TO SAIL THE NEW OCEAN OF SPACE

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The most advanced technological development of our time came to the notice of the world on October 4, 1957, when man sent into space the first artificial satellite of the Earth, the Soviet Sputnik. That first venture into space could have been ours—we had the ability to do it but not the foresight or the determination. This event was followed by the establishment in our country of the National Aeronautics and Space Administration, which came into existence officially on October 1, 1958. These events and the events of the intervening 6 years have had a profound impact on human affairs throughout the world, and especially within our own country. Repercussions have been felt in science, industry, education, government, law, ethics, and religion. No area of human activity or thought has escaped. The toys of our children, the ambitions of our young men and women, the fortunes of industrialists, the daily tasks of diplomats, the careers of military officers, the pronouncements of high church officials—all have reflected the all-pervading influence of the beginning steps in space exploration.

The exploration of space is a continuation of the geographical exploration by man of unknown areas of the earth from the days of the Phoenician mariners 3,000 years ago. The New World, the polar regions, the depths of the ocean, the limits of the atmosphere—have each in turn been the temporary goal. Space is the new frontier.

Ralph J. Cordiner gave an interesting analysis of this new frontier in his lecture in the "Peacetime Uses of Space" series of the University of California:

> At this stage, the new frontier does not look very promising to the profit-minded business man, or to the tax-minded citizen. . . .
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> Every new frontier presents the same problem of vision and risk. . . . Leif Ericson discovered America 500 years before Columbus, but apparently the Vikings did not have the vision to see anything worthwhile on that vast, empty continent, and so history waited for another half millenium. . . .
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> When a new frontier is opened, the new territory always looks vast, empty, hostile, and unrewarding. It is always dangerous to go there, and almost impossible to live there in loneliness and peril. The technological capacities of the time are always taxed to the utmost in dealing with the new environment. . . .
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> It takes an immense effort of imagination for the citizens to see beyond these initial difficulties of opening a new frontier. No one would pretend to foresee all the economic, political, social, and cultural changes that will follow in the wake of the first exploratory shots in space, any more than the people in the days of Columbus could foresee the Twentieth Century world. But such an effort at prophetic imagination is what is required of us as citizens, so that we will not, like Leif Ericson, leave the making of the future to others.

We have as a nation accepted the challenge of the new frontier and this year are spending a little more than $5 billion on the exploration of space for peaceful purposes. This represents an expenditure of approximately 50 cents per week by each of the 200 million inhabitants of our country. We have mustered a great array of manpower, money, and scientific and engineering talent for a peaceful undertaking—on a scale formerly reserved only for making war. I find great hope for the future course of mankind in the fact that we can mount such a vast scientific and engineering effort in the name of peace.

At the end of 6 years of intensive effort on the part of many thousands of dedicated citizens in industry, government, and the universities of the Nation, we are moving from a period of preparation to one of fruition.

Six years ago, before the Nation began to take space exploration seriously, and before NASA was formed, the United States managed, with great effort, to put a very small spacecraft of 31 pounds and limited capability in orbit. Plans were made immediately to over-

come the great disparity in capability between ourselves and the Soviets by initiating the Saturn I launch vehicle of 1½ million pounds thrust, utilizing existing small engines in a cluster of eight, by initiating the developing of the large F–1 engine with 1½ million pounds thrust in a single combustion chamber and nozzle and by initiating the application of liquid hydrogen-liquid oxygen fuels in the RL–10 engine. We began to explore space insofar as we could with the limited tools available.

On January 29th of this year, the plans for the Saturn I came to fruition, with its liquid hydrogen-liquid oxygen second stage, as the most powerful rocket known to exist placed the heaviest load yet in orbit—38,700 pounds—corresponding to a payload weight of more than 10 tons. We have developed many of the necessary tools and now have the capability of doing many more missions than available resources will permit. We are not only moving into a period of fruition but one in which we must look to refinement of the technology already developed and the scientific knowledge already gained. Most important, it is imperative that we look ahead to the things we must do now, or soon, to prepare for the space missions which the future will demand of us if we are to maintain leadership in space.

The history of research and development in advanced areas in this country is one of repeated preoccupation with the current requirements of the Nation at the expense of, or to the neglect of, the basic long-range efforts needed to maintain leadership in vital areas of science and technology.

Because of the initiative and the daring of the Wright brothers, this Nation gave man the capacity for powered flight, freeing him forever from the bonds which for thousands of years of human existence had confined his activities to land and sea. The United States became the first country in the world to possess a military airplane when, in 1908, the Army Signal Corps contracted for a Wright biplane.

Yet prior to World War I this Nation was still so preoccupied with conventional weapon systems that it totally neglected the development of aeronautics—the force which was to dominate warfare for the next quarter century. In 1914 the United States possessed fewer military aircraft—and of inferior types—than the six leading aeronautical nations (including Mexico). The United States in 1914 was the only major nation in the world not to possess an aeronautical laboratory with an up-to-date wind tunnel. By November 1918 not one aircraft of American design and manufacture had entered combat operations during World War I.

In the thirties we were so preoccupied with refinement of conventional piston-driven aeronautical systems that we made little progress in jet propulsion. Meanwhile the Germans set out to build a bigger and better NACA, predecessor agency to NASA; and to a large extent they did, developing jet-propelled military aircraft and 5½–ton V–2 rockets which almost spelled disaster in World War II.

In the late forties, despite the fact that Robert Goddard had demonstrated the feasibility of a liquid-fueled rocket engine in this country in 1926, and despite the memory of the V–2's raining on London during the blitz, we were so preoccupied with mating jet carriers to our exclusively held atomic-bomb capability that we neglected missilry while other nations forged ahead. And finally, in the fifties, our A-bomb advantage gone, we were so preoccupied with the development of our ballistic missile program that we neglected a clear opportunity to become first in space.

Today the Nation faces—we all face—this question: Have we learned enough from the often bitter and always costly experience of the last half century not only to carry out with determination this effort to meet the requirements of the present in space research and exploration but to exercise the vision which is demanded if we are not, once again, to find ourselves lagging in the next phase of this most challenging effort?

It must be hoped that we have learned enough from the sequence of events which I have just described to put aside for all time any feelings of comfortable assurance that science and technology are areas in which the United States will remain firmly and forever supreme. It is not surprising that we should have felt such assurance in the past, for we did, as a nation, establish an early technological ascendancy over the other countries of the world. But it is equally clear that many other nations have overcome our early lead and that future leadership in this competition, which has such great economic, military, and political significance, will not be easily held or won.

Thus, while we may all glow with pride over the Nation's recent accomplishments in space and our part in making them possible, we must not delude ourselves or the Nation with any thought that leadership in this fast-moving age can be maintained with anything less than determined, wholehearted, sustained effort.

The present gap in manned flight activity is a direct consequence of a postponement of the decision to proceed beyond Project Mercury from September 1960 until May 1961, when the late President Kennedy recommended the present manned lunar landing project as a national goal.

The decisions which confront us today are those which will determine whether this kind of history will repeat itself a few years hence and whether we will once again experience a bitter awakening to the fact that others have seized the initiative in the more advanced space missions of the future.

If one looks at the history of NACA, it is apparent that the aeronautical research conducted by that agency not only brought this country to a position of leadership in civil aviation but in military airpower as well. I well recall the statement of Frank Knox, the Secretary of the Navy in 1943, which pointed up the NACA contribution to airpower, and which, I am convinced, will apply with equal force to the NASA contribution to defensive strength in space. He said at that time:

> New ideas are weapons of immense significance. The United States Navy was the first to develop aircraft capable of vertical dive bombing; this was made possible by the prosecution of a program of scientific research by the NACA. The Navy's famous fighters—the Corsair, Wildcat, and Hellcat—are possible only because they were based on fundamentals developed by the NACA. All of them use NACA wing sections, NACA cooling methods, NACA high-lift devices. The great sea victories that have broken Japan's expanding grip in the Pacific would not have been possible without the contributions of the NACA.

Within recent weeks we have seen the first major example of the application of NASA research to military use, with the decision to employ Gemini technology in the Air Force MOL (manned orbiting laboratory) project. But this is merely the forerunner of similar applications not only in manned operations but in navigation, communications, and meteorology as well.

Our present major goals in space exploration were set by the late President Kennedy on May 25, 1961, following study and recommendation by President Johnson, then the Vice President and the Chairman of the National Aeronautics and Space Council. A definite decision was made to achieve a position of leadership in space science, space technology, and space exploration. One specific goal was to develop the capability for manned operations in space out to the distance of the Moon and to demonstrate this capability by sending a team of American explorers to the Moon and back before the end of this decade.

President Kennedy said to the Congress and to the Nation:

> 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. . . . 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.

Under the leadership of President Johnson, who has long advocated a strong national space program and who was one of the principal architects of the National Aeronautics and Space Act of 1958, we are making progress toward fulfillment of our destiny of becoming the world's leading spacefaring nation. We are proceeding to master this new environment as we have mastered the land on which we make our homes, the ocean which carries our ships, and the air that sustains us.

President Johnson reaffirmed the lunar exploration goal in his 1963 Budget Message in these words:

> Our plan to place a man on the moon in this decade remains unchanged. It is an ambitious and important goal.

We have chosen to go to the Moon because manned exploration of the Moon involves every facet of overall space capability this Nation must develop if we are to become a leading spacefaring nation. Also, the Moon's pockmarked surface, untouched by water or wind erosion since it has no atmosphere, bears the traces of everything which ever occurred there. But some say: "What do we want of the vast worthless area? To what use could we ever hope to put these deserts or these endless mountain ranges?" These identical words were used by an illustrious Senator from Massachusets in 1844. Daniel Webster was opposing an appropriation of $50,000 to extend mail service to California.

We do not know whether we will find materials of economic value on the Moon. Lawrence Lessing, in a recent article in *Fortune* magazine, made the point that the most compelling reason for space exploration is the accumulation of knowledge. He says, in part:

> The purposes of this (space) exploration are no clearer to many men in this age than they were in

> Galileo's, so it is not strange that there is opposition. In this economic age, however, the opposition is not so much theological as budgetary. Both seem equally mistaken in the context of their times. . . . new knowledge is a dukedom whose great wealth and resources cannot even begin to be estimated or exhausted. Already the new knowledge acquired in space exceeds by far the value of funds so far spent. For knowledge, more than guns or butter, is the true power of modern states.

The plan for reaching the Moon in Project Apollo, as the culmination of our efforts during this decade to master the new environment of space, calls for sending three astronauts into orbit about the Earth and then on a course toward the Moon. Near the Moon a rocket is fired to slow the Apollo spacecraft so that it goes into an orbit around the Moon. Two astronauts then transfer to a Moon ferry vehicle, fire a retrorocket, and descend to the lunar landing, using rocket thrust as a braking force since there is no atmosphere. The crewmen take turns leaving the ferry vehicle in their lunar space suits to explore the cratered surface of the Moon.

Returning to the ferry vehicle, the two astronauts fire rockets that shoot them upward to rejoin the Apollo spacecraft and then head back toward Earth and the tiny corridor about 40 miles high through which they can safely enter the atmosphere from space. Protected by a heat shield and in the later stages slowed by atmospheric drag and by parachutes, the astronauts return to Earth.

To perform this mission many capabilities must be developed and practiced, including the develpoment of rockets capable of launching the required load to the Moon, of making path corrections, of braking, and of taking off from the Moon; the development of the technique of bringing two spacecraft together in space, which we call *rendezvous*; the development of the technique of physically joining them to become a single spacecraft, which we call *docking*; the development of capability of astronauts to operate outside the spacecraft in space; the development of maneuverable spacecraft; and the development of guidance and control for all phases of the mission including reentry.

The development of rendezvous and docking begins with Project Gemini, which also permits an early test of the capabilities of men and machines up to periods of 2 weeks. Gemini involves a two-man spacecraft, a logical second-generation spacecraft emerging from the successful Mercury program. On April 8 the first unmanned orbital flight test of Gemini was successfully accomplished, and it is expected that the first manned flight will occur about the end of this calendar year.

The Apollo three-man spacecraft will be fully exercised in Earth orbit, practicing near the Earth the rendezvous and docking maneuvers with the actual vehicles later to be used near the Moon. It is estimated that NASA astronauts will have accumulated at least 2,000 hours of space flight time before we attempt the Moon voyage.

The achievement of our space goals requires hard work, resourcefulness, and daring. It requires the skills and abilities of scientists, engineers, educators, industrialists, artisans, and craftsmen all over the Nation; and it requires the determination of the American people. It is the aim of NASA to marshal a nationwide team of the most competent participants working toward a common goal in such a manner as to strengthen our free institutions in industry, universities, government, and local communities.

We are carrying forward an active national space program—not limited to the Moon—encompassing science, advanced engineering, practical applications, including manned space flight.

We are building toward preeminence in every phase of space activity—all the way from microscopic electronic components to skyscraper-tall rockets.

We are building a network of large-scale engineering facilities, space yards, proving grounds, and space ports to assemble, test, and launch the space vehicles we need now and in the future.

We are creating new national resources of lasting value in these facilities, in the industrial and managerial capabilities we are developing, and in the growing number of scientists and engineers who are learning about space and space technology.

We are filling the pipelines of hardware and knowledge and, as measured by the financial resources required, will be halfway toward our first manned lunar mission by mid-1965.

We are accumulating, in space, the basic scientific knowledge about the Earth, the solar system, universe, and about man himself.

We are bringing benefits not only to the United States but to all the world through the use of space and space technology, employing such new tools as weather, communications, and navigational satellites, and applying space-based techniques, equipment, and materials to improve industrial products, processes, and services.

We are providing a much-needed stimulus to the energies and creativity of people everywhere, particularly to the minds and aspirations of young people.

We are bringing about increased economic activity at a time when the effects of automation on our society are beginning to be felt.

And we are making certain, through our sustained efforts, that the realm of space now opening up to us shall be a domain of freedom.

It is for these reasons that we have mounted the greatest peacetime undertaking in the history of mankind.

I have emphasized the national character and scope of the program, but I am sure that the Northeastern area is finding and will find its role in the national effort. Other speakers from this region will no doubt give appropriate emphasis to the actual and potential participation of the universities and industrial firms of the community in the national program.

Congress gave its approval in March to NASA's plans to establish its Electronic Research Center in Greater Boston. The status of our plans is undoubtedly of interest to everyone in the Nation, since the Center will catalyze a much larger effort in research on problems arising from the use of electronics in space applications than is now in being, in part within the Center itself, but—as is characteristic of the general NASA program—also at the educational and industrial institutions of highest competence throughout the Nation. Our general plans have been described in detail in our report to the Congress on the Center.

Two top priority matters are now in progress, that of deciding on the specific location for the Center within the Greater Boston area and that of selecting the director. Both are being pursued urgently at this time but without specific schedules having been set for their completion. Too much of importance hinges on these decisions to be arbitrary in deciding when they must be made.

A Site Evaluation Committee, composed of six NASA officials from our headquarters and field staffs, is at work reviewing the many proposals that have been presented to us. Both urban and suburban sites are under consideration; and, whatever the final choice, NASA will want to insure a viable relationship between the Center and the university community in the area.

The selection of a director for the Center is not unlike the selection of a site, in that there are many candidates to be considered. NASA management is considering this matter carefully and will make its selection at the earliest possible time.

As we have advised the Congress, the buildup of the Research Center will take place at the most rapid rate possible that is consistent with the development of a competent, well-organized staff. It is estimated that it will take 4 to 5 years to reach our present goal of 2,100 people. We expect to house the first of these people in rented quarters that we will acquire later this year.

NASA wishes to get on with its plans for the Center. But the decisions immediately ahead of us are crucial to the successful integration of the Center into the Nation's space exploration team, and so these decisions must be made with care.

Almost a year ago today, at the Conference on Space Age Planning held in Chicago as part of the Third National Conference on the Peaceful Uses of Space, a message of greeting was sent by the late President John F. Kennedy. It said, in part:

> We know we cannot hold back tomorrow. The tomorrow of the space age is inevitable. For our Nation there can only be a determination that it will be a free tomorrow. We are outward bound. I am convinced that our broad and accelerating exploration of space will help bring this Nation to a destiny more splendid than any dreamed of by our predecessors.

This Fourth National Conference on the Peaceful Uses of Space may serve as the anvil on which we can forge our resolution that the limitless realm of space shall remain free.

As Deputy Administrator of the National Aeronautics and Space Administration, I am pleased to welcome you to this important conference. May your efforts meet with unqualified success.