N66-10880

Pages 19
Code 1
CR-56879

GPO
CFSTI
HC. 1.00
MF. .50

Cat 30

THE NATION'S MANNED SPACE FLIGHTS

by

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(Address given before the Governor's Conference on Oceanography and Astronautics, held at the Kauai Surf Hotel, Lihue, Kauai, Hawaii, October 1, 1965)

It has been an honor and a pleasure to accept the invitation of the Honorable John A. Burns, Governor of Hawaii, and the other officials of the State of Hawaii associated with him, to speak to the Governor's Conference on Oceanography and Astronautics. In reading the proceedings of the conference held in January of last year, I notice that the main focus of attention was the role of science and technology in the future of our nation, the nature of scientific and technological development, and the role of the State of Hawaii in contributing its part to the advancement of science and technology and their application to the problems of the modern world for the benefit of mankind. My talk deals with the newest of the frontiers of man, inaugurated on October 4, 1957, when man first left the surface of the earth to travel beyond the atmosphere in nearby space. I believe that Hawaii must participate in this enterprise for many reasons.

I recall a conversation during my visit to West Germany a few years ago for the purpose of exploring possible cooperation between the scientists and engineers of West Germany with the United States in the exploration of space, in accordance with one of the stated objectives of the National Aeronautics and Space Act of 1958, to conduct our activities in cooperation with other nations. My colleagues stated forcefully that Germany must find a way to participate in this enterprise if it ever hoped to become again a great leader in science and technology, for the exploration of space demands the most advanced developments in practically every field of science and technology to new levels of performance in every respect. An editorial in the New York Times of September 15, following a reference to some remarks by Mayor Willy Brandt of Berlin, stated that "businessmen and officials in many NATO countries share his (Brandt's) belief that the technological 'spin-off' from nuclear, missile and space research is giving American civilian industry a towering lead over its European competitors. It is certainly an exaggeration to say, as Mr. Brandt did, that West Germany will drop by 1975 to the status of a 'less-developed' nation unless it shares in American space-age know-how."

I do not believe that every country of the world must necessarily engage in the launching of satellites and space probes, although by means of bilateral, regional, and global agreement many nations can participate even in such activities. I believe that many nations can contribute through the use of sounding rockets and perhaps small earth satellites, and that opportunities can be made available for the scientists of the world to participate in both ground-based experiments essential to the space program and in the flight experiments.

Hawaii, of course, is one of our own fifty states and has already begun to make substantial contributions to our national program. I refer particularly to the Kokee Tracking Station in Kokee Park, which is one of the worldwide chain of stations for our manned space flight programs, and to our association with the University of Hawaii, looking to the expansion of astronomical facilities, particularly for more intensive observation of the planets on which we hope to land scientific instruments within the next few years, and to which, in the more distant future, we hope to send man himself. You are all familiar with the natural resources of Hawaii which make it most suitable for this purpose. I note also your association with the Communications Satellite Corporation, leading to an important role of Hawaii in the global communications via satellite.

But I believe that the interest of the citizens of Hawaii in space exploration and its importance to them lies not solely in the economic benefits that it may bring or in the material tools which it may contribute to our physical environment. Man is distinguished from other forms of life by his powers of reasoning and by his spiritual aspirations. Already the events of the last seven years have had a profound impact on all human affairs throughout the world. 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 impact can only be compared with those great developments of past history like the Copernican theory which placed the sun, rather than the earth, at the center of our solar system; the work of Sir Isaac Newton in relating the fall of an apple to the motion of the moon around the earth through the universal law of gravitation; to the industrial revolution; or other great landmarks in the history of mankind.

The origin of science can be traced far back in the distant past. Aristotle is quoted as saying that true science is the search of nature in the spirit of true scientific curiosity. For hundreds of years, science was mainly a purely intellectual activity, involving little of what we now call experimental science. Much has been written about those objectives of science which relate to gaining an understanding of the entire universe in which we live, of the excitement of studying the unknown, and of the contribution of science to man's intellectual and spiritual life. I wish to turn, however, to another aspect of scientific and technological development, which I may describe as the interaction of science, technology, and social need.

There is a mistaken impression in some circles today that scientific and technological development always proceeds by an orderly process in which, first, there is a basic concept or theory, followed by experimental verification, leading to further theoretical and experimental investigations and applied research, followed finally by application to some social need. Actually, of course, the situation is not so simple; the situation is a dynamic one with continual interactions between theory, experiment, application, and social need. In my reading of the history of scientific development, I have been impressed time and time again by the almost dominant role of the specific social environment in which the scientist and engineer work, which in most instances seems to be a prerequisite for the intensive development of the scientific concept itself as well as the ensuing technology. One or two examples will illustrate.

Most of the work for which Pasteur is famous originated in the social needs of the community in which he worked. Beginning in 1854 he addressed himself to the reason for unsatisfactory results obtained in the fermentation of beer, and in 1857 showed that the troubles arose from small organisms which interfered with the growth of yeast cells responsible for fermentation. Later he turned his attention to similar problems in the production of good wine. Later, under great social pressure, he studied the small organisms responsible for certain diseases of the silkworm, of cattle, of chickens, and of dogs and man. Thus social needs provided the incentive for and the support of Pasteur's scientific work in solving the "problems of the infinitely small."

Another classic story begins with the work of James Maxwell starting about 1850. In 1865 and 1873 he described the propagation of electromagnetic waves and suggested that light was a phenomenon produced by the travel of electromagnetic waves in the ether. I believe the first experimental demonstration of electric waves was by Hertz in 1883, who invented an oscillator to produce such waves. There was some limited further theoretical and experimental development by scientists such as Lodge and Righi in the last two decades of the nineteenth century. Marconi began a study of the application of electric waves to signaling in 1895 and succeeded in sending signals across the Atlantic in 1901. I think it is now obvious to everyone that this application by Marconi to a practical social need marked the beginning of greatly increased support for theoretical and experimental research in this field, that it marked the foundation of very large industrial developments, and that there has been a very great social impact.

These cases are of course the traditional ones that everyone quotes. There are many others, such as the development of probability theory and modern statistics from the "social need" of the members of high society in France interested in gambling.

I believe that in our world today social needs have become much more complex and go far beyond the material aspects of our life. A short time ago, at the bicentennial celebration of the Smithsonian Institution in Washington, the humanist Lewis Mumford attacked the notion that man is a creature whose use of tools played the largest formative part in his development. Said Mumford, "By what logic do we now take these tools away, so that he will become a functionless, workless being, conditioned to accept only what the Megamachine offers him: an automation within a larger system of automation, condemned to compulsory consumption, as he was once condemned to compulsory production. Instead of liberation from work being the chief contribution of mechanization and automation, I suggest that liberation for work, for educative mind-forming work, self-rewarding even on the lowest physiological level, may become the most salutary contribution of a life-centered technology."

I believe that activities in the exploration of space represent a "social need" in this broader sense. That it is a modern social need is recognizable from the passage of the National Aeronautics and Space Act and the appropriation of large sums of money by the Congress. This social need provides that essential environment to accelerate greatly the growth of theoretical and experimental science in many areas. It is true that this accelerated growth in science and technology is essential to the on-going development of space capability, but a deeper significance is the complex, dynamic interaction between science, technology, and space exploration, which is essential to the growth of science, technology, and space exploration. In this case, as in the cases previously cited, to use an analogy from bacteriology, there has to be a nutrient solution (money and employment opportunities) to feed the scientific and technological effort. And as soon as this environment is provided, many latent efforts in science and technology begin to assert themselves and move forward.

It is for reasons such as this that the citizens of our nation, including those of Hawaii, and in fact the citizens of the world, have a stake in the exploration of space.

The fundamental goals of our nation's space activities were expressed by Congress in the National Aeronautics and Space Act of 1958. The first of these is the expansion of human knowledge of the atmosphere and space, a goal which the President's Science Advisory Committee later restated as the "exploration of outer space in response to the compelling urge of man to explore and to discover." Prior to 1957, the exploration of outer space was carried on by astronomers in observatories on the ground, although some information about the lower atmosphere was obtained from sounding rockets, balloons, and airplanes. All of the information came to the astronomer in the form of waves radiated from the sun, the stars, and planets that reached our telescopes and spectrographs on the ground. Much of this radiation is blanketed out by the atmosphere, so that only a small fraction reaches the ground. However, during the past centuries, astronomers have learned a great deal about the composition of the stars, their life histories from the time of birth in the chance condensation out of the gas and dust of interstellar space, to their eventual destruction and the explosion of the supernovae.

Now the new tools of space exploration, the sounding rocket, the satellite, and the space probe, have made it possible to put instruments above the atmospheric curtain to cover the entire wavelength range from gamma rays to radio waves. Instruments can now be sent to the nearest planets, and probably in a few years to the outer reaches of the solar system. The knowledge obtained by these tools has come to be known as space science, but it is important to remember that this field is merely an extension of numerous scientific disciplines into the domain of space by means of the new tools.

Space science has already opened up completely new vistas on some of the oldest and most fundamental problems challenging science, including the structure of the universe, the abundance of the elements in the cosmos, the evolution of the stars and galaxies, the formation of the sun, and the origin of the earth. Extensive exploration has already been carried out in the near-earth region, the upper atmosphere, the ionosphere, and the magnetosphere in which the magnetic field lines anchored in the earth extend out into space. The investigations have been extended into the interplanetary medium beyond the influence of the earth's magnetic field. Finally, extensive attention has been given to the sun, whose activity is responsible for many of the phenomena observed in the space near the earth. Further, a beginning has been made on astronomical investigations made above the blanketing influence of the earth's atmosphere.

In the September issue of PHYSICS TODAY, Dr. Homer Newell reviews the impact of space techniques on geophysics. First, space techniques have provided new tools for studying old problems in such areas as geodesy, meteorology, upper atmospheric physics, ionospheric research, and sun-earth relationships. Second, space exploration has turned up a number of exciting new problems, greatly broadening the scope of the discipline. For example, the discovery of the Van Allen Radiation Belt on the flight of Explorer I led to the acceptance of a new concept, namely, that of the magnetosphere. It pointed to relationships among the solar wind, which was discovered by instruments in space probes, the magnetosphere, the radiation belts, the aurora, magnetic storms, ionospheric disturbances, and possibly even some influence of particle radiations on our weather.

Third, as space probes, and eventually men, reach other bodies of the solar system, such as the moon and planets, the domain of geophysics grows beyond the confines of a single body of the solar system and throws new light on the study of our own planet. Everyone is familiar with the vast amount of information obtained in three television transmissions, lasting less than 30 minutes each, from Rangers VII, VIII, and IX.

The instruments of these three spacecraft sent back a total of some 17,000 useful photographs of the lunar surface from altitudes ranging from more than 1000 miles in space down to virtually the point of impact. These photographs, by far the best ever taken of the moon, were so clear that astronomers can distinguish details as small as 18 inches across, with an accuracy 2000 times better than pictures taken from earth with conventional telescopes. The success of the Mariner IV flight to the planet Mars is well known. Philip H. Abelson, editor of the magazine SCIENCE, September issue, states that "the results of the Mariner IV mission constitute the most important advance in space research since the discovery of the Van Allen Radiation Belts." Photographs show that Mars resembles the moon in topography by exhibiting many craters but no evidence of mountain chains. The magnetic field of Mars is not more than 1/1000 that of the earth, and Mars has no radiation belt. One experiment gives independent evidence that the atmosphere of Mars is tenuous and unlike that of the earth.

The subject of this talk emphasizes the manned space flight program, so that further time cannot be given to the space science program in this talk. I do wish to remind you, however, that the scientific measurements of the space environment are absolutely essential in the design of satellites and space probes, whether manned or unmanned, in order to assure their successful operation in space. Thus Mariner IV, representing a superb engineering achievement, requiring the proper functioning of 134,000 parts after seven months in space, could not have been successfully designed to meet the rigors of the space environment without the advance knowledge provided by the scientific exploration of space.

As we pursue investigations in basic science in the space program, we are also developing areas of applications such as meteorology and communications. These, as much as anything else we do, will serve to knit closer together the peoples of this earth in a bond of better understanding of each other's problems and of mutual assistance and benefits that will come with better weather predictions. Nine Tiros meteorological satellites have been launched, as well as the first of the second-generation meteorological satellites, Nimbus I. Cloud pictures from these satellites are now being used daily by operational meteorologists in their weather predictions, as well as being used for research on the dynamics of the weather. Their role in the location and following of hurricanes has been well publicized. Equipment has been developed which automatically transmits the cloud pictures seen by Tiros to telemetry stations within range, so that any country is able to observe the local weather immediately on passage of the satellite.

Eight successful communication satellites have been launched of three types, namely: passive, two Echo spheres; low altitude active, including two Telstars and two Relays; and two synchronous satellites, Syncom II and III. These satellites have been used to demonstrate transcontinental and transoceanic communication in all its forms, including telephone, teletype, and television. The experimental work carried out by these satellites forms a foundation for the operational system now being established by the Communications Satellite Corporation in cooperation with many other nations. There are no real technical barriers to communication between individuals anywhere in the world, no matter how remote their locations. There are, however, many other problems, especially economic ones in providing the wider networks of ground communication from the individual to the transmitting and receiving terminals which are linked via the satellite. Certainly in the next decade international radio and television will be almost as commonplace as local broadcasts.

All of our flight missions are undergirded by a program of advanced research and technology, carried out in in-house government laboratories of NASA and other government agencies, and in industrial and university laboratories under contract. The work ranges from basic research to applied research and advanced technological development, and there are literally thousands of projects which cannot be described here in detail. The principal fields, all relevant to space exploration, are physical science, engineering science, cosmological science, socio-economic studies, vehicle systems technology, tracking and data acquisition and processing, space operations technology, space propulsion technology, flight medicine and biology, basic medical and behavioral sciences, and space biology (effects of space environment on biological phenomena and extraterrestrial life).

At present something more than half of our national space effort is devoted to manned space flight. Within the past three years we have made substantial progress in manned space flight in orbit about the earth. On February 22, 1962, John Glenn made three orbits in Friendship 7.

On May 24, the same year, Scott Carpenter made three orbits in Aurora 7. On October 3, Walter Schirra made six orbits in Sigma 7. And the program was completed with the flight of Gordon Cooper on May 15, 1963, in Faith 7, for 22 orbits. Project Mercury demonstrated that man can take his environment with him into space and there do useful work, for flight durations up to one day.

Attention was then turned to the Gemini program, and the first developmental flight took place on April 8, 1964, with the successful demonstration of the launch vehicle and guidance systems and of the structural integrity and compatibility of the spacecraft and launch vehicle. A second unmanned flight, Gemini 2, on January 19, 1965, utilized the Gemini capsule with all of its subsystems in a proof test. Then on March 23, the first manned flight, Gemini 3, was accomplished by Virgil Grissom and John Young, consisting of three orbits. On June 3, James McDivitt and Edward White traveled in Gemini 4 for 62 orbits. On one of these orbits, Edward White walked in space, and I will show you a color film of his walk at the end of this talk. On August 19, Gordon Cooper and Charles Conrad completed an eight-day mission in Gemini 5, which not only placed our country in first place for duration of mission but also broke several other records. The use of propulsion for maneuvering in space to change orbit was demonstrated, and certain experiments were made to study the problem of rendezvous with another spacecraft. Much more important, the Gemini 5 flight demonstrated that Project Apollo, which will send American explorers to the moon and back, is well within the physical capabilities of human astronauts. In the words of one of the engineers, this flight qualified the first subsystem of Project Apollo, i.e., the human crew, for the lunar mission.

The broad purpose of the Apollo program is the establishment of a national competence for manned space flight out to distances of the moon, including the industrial base, trained personnel, ground facilities, flight hardware, and operational experience. The use of this capability for manned flight to the moon and return and for further space explorations out to distances of the moon is intended to bring about United States leadership in space. We then will be in a position to do whatever our national interests require in the further study and use of this new environment.

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 retro rocket, 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 development 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. Some of these capabilities have already been demonstrated.

The development of rendezvous and docking begins with Project Gemini, the two-man spacecraft, which also permits an early test of the capabilities of men and machines up to periods of two weeks.

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 astroanuts will have accumulated at least 2000 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 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, and practical applications, including manned space flight.

We are building toward pre-eminence 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, spaceyards, proving grounds, and spaceports 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, were about halfway toward our first manned lunar mission in mid-1965.

We are accumulating, in space, the basic scientific knowledge about the earth, the solar system, the 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.

Last year the German space pioneer Hermann Oberth quoted a word from his deceased colleague Eugen Sänger in a paper on "The Meaning of Space Travel" as follows: "Nature has placed a kindly veil over the goals which it has for us humans in her cosmic plan. In order to lead us to these goals, it has planted within us not only a bright intellect in the brain but also obscure impulses as a compass in our breasts. Eternal unrest and the will to go to far places for thousands of centuries let mankind wander over the entire earth. This eternal longing to wander let us develop land, sea, and air transportation. From the very beginning only the bare human instincts have determined the directions of human history until today and brought us to the threshold of space travel. Only the unclear distant travail of humanity will now lead us over this threshold. Space flight comes upon us as a natural event born in the deepest depths of the human soul, before which we can only stand humble or defiant; space travel comes upon us whether we love it or hate it or do not heed it at all, whether we believe in it or ridicule it, just as war and high flood tides and death come over us."

In a speech a few years ago, I gave my own answer to the question of the significance of space exploration to the ordinary citizen in every country of the world, as follows: "The exploration of space can give you new interests and new motivations arising from an expansion of your intellectual and spiritual horizons as you take a longer view of man's role in time and space at this point in the history of the human race."

President Johnson stated another goal in his remarks following the completion of the Gemini 5 mission. He said: "As man draws nearer the stars, why should he not also draw nearer to his neighbor?

"No national sovereignty rules in outer space. Those who venture there go as envoys of the entire human race. Their quest, therefore, must be for all mankind--and what they find should belong to all mankind."

The President has stated many times his hope that the exploration of space will draw mankind more closely together in friendship and cooperation. But seldom has he been more eloquent than in this statement, the closing words of which I would like to use at this time to conclude my own remarks:

". . . Gemini 5 was a journey of peace by men of peace. The successful conclusion is a notable moment for mankind--and a fitting opportunity for us to renew our pledge to continue our search for a world in which peace reigns and justice prevails . . .

"Gemini is but the beginning. We resolve to have many more such journeys--in space and on earth--until man at last is at peace with himself."

Thank you. And now let us view together some of the most dramatic moments in our manned space flight program: Astronaut Edward White's famous "walk in space."

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