must be used on the way to the moon.

Once outside the radiation belt, on a flight to the moon, a manned spacecraft will be exposed to bursts of high speed protons released from time to time from flares on the sun. These bursts do not penetrate below the radiation belt because they are deflected by the earth's magnetic field, but they are highly dangerous to man in interplanetary space.

The approach and safe landing of manned spacecraft on the moon will depend on more precise information on lunar gravity and topography. In addition, knowledge of the bearing strength and roughness of the landing site is of crucial importance, lest the landing module topple or sink into the lunar surface.

Many of the data required for support of the manned lunar landing effort have already been obtained, but as indicated above there are many crucial pieces of information still unknown. It is unfortunate that the scientific program of the past decade was not sufficiently broad and vigorous to have provided us with most of these data. We can learn a lesson from this situation, however, and proceed now with a vigorous and broad scientific program not only to provide vital support to the manned lunar landing, but also to cover our future requirements for the continued development of manned flight in space, for the further exploration of space, and for future applications of space knowledge and technology to practical uses.

<u>Advanced Research and Technology</u>

The history of modern technology has clearly shown that pre-eminence in a given field of endeavor requires a balance between major projects which apply the technology, on the one hand, and research which sustains it on the other. The major projects owe their support and continuing progress to the intellectual activities of the sustaining research. These intellectual activities in turn derive fresh vigor and motivation from the projects. The philosophy of providing for an intellectual activity of research and an interlocking cycle of application must be a cornerstone of our National Space Program.

The research and technology information which was established by the NASA and its predecessor, the NACA, has formed the foundation for this nation's pre-eminence in aeronautics, as exemplified by our military weapons systems, our world market in civil jet airliners, and the unmatched manned flight within the atmosphere represented by the X-15.

More recently, research effort of this type has brought the TFX concept to fruition and similar work will lead to a supersonic transport which will enter a highly competitive world market. The concept and design of these vehicles and their related propulsion, controls, and structures were based on basic and applied research accomplished years ahead. Government research laboratories, universities, and industrial research organizations were necessarily brought to bear over a period of many years prior to the appearance before the public of actual devices or equipment.

These same research and technological manpower and laboratory resources of the nation have formed a basis for the U. S. thrust toward pre-eminence in space during the last four years. The launch vehicles, spacecraft, and associated systems including rocket engines, reaction control systems, onboard power generation, instrumentation and equipment for communications, television and the measurement of the space environment itself have been possible in this time period only because of past research and technological effort. Project Mercury could not have moved as rapidly or as successfully without the information provided by years of NACA and later NASA research in providing a base of technology for safe re-entry heat shields, practical control mechanisms, and life support systems.

It is clear that a pre-eminence in space in the future is dependent upon an advanced research and technology program which harnesses the nation's intellectual and inventive genius and directs it along selective paths. It is also clear that we cannot afford to develop hardware for every approach but rather that we must select approaches that show the greatest promise of payoff toward the objectives of our nation's space goals. Our research on environmental effects is strongly focused on the meteoroid problem in order to provide information for the design of structures that will insure their integrity through space missions. Our research program on materials must concentrate on those materials that not only provide meteoroid protection but also may withstand the extremely high temperatures which exist during re-entry as well as the extremely low temperatures of cryogenic fuels within the vehicle structure. Our research program in propulsion must explore the concepts of nuclear propulsion for early 1970 applications and the even more advanced electrical propulsion systems that may become operational in the mid-1970's. A high degree of selectivity must be and is exercised in all areas of research and advanced technology to ensure that we are working on the major items that contribute to the nation's goals that make up an over-all pre-eminence in space exploration. Research and technology must precede and pace these established goals or a stagnation of progress in space will inevitably result.

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Space Applications

The manned lunar landing program does not include our satellite applications activities. There are two such program areas under way and supported separately: meteorological satellites and communications satellites. The meteorological satellite program has developed the TIROS system, which has already successfully orbited six spacecraft and which has provided the foundation for the joint NASA-Weather Bureau planning for the national operational meteorological satellite system. This system will center on the use of the Nimbus satellite which is presently under development, with an initial research and development flight expected at the end of 1963. The meteorological satellite developments have formed an important position for this nation in international discussions of peaceful uses of space technology for world benefits.

NASA has under way a research and development effort directed toward the early realization of a practical communication satellite system. In this area, NASA is working with the Department of Defense on the Syncom (stationary, 24-hour orbit, communications satellite) project in which the Department of Defense is providing ground station support for NASA's spacecraft development; and with commercial interests, for example, AT&T on the Telstar project. The recent "Communications Satellite Act of 1962" makes NASA responsible for advice to and cooperation with the new Communications Satellite Corporation, as well as for launching operations for the research and/or operational needs of the Corporation. The details of such procedures will have to be defined after the establishment of the Corporation. It is clear, however, that this tremendously important application of space technology will be dependent on NASA's support for early development and implementation.

University Participation

In our space program, the university is the principal institution devoted to and designed for the production, extension, and communication of new scientific and technical knowledge. In doing its job, the university intimately relates the training of people to the knowledge acquisition process of research. Further, they are the only institutions which produce more trained people. Thus, not only do they yield fundamental knowledge, but they are the sources of the scientific and technical manpower needed generally for NASA to meet its program objectives.

In addition to the direct support of the space program and the training of new technical and scientific personnel, the university is uniquely qualified to bring to bear the thinking of multidisciplinary

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groups on the present-day problems of economic, political, and social growth. In this regard, NASA is encouraging the universities to work with local industrial, labor, and governmental leaders to develop ways and means through which the tools developed in the space program can also be utilized by the local leaders in working on their own growth problems. This program is in its infancy, but offers great promise in the working out of new ways through which economic growth can be generated by the spin-off from our space and related research and technology.

International Activity

The National Space Program also serves as the base for international projects of significant technical and political value. The peaceful purposes of these projects have been of importance in opening the way for overseas tracking and data acquisition sites necessary for manned flight and other programs which, in many cases, would otherwise have been unobtainable. Geographic areas of special scientific significance have been opened to cooperative sounding rocket ventures of immediate technical value. These programs have opened channels for the introduction of new instrumentation and experiments reflecting the special competence and talent of foreign scientists. The cooperation of other countries -- indispensable to the ultimate achievement of communication satellite systems and the allocation of needed radio frequencies -- has been obtained in the form of overseas ground terminals contributed by those countries. International exploitation and enhancement of the meteorological experiments through the synchronized participation of some 35 foreign nations represent another by-product of the applications program and one of particular interest to the less developed nations, including the neutrals, and even certain of the Soviet bloc satellite nations.

These international activities do not in most cases require special funding; indeed, they have brought participation resulting in modest savings. Nevertheless, this program of technical and political value can be maintained only as an extension of the underlying on-going programs, many of which are not considered part of the manned lunar landing program, but of importance to space science and direct applications.

Summary and Conclusion

In summarizing the views which are held by Dr. Dryden, Dr. Seamans, and myself, and which have guided our joint efforts to develop the National Space Program, I would emphasize that the manned lunar landing program, although of highest national priority, will not by itself create the pre-eminent position we seek. The present interest of the United States in terms of our scientific posture and increasing prestige, and our future interest in terms of having an adequate scientific and technological base for space activities beyond the manned lunar landing, demand that we pursue an adequate, well-balanced space program in all areas, including those not directly related to the manned lunar landing. We strongly believe that the United States will gain tangible benefits from such a total accumulation of basic scientific and technological data as well as from the greatly increased strength of our educational institutions. For these reasons, we believe it would not be in the nation's long-range interest to cancel or drastically curtail on-going space science and technology development programs in order to increase the funding of the manned lunar landing program in fiscal year 1963.

The fiscal year 1963 budget for major hardware development and flight missions not part of the manned lunar landing program, as well as the university program, totals $400 million. This is the amount which the manned space flight program is short. Cancellation of this effort would eliminate all nuclear developments, our international sounding rocket projects, the joint U.S.-Italian San Marcos project recently signed by Vice President Johnson, all of our planetary and astronomical flights, and the communication and meteorological satellites. It should be realized that savings to the Government from this cancellation would be a small fraction of this total since considerable effort has already been expended in fiscal year 1963. However, even if the full amount could be realized, we would strongly recommend against this action.

In aeronautical and space research, we now have a program under way that will insure that we are covering the essential areas of the "unknown." Perhaps of one thing only can we be certain; that the ability to go into space and return at will increases the likelihood of new basic knowledge on the order of the theory that led to nuclear fission.

Finally, we believe that a supplemental appropriation for fiscal year 1963 is not nearly so important as to obtain for fiscal year 1964 the funds needed for the continued vigorous prosecution of the manned lunar landing program ($4.6 billion) <u>and</u> for the continuing development of our program in space science ($670 million), advanced research and technology ($263 million), space application ($185 million), and advanced manned flight including nuclear propulsion ($485 million).

The funds already appropriated permit us to maintain a driving, vigorous program in the manned space flight area aimed at a target date of late 1967 for the lunar landing. We are concerned that the efforts required to pass a supplemental bill through the Congress, coupled with Congressional reaction to the practice of deficiency spending, could adversely affect our appropriations for fiscal year 1964 and subsequent years, and permit critics to focus on such items as charges that "overruns stem from poor management" instead of on the tremendous progress we have made and are making.

As you know, we have supplied the Bureau of the Budget complete information on the work that can be accomplished at various budgetary levels running from \$5.2 billion to \$6.6 billion for fiscal year 1964. We have also supplied the Bureau of the Budget with carefully worked out schedules showing that approval by you and the Congress of a 1964 level of funding of \$6.2 billion together with careful husbanding and management of the \$3.7 billion appropriated for 1963 would permit maintenance of the target dates necessary for the various milestones required for a final target date for the lunar landing of late 1967. The jump from \$3.7 billion for 1963 to \$6.2 billion for 1964 is undoubtedly going to raise more questions than the previous year jump from \$1.8 billion to \$3.7 billion.

If your budget for 1964 supports our request for \$6.2 billion for NASA, we feel reasonably confident we can work with the committees and leaders of Congress in such a way as to secure their endorsement of your recommendation and the incident appropriations. To have moved in two years from President Eisenhower's appropriation request for 1962 of \$1.1 billion to the approval of your own request for \$1.8 billion, then for \$3.7 billion for 1963 and on to \$6.2 billion for 1964 would represent a great accomplishment for your administration. We see a risk that this will be lost sight of in charges that the costs are skyrocketing, the program is not under control, and so forth, if we request a supplemental in fiscal year 1963.

However, if it is your feeling that additional funds should be provided through a supplemental appropriation request for 1963 rather than to make the main fight for the level of support of the program on the basis of the \$6.2 billion request for 1964, we will give our best effort to an effective presentation and effective use of any funds provided to speed up the manned lunar program.

With much respect, believe me

Sincerely yours,

Original Signed By
James E. Webb

James E. Webb
Administrator

cc: The Vice President
Director, Bureau of the Budget
Director, Off. Science & Technology
Program Directors and Staff Officers

7/12/63

A-6 Philip T. Drotning

M D. Brainerd Holmes (signed)

Pace of the Manned Space Flight Program

This is in response to your memorandum of June 25, in which you ask a series of questions relating to the pace of the effort to begin the manned exploration of the moon in this decade.

The primary consideration, of course, is international competition. It has been frequently observed that we in the United States are handicapped by a lack of knowledge of Soviet plans and intentions. With what little we do know, we can conceive of the possibility that, had they begun two or three years ago on a program aimed at landing men on the moon, they could do so in the 1966-70 time period. Prudence, therefore, indicates a need to carry on a United States program paced with a reasonable degree of urgency and in which a few calculated risks are taken.

However, the pace of the United States program was not established on the basis of a narrow, single-minded, closed-end program limited to manned lunar landing. We are providing also for general technological advance and for a national capability that will enable us to go in many possible directions in space--a capability that will make the United States truly preeminent. Providing this broad national competence limits the pace to some extent and increases the costs somewhat in comparison with a more narrow program.

Within that framework, let us examine whether the pace of the manned lunar landing program is reasonable. There are three fundamental considerations, partly based on technical factors and partly based on management experience and other elements less subject to precise measurement. They are as follows:

1. Relation of the pace to the state of technology.

2. Economics.

3. Motivation of the participants.

So far as the first consideration is concerned, we can ask the question: Is the state of the art such that it is reasonable to freeze the design of hardware required to achieve the objectives of Project Apollo and carry out the program at its present pace, or can we foresee technical breakthroughs that would enable us to do so much more simply or at considerably less cost if the time scale were longer?

To answer this question, let us look at the required technology in six essential areas--propulsion, guidance and navigation, human factors, knowledge of the lunar surface, communications, and reliability. In five of these areas, we can foresee no such major advance. It is unlikely, for example, that nuclear propulsion would be available if we waited five years. Prior to the availability of nuclear propulsion, only modest improvements are predictable in propulsion technology. Similar statements can be made for the areas of guidance and navigation, human factors, and communications.

In the area of reliability, it could be argued that greater improvements could be expected in a program spread over a longer period of time. This is true to some extent insofar as components are subject to testing on the ground. With respect to the reliability to be gained from flight testing, it is not true because we would not in fact carry out the additional flights. In a program stretched out over a longer period of time, we would begin flights at a later date than under present plans. By conducting a fast-paced program, we will begin flights at an early date. Testing will continue until the time that the overall reliability of the system has reached the required level for manned flights.

In the sixth area, knowledge of the lunar surface, our present lack of knowledge limits us to some extent in the design of the landing gear of the Lunar Excursion Module. We look forward with great anticipation to information that will be obtained in the next few years from the unmanned lunar exploration programs. We are quite distressed at any proposals to reduce emphasis in this area of the NASA program.

Some of the design of the Lunar Excursion Module will be frozen in advance of the availability of information from the unmanned Ranger and Surveyor programs. Consequently, we will select a very conservative design and we will provide for flexibility in design change over the next few years. There are adequate weight margins in the Apollo system to provide for this flexibility. Thus this problem does not threaten the success of the program.

In sum, we do not believe this is an unreasonable time in the history of technology to be conducting a program to develop the hardware for carrying men to the moon and back, and the pace of the program does not place unreasonable strains on the state of technology. Any research and development effort stretches the state of the art to some degree. If it did not, it would merely be a production program. But the advancement of technology required to accomplish the goals of Project Apollo is well within our reach. This advancement of technology, as stated previously, is one of the objectives of Project Apollo.

Economics is a second major consideration. It is reasonable to ask whether the total cost of the program is materially increased by the pace at which we are conducting it. We are conducting further analysis to provide as precise an answer to this question as is possible. However, we have reached tentative conclusions on the basis of experience and preliminary study.

The cost of a major research and development program is roughly the sum of three factors as follows: (1) a constant factor that designates work that must be done and facilities that must be constructed, regardless of the pace at which the program is conducted; (2) an operating burden, which designates costs that are relatively fixed and therefore almost in direct proportion to the length of the program; and (3) a time-saving factor, which includes funds expended for such purposes as overtime, parallel paths of development, the purchase of hardware and facilities beyond those required for a slower-paced program, and the provision of duplicate personnel complements for launch preparations and associated efforts.

If a research and development program is conducted on too short a time scale, the time-saving factor will become excessive and the total cost will rise. Similarly, if the time scale is stretched out over too long a period, the accumulated operating burden will become excessive, and the total cost will also rise. Somewhere between these extremes, there is a time scale at which these opposing factors balance and the total cost is at a minimum.

In theory, a minimum-cost program would be one in which the amounts expended on operating burdens and the time-saving factor would be roughly equal. A cursory examination of the present Apollo program costs from this point of view fails to disclose very great expenditures on the time-saving factor. Overtime is quite limited. Very few parallel approaches are being taken. Even if Congress appropriates every penny we have requested for the current fiscal year, funding will begin to be a distinct limiting factor in establishing the pace. Thus, it is conceivable that a further analysis might indicate that a minimum-cost program would be one conducted at a faster pace than the present one. In any case, we have failed thus far to find any evidence that any excess of time-saving expenditures over the operating burden is adding significantly to the total cost of the program. In our judgment, based on experience with the management of R&D programs in the past, the present pace of Project Apollo is quite close to the optimum--one that would enable it to be carried out at a minimum total cost.

As for the third major consideration, experience has demonstrated that participants are most highly motivated when extremely tight but achievable deadlines are set. The time required to do a job in research and development often expands in relation to the time available. It will always be possible to make marginal improvements in any piece of hardware. If the time is extended over too long a period participants lose motivation and their sense of urgency.

In the consideration of motivational factors, it is important that the goals of the program be understood by all. In a very large program, in which hundreds of thousands of persons will take part, difficulties in communicating this information might be anticipated. In Project Apollo, however, the goal is easily communicated. This motivational factor is a considerable portion of the "magic" of beginning lunar exploration in this decade.

In this discussion, I have covered most of the detailed questions in your memorandum. Let me, however, deal with them individually, even if this requires some repetition.

1. Would our costs be reduced if we proceeded toward the lunar landing at a slower pace? Conversely, might a slower pace involve greater rather than lower costs?

Our judgment, based on experience, is that a slower pace would involve greater total costs. We are continuing examination of the program for information bearing on this question.

2. Is there any validity to the assertion that costs are excessive because we are stretching the limits of the state of the art?

No. The required advances in the state of the art are well within our reach. Indeed, in many cases, employing the present state of the art would be a more difficult or more expensive way to solve our problems.

3. Is there any basis for the assertion that without previous unmanned exploration of the lunar surface we may find that we have designed equipment inadequate to deal with the conditions which exist there?

It is true that we are paying an engineering penalty for this lack of information. However, the problem involves only the landing gear of the Lunar Excursion Module. We plan to select a sufficiently conservative design of this gear to provide reasonable assurance of its effectiveness. If later information obtained from the unmanned lunar programs indicates the necessity, we will modify the design.

4. Is there any basis for the assertion that our lunar efforts might have greater success at lower cost if we slowed the pace to permit greater scientific understanding of the environment?

We have already dealt with the questions of lower cost. We do not believe that a slower pace would lead to significantly reduced costs. The degree of success in Project Apollo flight missions is not at issue. Following the practice established in Project Mercury, we intend to commit astronauts to flight only after we have taken all necessary and reasonable precautions.

As to the question of scientific understanding of the environment, present data leads us to believe that radiation and the incidence of micrometeoroids do not impose serious design problems. The only major question about the environment is the strength and condition of the lunar surface at the point of landing.

In this regard, we will proceed as stated previously on the basis of a very conservative assumption. We will not design equipment involving this assumption until we must; we will retain a high degree of flexibility to change the design if necessary; and we will assume stringent requirements based upon all of the facts available and taking into consideration all reputable expert opinion. Nevertheless, there will remain some risk that this aspect of the program will be more expensive or more difficult than we now expect.

As stated earlier, some calculated risks are being taken in this program. Indeed, calculated risks must be taken in any major research and development program conducted at any pace to meet any deadline. A good case can always be made for delaying any hardware decision until more information is available. But if we were to allow caution to dominate all other considerations, we would fail to proceed at all. By carrying this sort of argument to its extreme, one might even make the statement that if all of our assumptions about the environment are wrong, it might be impossible to go to the moon at all.

5. What can be said in response to the repeated assertion by persons outside of NASA that this is a "crash program?" When does an "orderly, fast-paced program" become a "crash program?"

The term "crash program" is generally used to denote one in which the cost is not the major consideration, in which several parallel approaches are taken for the solution of each major problem, and in which overtime and multiple shifts are utilized to a very large degree. None of these statements are ~~true~~ true for Project Apollo.

As to the orderliness of the approach, it might be noted that following the President's statement of May, 1961, NASA first reorganized its headquarters and selected major sites. Following several months of NASA/DOD study, the Saturn V launch vehicle program was initiated in December, 1961. More than a million man-hours of engineering studies preceded the announcement of tentative decision on the lunar orbit rendezvous mode of flight in July, 1962, and several months of additional studies were conducted before that decision was confirmed in November, 1962. During all of this time, we have built up the scope of our efforts rapidly, but the program is fully under control.

I would make one additional observation regarding the pace of the effort. This program has been under way for more than two years. It has generated a momentum of its own. Even if we were to find that some other pace would have been a more desirable one to have selected, a major change in pace would have to be carefully considered in view of the attendant inefficiencies which would accrue by virtue of the change itself. This country learned through its experience with the missile programs of the 1950's of the waste involved in the continual changing of the scope and objectives of research and development, and the repated starting and stopping of programs. A good R&D team takes time to organize; it is terribly wasteful to disband such a team after it has learned to work together.

cc: Mr. Webb
Dr. Dryden
Dr. Seamans

NASA HEADQUARTERS

June 25, 1963

MEMORANDUM for Mr. D. B. Holmes - M

The Administrator has requested a document for high level government use which will deal with some of the questions which have been raised about the nature and pace of our present civilian space effort.

As you are aware, the pace of the effort -- the question, "What is magic about getting to the moon by 1970" -- has been under sharp attack in many quarters. In responding to this argument, I would appreciate any comment and factual information which you and your associates can give me in answer to the following questions:

1. Would our costs be reduced if we proceeded toward the lunar landing at a slower pace? Conversely, might a slower pace involve greater rather than lower costs?

2. Is there any validity in the assertion that costs are excessive because we are stretching the limits of the state of the art?

3. Is there any basis for the assertion that without previous unmanned exploration of the lunar surface we may find that we have designed equipment inadequate to deal with the conditions which exist there?

4. Is there any basis for the assertion that our lunar efforts might have greater success at lower cost if we slowed the pace to permit greater scientific understanding of the environment?

5. What can be said in response to the repeated assertion by persons outside NASA that this is a "crash program." When does an "orderly, fast-paced program" become a "crash program"?

Anything which you can give me which will support a strong statement in defense of our present level of effort and lunar target dates will be appreciated.

As a separate item, I would appreciate anything you can supply which would support the conclusion that an indirect benefit from the space program will be the development of new management techniques which will be of value to industry.

Because of our deadline requirements, I would appreciate having this material by July 8 - earlier, if possible.

Thanks.

P T Drotning

Phillip T. Drotning

C O P Y

THE VICE PRESIDENT
Washington

July 31, 1963

Dear Mr. President:

This is in response to your memorandum of July 29, 1963, in which you asked two questions regarding the moon program and our military space requirements.

There was no Administration moon program until your message to Congress in May 1961. The previous Administration undertook studies on this question, but no commitment for hardware, facilities, or schedule was made.

It is not possible to ascribe a quantitative measure to the military spin-offs from the non-military portion of the space program. However, all of the scientific and engineering ability and experience in space has direct or indirect value, no matter whether it is now being applied to military or non-military missions.

NASA's manned space flight program will contribute competence in rendezvous technique, in control and guidance systems, in life protection measures, and in improvement in propulsion. All of these have military significance and can materially contribute to military control in space.

The space program is expensive, but it can be justified as a solid investment which will give ample returns in security, prestige, knowledge, and material benefits.

This reply has been concurred in by all members of the Space Council.

Sincerely,

/s/ Lyndon B. Johnson

Lyndon B. Johnson

The President
The White House

C O P Y

B-I-12

NASA FACTS

AN EDUCATIONAL PUBLICATION OF THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NF-23/VOL. IV, NO. 7 *

Manned Space Flight: Apollo

Apollo is the third step in NASA's manned space flight program. Its goals:

* To land American explorers on the moon and bring them safely back to earth.

* To establish the technology required to meet other National interests in space.

* To achieve for the United States pre-eminence in space.

Apollo was preceded by Project Mercury which pioneered the technology and man's capabilities for manned space flight and by Gemini which significantly extended the technology and experience gained through Mercury. Both Mercury and Gemini were programs in which astronauts test piloted spacecraft which were largely experimental. Apollo, on the other hand, calls for an operational spacecraft capable of carrying astronauts safely to and from another body in the solar system.

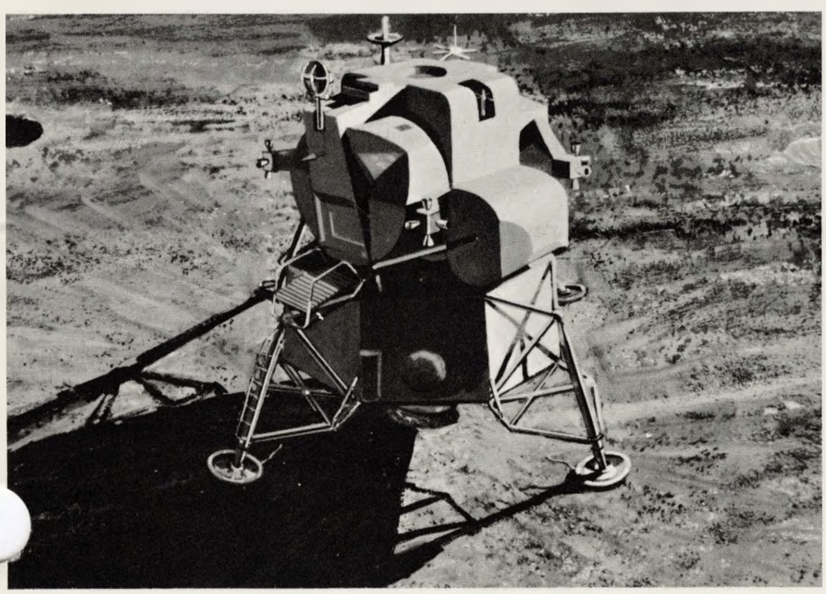
LUNAR ORBIT RENDEZVOUS

Three methods were considered to accomplish the manned lunar landing mission. They were: 1) direct flight of a full-size spaceship from the earth to the moon and back, 2) launching two separate sections of a spaceship from earth into orbit, joining them together, and sending them as a single spacecraft to land on and take off from the moon; and 3) launching the whole spacecraft from earth to lunar orbit and landing a section of the craft on the moon while the other part waits in orbit for the landing craft to return.

The third method, called lunar orbit rendezvous, was chosen after careful study. This method reduced significantly the rocket power required for landing on and taking off from the moon. Moreover, a craft using the earth-orbital rendezvous method (2) would weigh more than twice as much as the one using the lunar-orbit rendezvous method, mainly because of additional fuel.

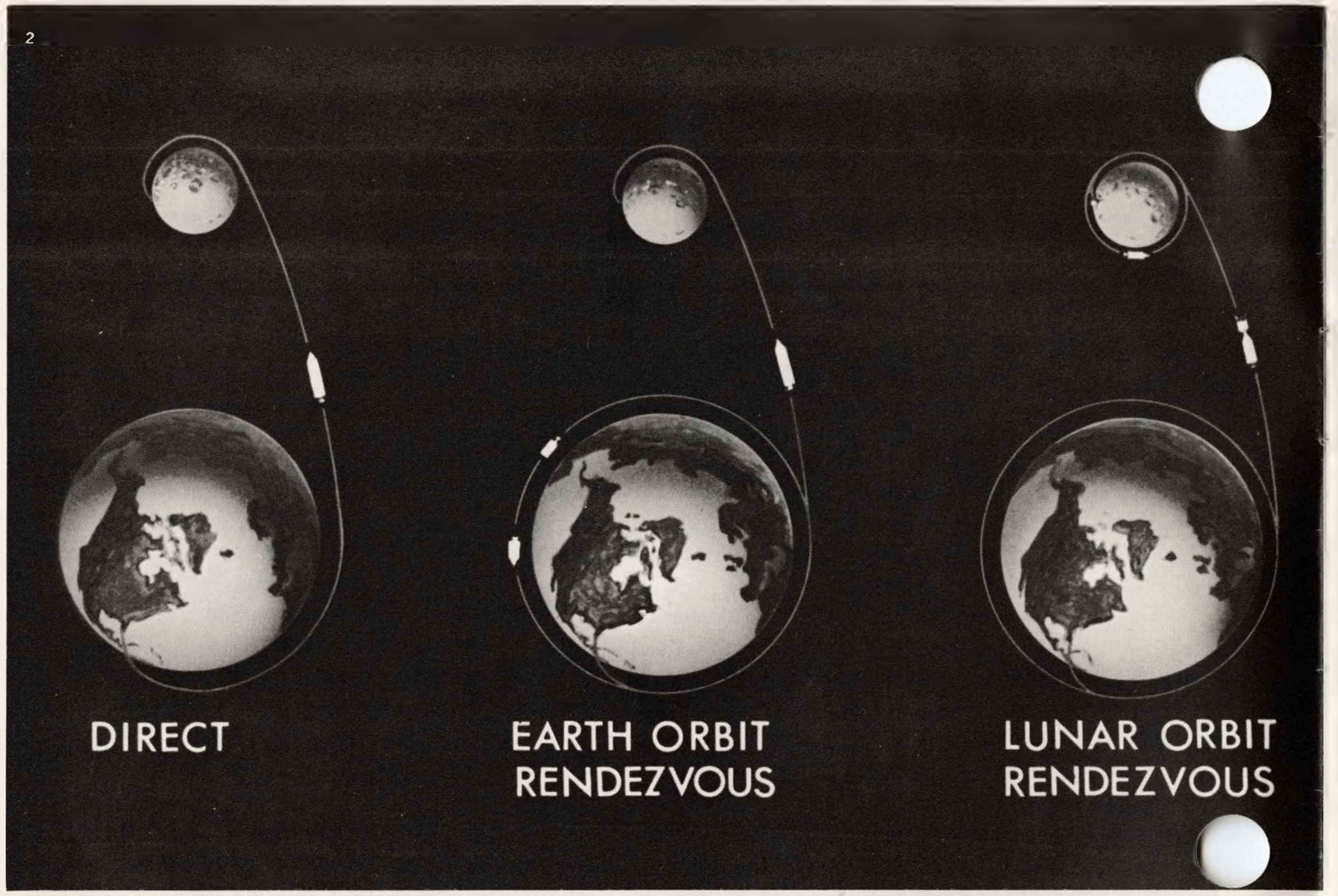
APOLLO SPACECRAFT

The Apollo spacecraft assembly is 82 feet tall and weighs about 45 tons. It is composed of three modules (separable units or "blocks"), plus an adapter and a launch escape system (LES).



Lunar Module of Apollo spacecraft, piloted by two astronauts, moments after touchdown on the moon.

* REPLACES VOL. III, NO. 1



COMMAND MODULE

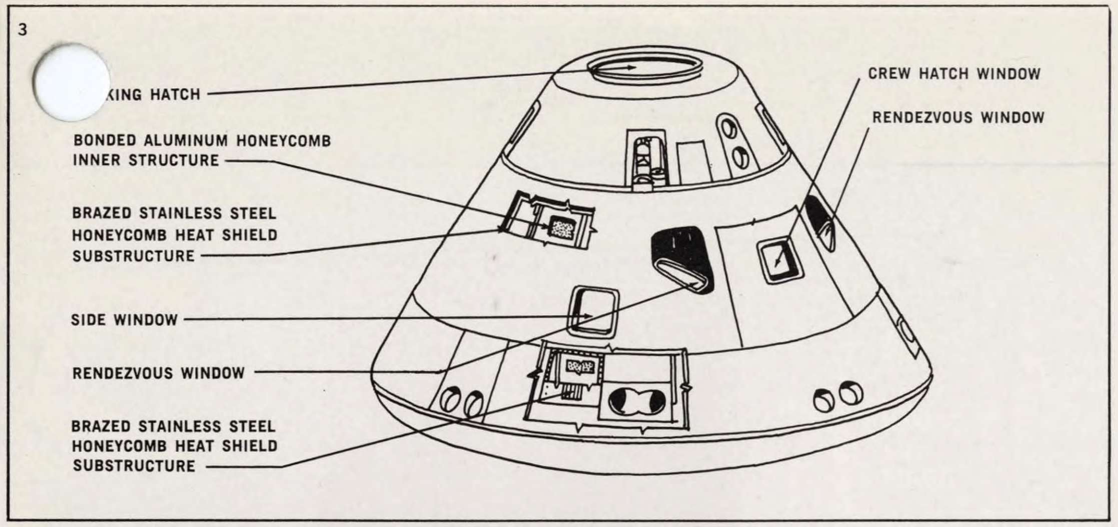
The Command Module (CM) is the only module which will return to earth from the lunar mission. It contains the crew's living compartment and all the controls for the various in-flight maneuvers. Similar in shape to a cone, this module has a bottom width of 13.8 feet and stands about 12 feet high. It consists of two shells: a pressurized inner crew compartment and an outer heat shield. Launch weight is about 12,000 pounds. More elaborately equipped for human comfort than either the Mercury or Gemini spacecraft, the Apollo CM contains a pilot cockpit for three astronauts. It has two side windows, a crew hatch window, and two rendezvous windows which face toward the nose of the CM.

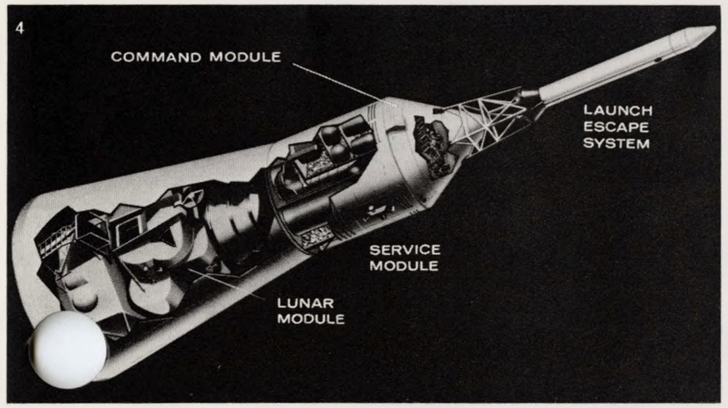
The Apollo Environment Control System (ECS) is similar to that of the Gemini spacecraft. It supplies pure oxygen in the cabin at 5 psi (pounds per square inch), a temperature of approximately 75° with a humidity index between 40% and 70%.

LAUNCH ESCAPE SYSTEM

On top of the Command Module at launch is the Launch Escape System (LES) tower, with rocket motors similar to those used on the Mercury escape system. The LES is 33 feet tall and weighs about 8,200 pounds. With this tower and motors, the launch pad Apollo spacecraft (without its booster) has a total height of 82 feet. It is almost as tall as the combined Mercury-Atlas vehicle that placed John Glenn in orbit on America's first manned orbital flight in 1962.

The LES is designed to separate the command module from the rest of the launch vehicle should an emergency occur on the launch pad or shortly after lift-off. The system rockets the command module a safe distance away from the launch vehicle and to an altitude high enough for parachutes in the module to function for descent to earth. The LES is jettisoned about 35 seconds after ignition of the launch vehicle's second stage.





2 Techniques considered for the lunar landing mission.
3 Apollo Command Module.
4 Apollo spacecraft.

SERVICE MODULE

Beneath the Command Module at launch is the Service Module, a cylindrical unit 12.8 feet in diameter and 22 feet tall, weighing 55,000 pounds. It contains the spacecraft's electrical power supply equipment and its primary propulsion system, which produces 22,000 pounds of thrust. This stop-and-restart engine will be used for several important maneuvers while the spacecraft is moon-bound. It will also be used to slow the spacecraft to go into lunar orbit, to make midcourse corrections while earth-bound.

Having fulfilled all these functions during the round trip, the Service Module will be jettisoned prior to the Command Module's reentry into the earth's atmosphere.

ADAPTER

Under the Service Module, at launch, is the adapter section which connects the Apollo spacecraft to the third stage of the Saturn V launch vehicle and serves as the housing for the Lunar Module (LM), the lunar landing vehicle.

The adapter section is a fairing 28 feet tall. It is 12.8 feet in diameter at the top to match the width of the Apollo spacecraft. At the bottom it flares out to a diameter of 22 feet in order to match the width of the Saturn V booster's third stage (S-IVB). Weight of the adapter section is about 4,000 pounds.

LUNAR MODULE

The Lunar Module (LM), which weighs approximately 35,000 pounds, is the flight unit that will detach from the orbiting Command and Service Modules and descend to the moon's surface with two of the three astronauts aboard. Called the "bug" because of its appearance, it has two windows that will serve as "eyes" for the landing maneuvers, a tubular "mouth" for entry and exit, and four spidery "legs" for steady support after lunar touchdown.

The LM has its own complete guidance, propulsion, computer, control, communications, and environmental control systems, all with at least one and sometimes two backup systems. These precautions are necessary because landing on the moon will be the lunar mission's most critical phase.

The LM's descent propulsion system has a throttle control—its rocket engine's thrust power can be varied from low to high (1,050 pounds to 10,500 pounds) in order to control the lunar touchdown flight with great precision. The pilots will use this engine to provide braking thrust for the moon landing.

The final descent can be slowed to 3 mph at an altitude of 15 feet, but if the LM should drop at twice this speed, its four jointed steel-truss legs can absorb the landing shock without harm to the craft or crew. The legs are also designed to land on slopes up to 12 degrees in slant, or to retain balance if one or two legs sink into a layer of dust as much as 12 inches deep.

The LM is a two-stage vehicle. The bottom stage contains the rocket engine and legs for lunar landing. For the return trip, this stage also serves as the "launch platform" for the upper stage, which includes the cabin for the astronauts and the ascent engine. The ascent engine propels the upper stage from the lunar surface for rendezvous and docking with the CSM (combined Command and Service Modules) which had remained in lunar orbit.

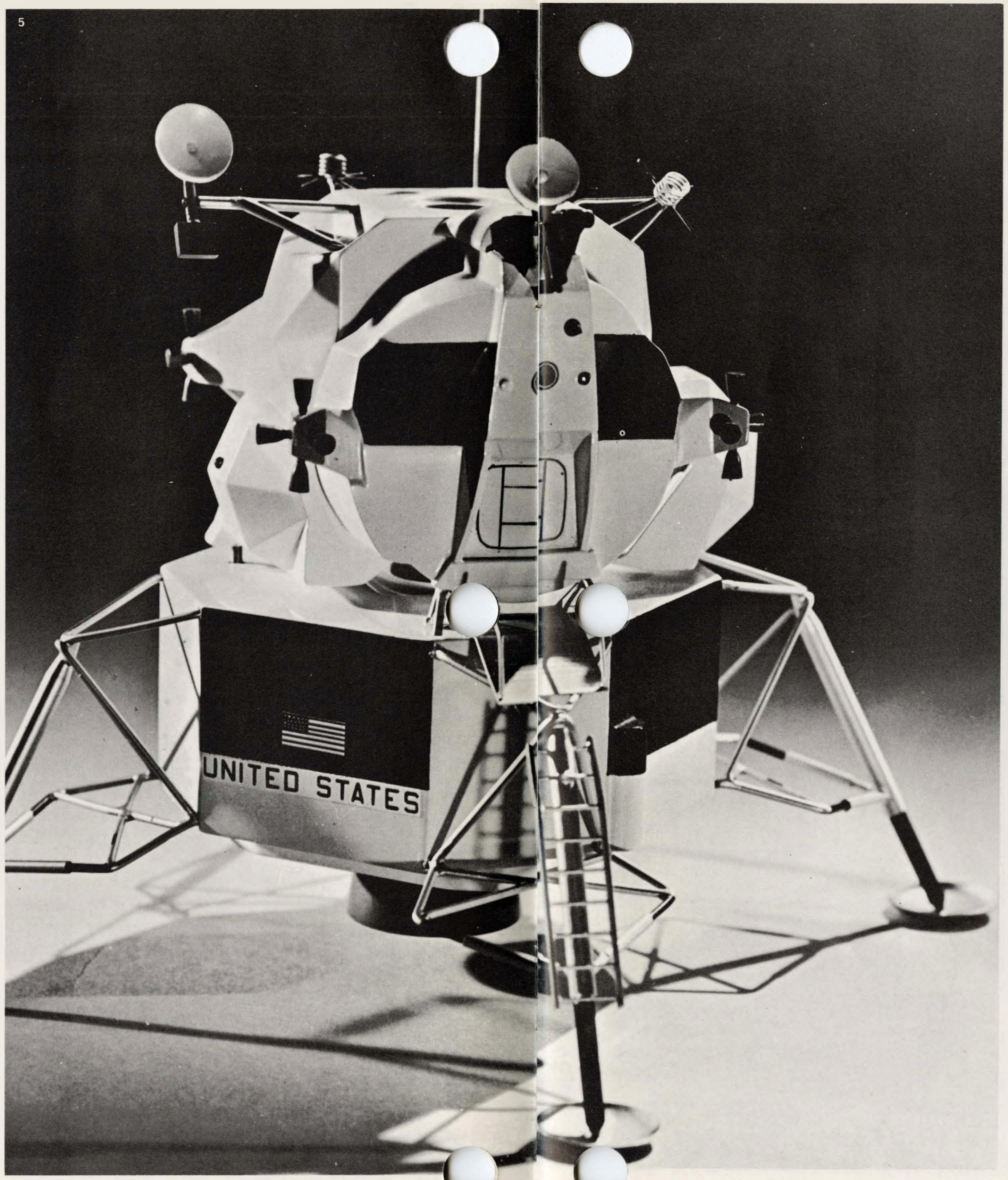
GUIDANCE AND NAVIGATION

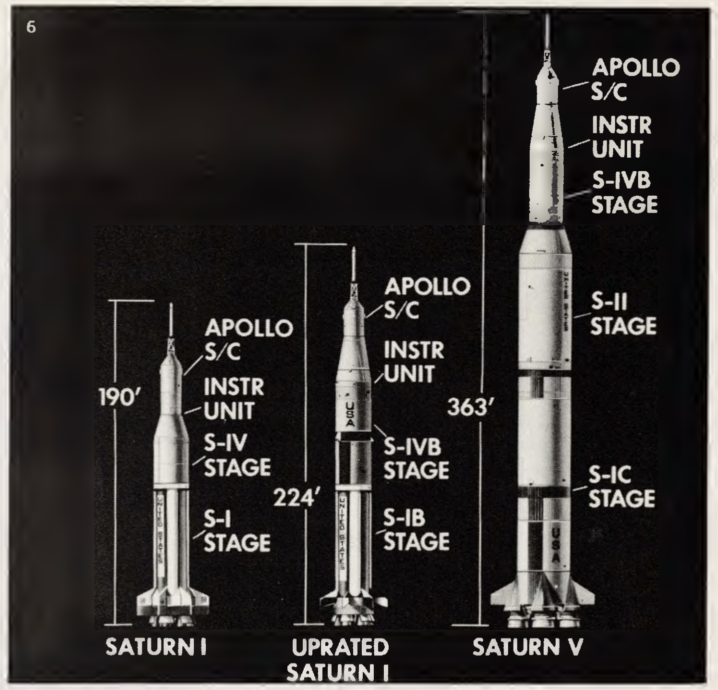
The Apollo space navigation system includes two relatively conventional units—inertial guidance platform and flight pattern computer. A third unit is an optical space sextant with which the astronauts will take sightings of the earth, moon, and reference stars to check out their position before each maneuver.

ASTRONAUT WARDROBE

The Apollo crewmen will have a changeable wardrobe for wear at different times. On the trip, two of the men (in rotation with the third) may relax in their "constant wear garment," a two-piece, close-fitting garment which covers all the body except the head and hands.

The third man will be in the Apollo space suit, with "accordion" joints (bellows principle) for flexible ease in walking, bending, or moving his limbs, and a helmet that has a pivoted visor for



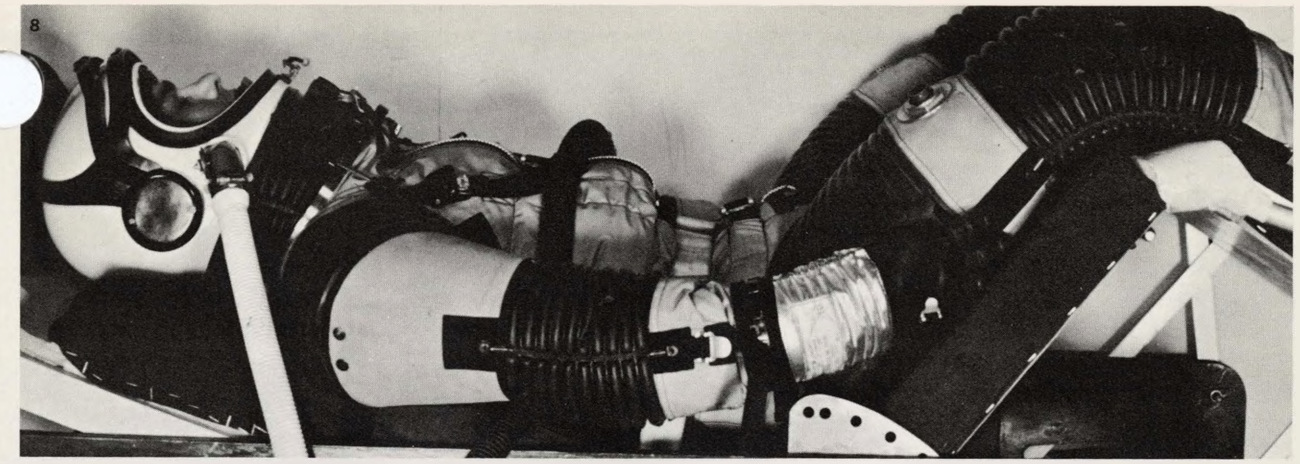


5 Model of Apollo Lunar Module.
6 The Apollo launch vehicles. (see text page 7)

7

7 Wearing an Apollo pressure suit and buoyed by apparatus that cancels out five-sixths of his weight, an engin carries out an experiment in a simulated lunar crater.

8



8 Test of Apollo pressure suit.

quick closing and sealing.

The same type of space suit will be worn by the two LM astronauts who explore the moon. Underneath the pressure suit will be a special undergarment interwoven with a fine network of water-circulating tubes to carry away body heat. Covering the entire space suit will be a "thermal garment," or a white coverall with hood, to protect the astronaut from blistering sunshine on the airless moon. Finally, a "meteoroid cape" on his back will protect him from micrometeoroid dust which may rain down on the moon at high speed. Meteoroids that would penetrate the cape are calculated to be rare.

An important unit of the Apollo space suit system is the strap-on backpack for lunar exploration which includes a 4-hour oxygen supply, two-way radio, heat-dumping radiator, and dosimeter (radiation gauge). Partial radiation protection is built into the space suit fabric.

LAUNCH VEHICLES

The Apollo launch vehicles are the Saturn I, Uprated Saturn I, and the Saturn V.

(1) The Saturn I developed 1.5 million pounds of thrust in its first stage (S-1) through the clustering of eight H-1 rocket engines burning RP-1 (refined kerosene) and LOX (liquid oxygen). Its second stage (S-IV) had six RL-10-A3 engines burning liquid hydrogen and LOX, producing 90,000 pounds total thrust. With a diameter of 21.5 feet and standing 125 feet tall (without spacecraft), this two-stage vehicle delivered a payload of 22,000 pounds into low earth orbit.

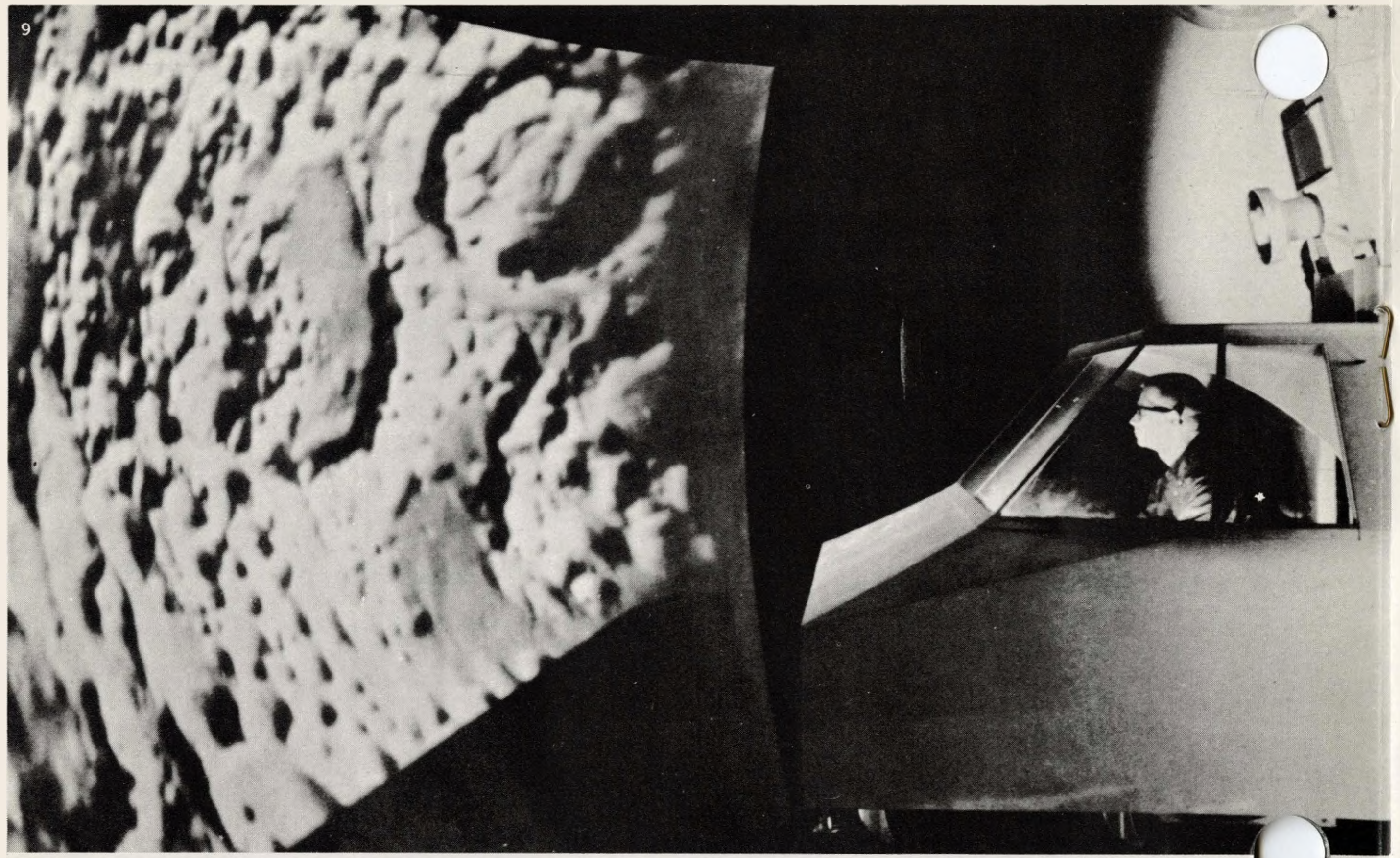
The Saturn I has placed the Command and Service Modules of the Apollo spacecraft into orbit in unmanned test flights and has been used to launch the Pegasus micrometeoroid technology satellites. The Saturn I program was completed in 1965 with ten successes in as many launches.

(2) The Uprated Saturn I has an improved version of the Saturn I first stage and a new and more powerful second stage—the S-IVB. The Uprated Saturn I is designed to launch the first manned Apollo flights into earth orbit.

The second stage (S-IVB) has one J-2 engine which burns liquid hydrogen and LOX and produces 200,000 pounds thrust. Low earth-orbit payload for the Uprated Saturn I is 40,000 pounds.

(3) The Saturn V is a vehicle of gigantic size and power. The first stage (S-IC) has a diameter of 33 feet and is powered by a cluster of five F-1 engines, each developing 1.5 million pounds of thrust, for a total of 7.5 million pounds.

The Saturn V second stage (S-II) has a cluster



9 Space flight simulator, with image of the moon on left, shows what man can and cannot do in controlling spacecraft during actual missions.

10 An Apollo-Saturn V test vehicle.

of five J-2 engines that furnish a total of 1 million pounds of thrust. The Saturn V's third stage (S-IVB) is identical with the Uprated Saturn I's second stage and produces 200,000 pounds of thrust.

This immense three-stage booster is 281 feet tall. The entire Apollo-Saturn V assembly will stand 365 feet high at the launch pad and will weigh 6 million pounds fueled before a moon flight. It will furnish the power to boost the Apollo Command, Service, and Lunar Modules into both manned earth orbital and lunar flights.

The mighty Saturn V launch vehicle will be able to launch 140 tons into a low earth orbit at a speed of 5 miles per second (mps), and accelerate 47.5 tons of payload to an escape velocity of 7 mps. This means that both the Apollo spacecraft and the Saturn V third stage will go into parking orbit, after which the S-IVB will re-ignite and add speed of 2 mps to send the spacecraft on its way to the moon.

UNMANNED MOON EXPLORATION

Three manned spacecraft programs are contributing to planning for manned landings by providing close-range pictures and other information about the moon. The first of these was Ranger, completed in 1965, which telecast close-ups of selected lunar areas before crashing as intended on the moon.

Another spacecraft is Lunar Orbiter which takes sharp close-range photographs of extensive areas from relatively low orbits around the moon. The photographs are being used primarily to select sites for manned landings. In a closely coordinated effort, Surveyor spacecraft are soft-landed on the moon to transmit pictures and other information about the lunar surface in their vicinity. These are coordinated with the broader overhead views provided by Lunar Orbiters.

TRAINING

Astronaut training for the Apollo program includes the "basic space training" of the Mercury and Gemini programs along with the new Apollo specialties which are added from time to time, among them:

* "Moon Trips" in trainers that provide a realistic simulation of travel through space, descent to the moon, and return to earth.

* "Lunar Obstacle Course," a 328-foot-wide simulation of the moon's rugged surface, complete with craters up to 50 feet wide and 15 feet deep, large boulders, a dust layer, and fissures over which to jump. A suspension harness reduces an astronaut's weight to the moon's value (1/6th earth weight).

* "Space Suit Workouts," during which astronauts wear experimental Apollo pressure garments to practice walking, bending, opening of visor, and other operations.

MOON FLIGHT TRACKING SYSTEM

A network of tracking stations around the world was established for Project Mercury; augmented for Gemini, and redesigned and rebuilt for Apollo.

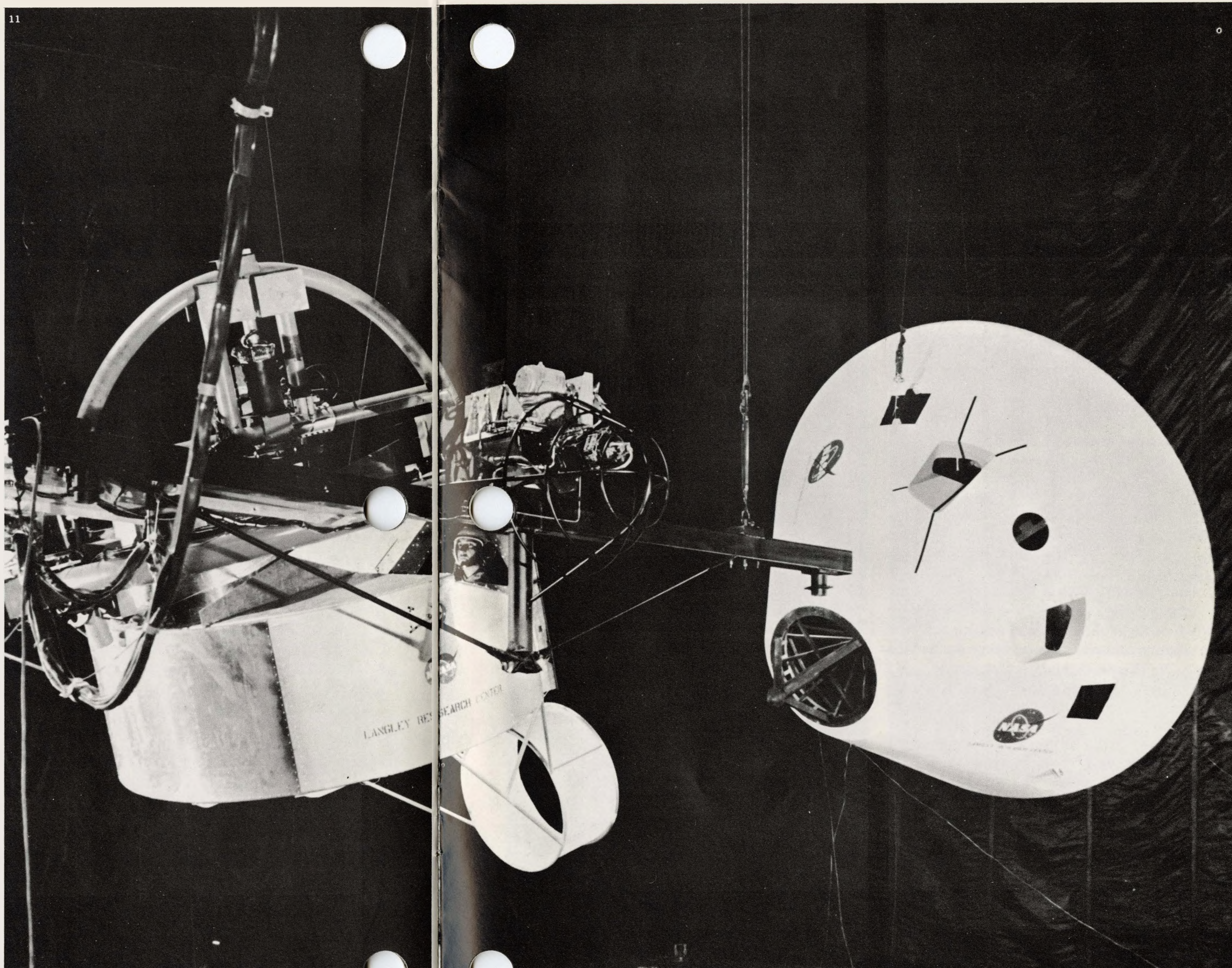
One group of network stations will follow the Apollo spacecraft at launch, during earth orbit, and again at the end of the flight after the moon trip is finished.

As the spacecraft leaves earth orbit and starts toward the moon, it passes from range of these stations. Tracking then switches to a second group of stations whose powerful transmitters and sensitive receivers are dependable for communications at great distance.

These stations have huge 85-foot diameter dish-shaped antennas and are similar in appearance to those which communicate with spacecraft, such as Mariner, millions of miles away in the vicinity of Mars or Venus or orbiting the sun.

Located at Goldstone, California; Madrid, Spain; and Canberra, Australia, they stand approximately one-third of the earth's circumference (120°) apart. As the rotating earth cut offs one station's direct line of contact with the spacecraft on its way to the moon or back, the next station rises above the horizon and takes over.

When the returning Apollo, speeding toward earth at 25,000 mph, enters the range of the earth-orbital tracking chain, these stations go into operation again and monitor the vital reentry and recovery.



Rendezvous docking simulator enables astronauts to practice the last 200 feet of lunar orbit rendezvous and docking.

Sequence of major events in Apollo lunar landing mission.

FLIGHT TO THE MOON

The first U.S. manned flight to the moon will take place sometime before the end of this decade. The mission will begin with launch of the 365-foot Apollo-Saturn V vehicle. The first and second stages will be jettisoned after burning all their propellants, but the third stage will burn only enough to place itself and the three-module Apollo spacecraft in "parking" orbit about 100 miles high.

Later, when the lunar "launch window" (best period of time for takeoff) is open, the third stage will refire and add enough speed for the Apollo spacecraft to escape from earth orbit.

On the way to the moon, the crew will reorient the combined Command and Service Modules (CSM) and dock (link-up) the nose of the Command Module with the nose of the Lunar Module (LM). The CSM then extracts the LM from the adapter section and the third stage of the launch vehicle.

Mid-course maneuvers may be made if the lunar trajectory, or flight path, requires adjustment. The maneuvers are accomplished by firing the Service Module's 22,000-pound-thrust rocket engine.

By about 54 hours after launch, earth's gravity will have slowed the spacecraft gradually from about 25,000 mph to about 2,500 mph. When it enters the area where the moon's gravitational field is dominant, the spacecraft will be accelerated toward the moon.

About 64 hours after launch, the spacecraft will near the moon at a speed of about 5,200 mph and the astronauts will apply the retro power of the Service Module propulsion system for about 6 minutes to slow the spacecraft down to about 3,600 mph. This will cause the craft to swing into a lunar orbit about 80 miles high. For the lunar landing, two men will transfer into the LM.

After about 68 hours of mission time, the LM will separate from the CSM with a difference in velocity of about 3 mph and will move away about 735 feet. The descent engine will then put the LM into a transfer orbit at a velocity of 3,500 mph. The LM will coast until an altitude of about 49,500 feet is reached; then powered descent will begin. Powered descent will take the LM to the hover altitude of 200 feet, where either a manual or automatic hover-to-touchdown procedure will be initiated. In either method, the engine will be cut off at LM altitude of about 15 feet, giving the LM a lunar impact speed of about 3 mph.

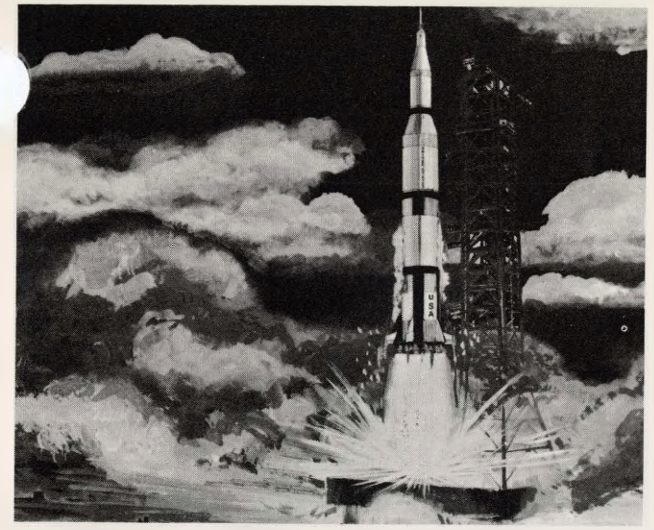
ASTRONAUT EXPERIMENTS ON THE MOON

Plans call for the astronauts to stay on the moon about 18 hours. Of this time, they will work on experiments for two separate 3-hour periods, in between which they will have about 6 hours of sleep. The remaining time will be spent on such matters as equipment checks, meals, making ready for experiments, post-landing inspection, and preparation for take-off.

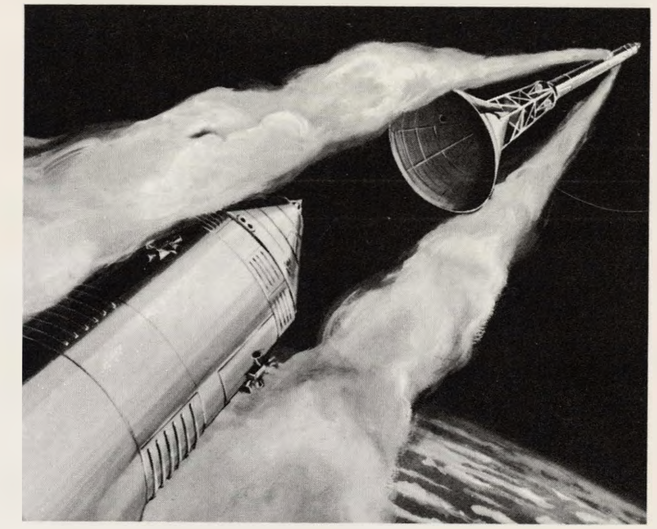
The most important parts of the astronauts' duties are their radioed descriptions, photographs, and direct telecasts of the moon and the 60 pounds of assorted rock samples they are to bring home in vacuum-sealed containers. In addition, the astronauts are to set up a group of Lunar Surface Experiments which will continue to radio their information to earth for as long as a year. The experiments are designed to report on such scientific phenomena as temperature changes, radiation levels, moonquakes, and micrometeoroids (tiny particles of matter in space).

RETURN FLIGHT TO THE EARTH

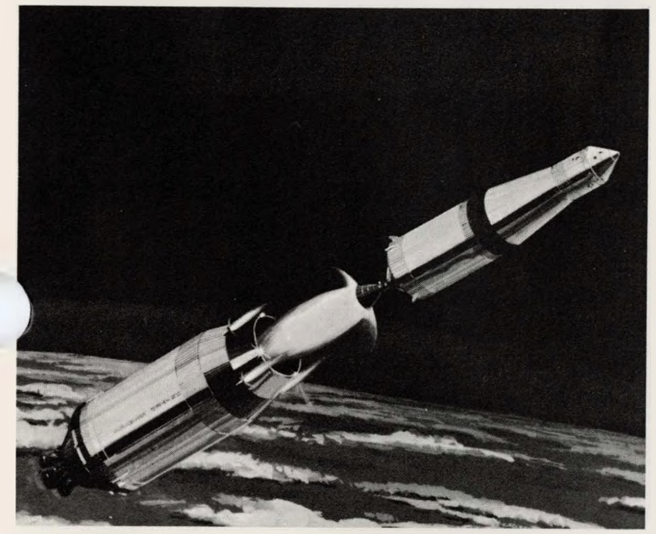
When the time arrives for leaving the moon's surface and joining the orbiting CSM, the lower stage of the LM will be used as a launching pad and left behind on the moon.



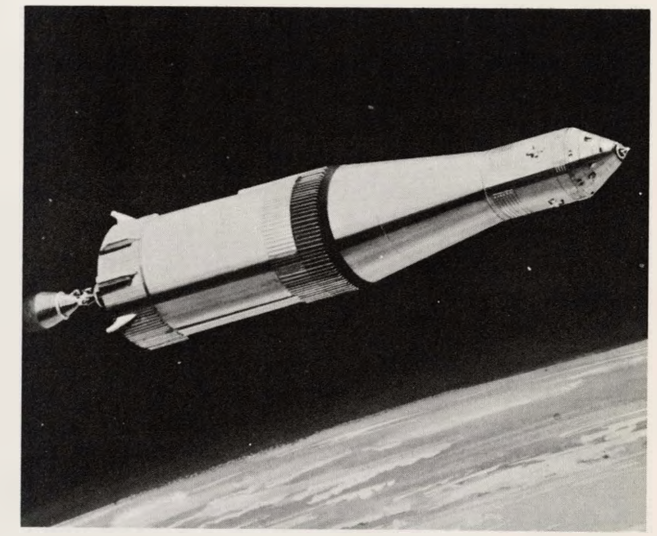
1 Lift Off.



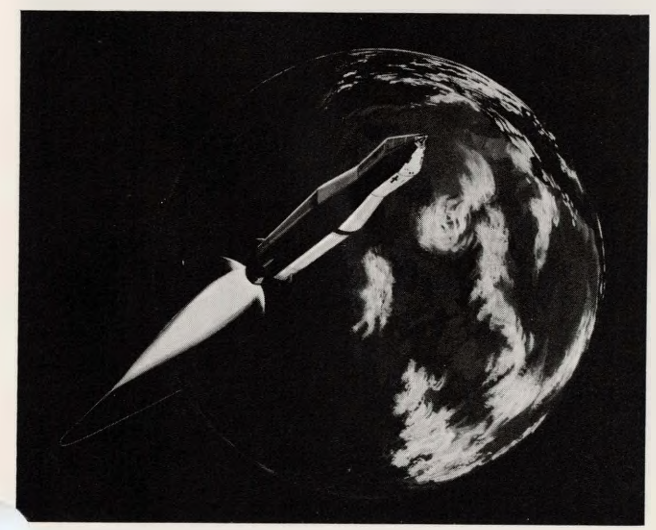
2 Jettison Launch Escape System



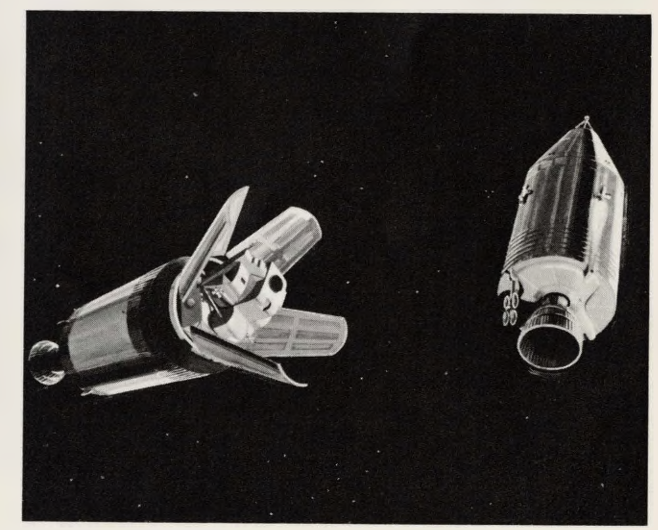
3 S-II Stage Separation, S-IVB Stage Thrusting.



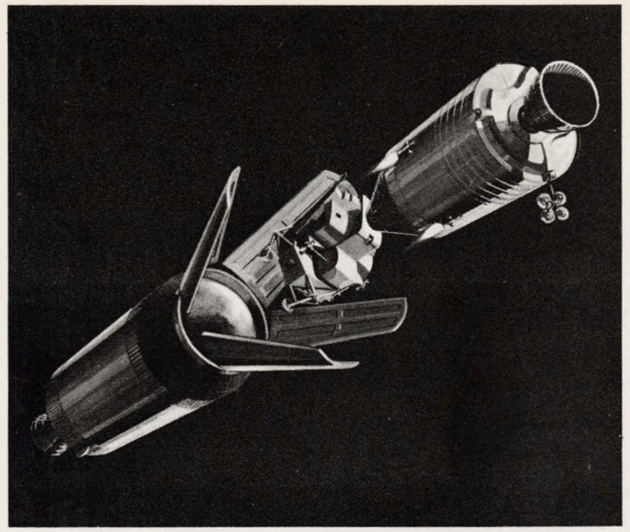
4 Earth Orbit Insertion of the S-IVB Stage and Spacecraft



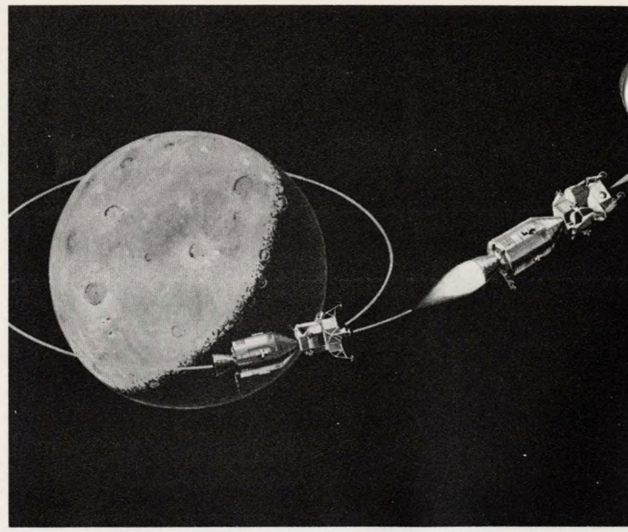
Translunar Injection.



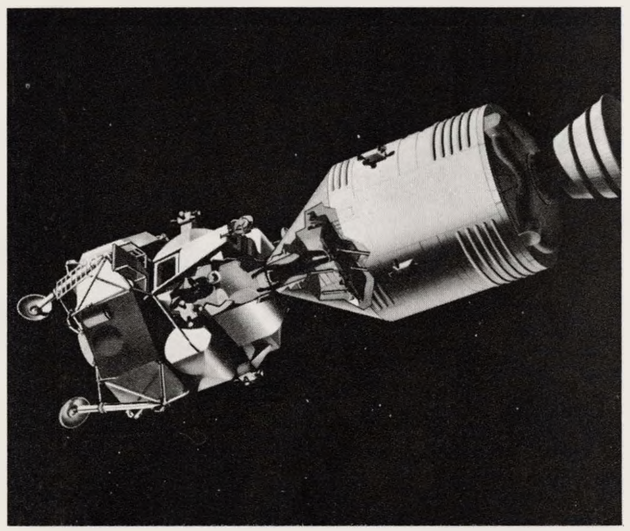
6 Turnaround of CSM.



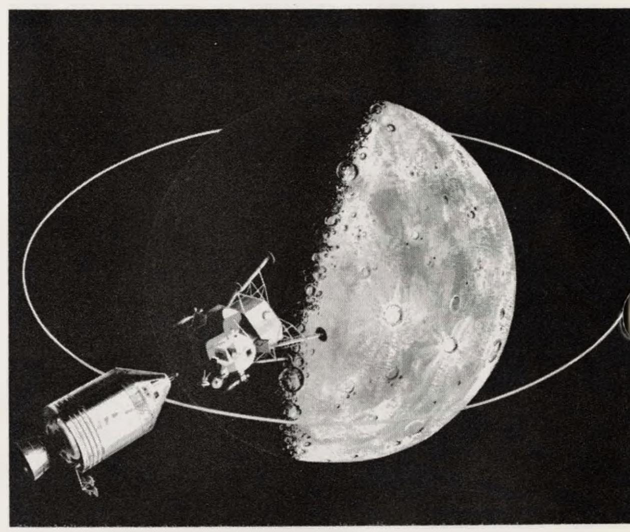
7 Docking and Separation of Spacecraft From S-IVB



8 Lunar Orbit Insertion



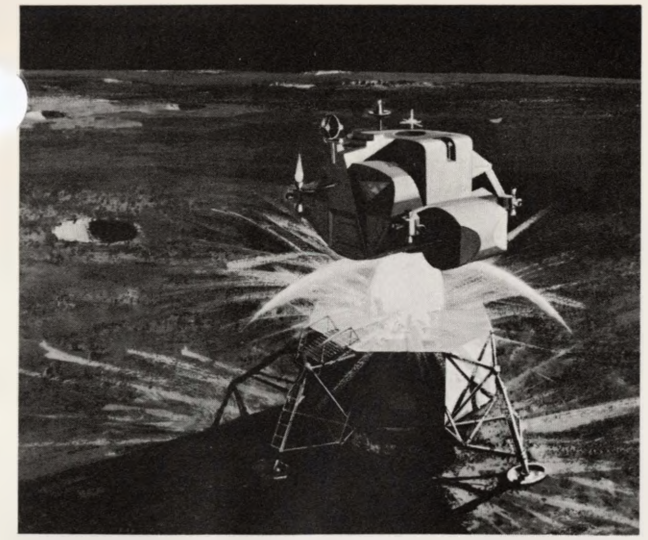
9 Transfer to LM



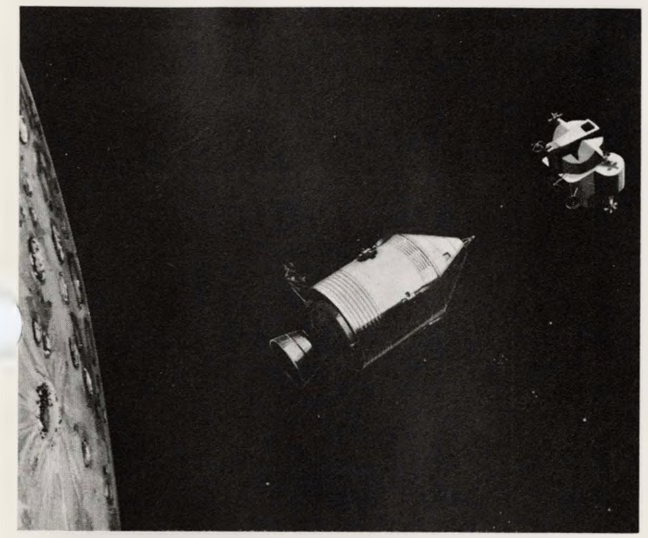
10 LM Separation

11 Final Descent

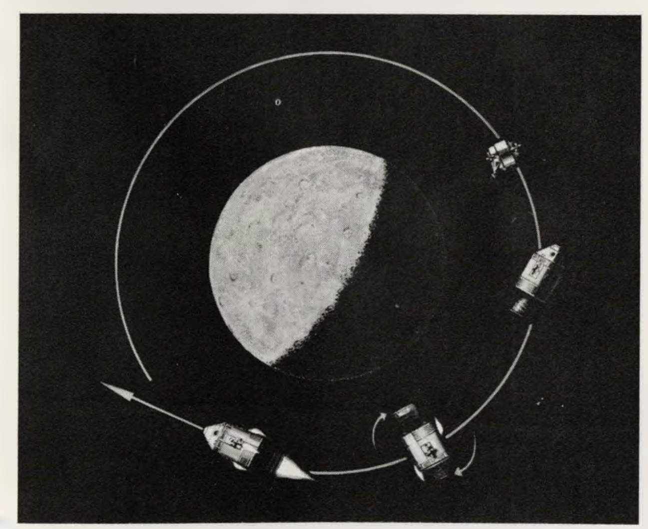
12 Exploration of Lunar Surface



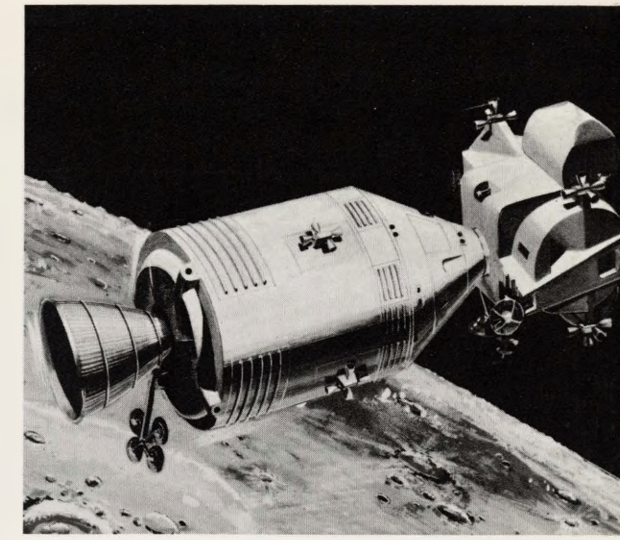
13 Ascent Stage Liftoff



15 LM Jettison



6 Transearth Injection



14 LM Ascent—CSM Docked

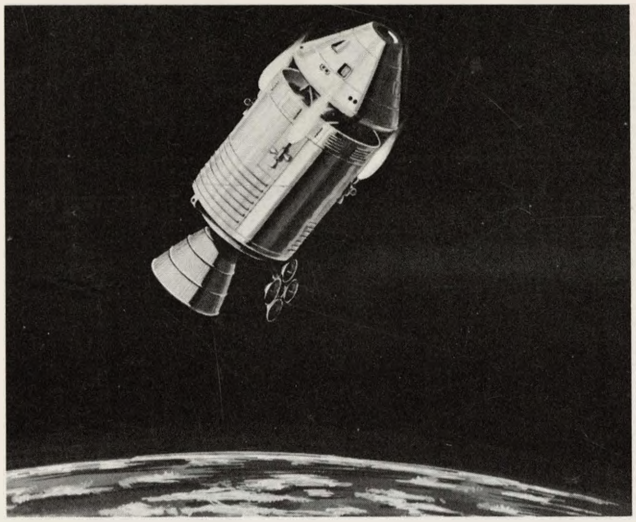
With launch timed for rendezvous with the orbiting CSM, the LM ascent stage will ascend to an altitude of 80 miles and dock with the CSM. After the two astronauts have transferred to the CSM, the LM will be jettisoned and left in moon orbit. The Service Module's rocket engine will be ignited to build up lunar escape velocity of 5,460 mph. About 29,000 miles outward, the spacecraft will reach the point where the earth's gravitational influence becomes dominant. Then, subject to the earth's pull, the CSM will return at ever-increasing speed until it reaches the same velocity at which the spacecraft left earth—about 25,000 mph.

After using its propulsion for final course corrections, the Service Module will be jettisoned, leaving the Command Module to plunge into the earth's atmosphere.

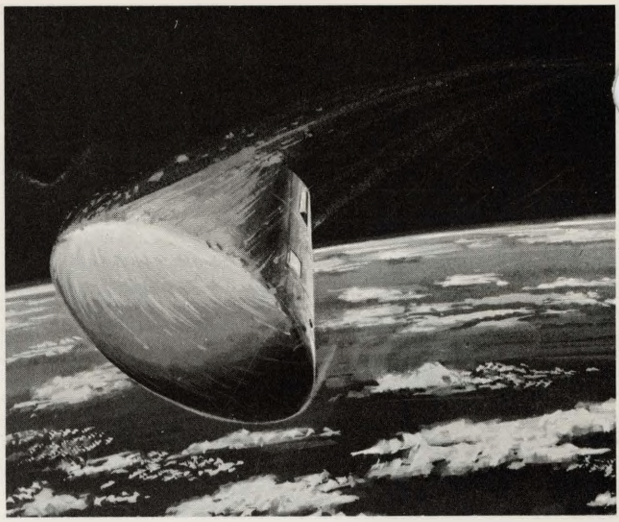
At the velocity of 25,000 mph, reentry will be trickier for the Apollo spacecraft than it was for the Gemini or Mercury spacecraft. The Command Module must enter the top of the earth's atmosphere and transfer into an earthbound ballistic path. The safe "reentry corridor" will be only 40 miles wide, while the angle of attack (slant toward earth horizontal) must be kept between $5\frac{1}{2}^\circ$ to $7\frac{1}{2}^\circ$.

Apollo's reentry temperature will be about 5,000°F. As in Mercury and Gemini, the heat shield will protect the crew as air resistance rapidly cuts velocity to a safe point for parachute deployment and landing.

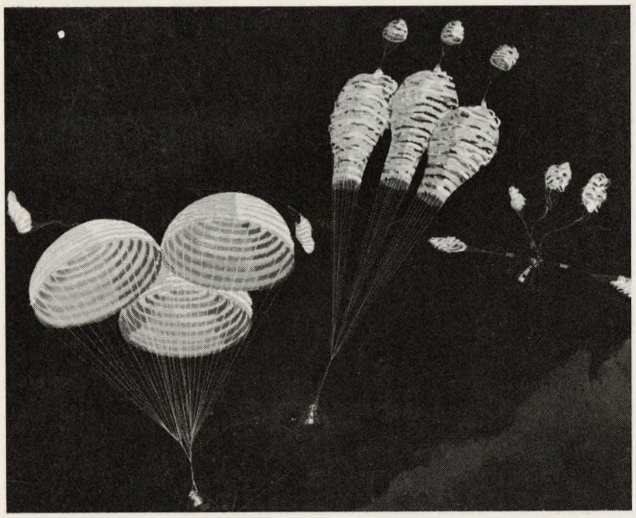
From earth launch to earth touchdown, the total moon trip time will be approximately 198 hours, or about 8 days.



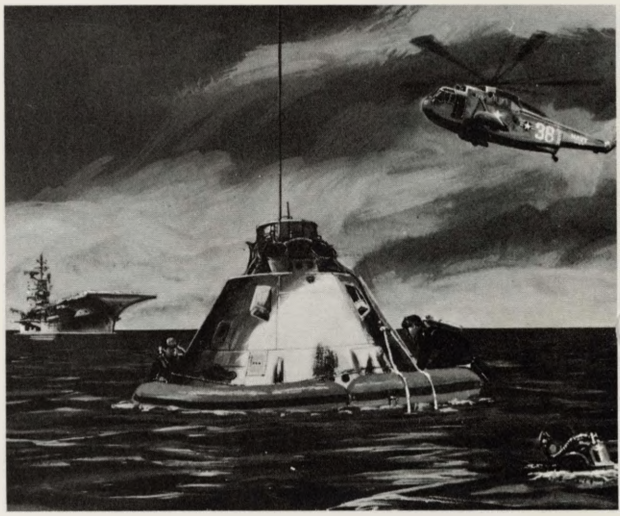
17 CM.SM Separation



18 Entry into Earth Atmosphere



19 Main Parachute Deployment



20 Spacecraft Recovery

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