Mueller

Address by

Dr. George E. Mueller
Associate Administrator for Manned Space Flight
National Aeronautics and Space Administration

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MAN IN SPACE

It is a pleasure to participate in this important conference. On your program is an impressive group of papers on the major aspects of transportation. My work requires me to be a rather large consumer of transportation services. Thus I have a special interest in the success of your efforts.

You have asked me to talk on man in space, which certainly illustrates the exponential increase in the speeds at which we travel--from 10 to 15 miles an hour in horse-drawn vehicles a century and a half ago, to a mile a minute in automobiles and passenger trains and to ten miles a minute in a jet airliner. Now the space vehicle enables man to travel 300 miles a minute in orbit around the earth and within a short time it will be 400 miles a minute on the way to the moon.

Space travel is not quite in the same category as land, marine and air transportation, the subjects of today's discussion. Yet it is now a reality in an experimental stage and will be commonplace in daily life far sooner than most of us suspect.

In my presentation today, I propose to discuss the purposes of our present space program, the status, the investment, the capability for future activities in space and the support than can be provided for activities of importance on earth, such as transportation. Finally, I would like to raise a question regarding our goals for the future.

By now I think the motivation of the nation's present program are well understood. However, I will restate them briefly to establish a perspective for the remainder of our discussion.

The stimulus was international competition, which shaped two basic decisions. The first was the National Aeronautics and Space Act of 1958, which followed the orbiting of the first Soviet Sputniks. The second was the 1961 expansion and acceleration of the program to include the beginning of manned exploration of the moon in this decade. This followed the flight of the first Soviet cosmonaut.

The competition persists. The Soviets are devoting about the same amount of man-hours, material and resources to their space program as is devoted in this country. In view of their smaller gross national product, the Soviet effort is greater in proportion than that of the United States. Their program shows every evidence of a continuing major commitment to long-term large-scale operations in space.

The primary purpose of our program has been to develop broad-gauged, long-term capability to operate in space. The Apollo program focuses these efforts. The goal and the schedule of Apollo are easily understood--to provide the means for moving men to the moon and their safe return in this decade. The result is a clear sense of direction among participants, as well as a feeling of momentum that contributes to public understanding.

To satisfy Apollo requirements, we have had to train people, mobilize industrial support, build ground facilities, develop flight vehicles, activate a worldwide tracking system, gain operational experience and manage an unprecedentedly large research and development program. All of these abilities are of enduring value. Together, they enable the United States to operate with freedom in space, so as to carry out a wide variety of flight activities as may be required by the national interest.

The ability to travel and operate in space contributes directly to national power. In addition, accomplishments in space comprise a vital element in demonstrating to the world that ours is a "can do" country, able to compete but in a manner consistent with our best traditions.

More than 90 percent of the investment in Apollo is relevant to operations in earth orbit, which would be necessary even if the moon did not exist. The remainder, even though primarily related to the moon, applies also to any program of space flight beyond the immediate vicinity of the earth.

But even as we recognize these principal motivations, it is worth noting that the moon is an object of high scientific interest. Last summer, the Space Science Board of the National Academy of Sciences conducted a month-long study of the future directions of our space program. One of the conclusions was that Mars, Venus and the Moon should be assigned the highest priority in the solar system for exploration.

The Apollo program is on schedule. Over 400,000 people are at work throughout the United States on various aspects of the space program. More than 90 percent are employed by contractors in industry, universities and other research and development institutions. Numerous other government agencies provide needed and welcome support.

Let me briefly touch on the status of parts of the program most directly related to man in space--the Gemini program to develop manned space flight experience, the activation of major facilities, the unmanned exploration of the moon and the development and testing of Apollo-Saturn flight vehicles.

In Gemini, we have now conducted seven two-man flights. These, together with the earlier Mercury experience, had given the United States 1,375 man-hours in space, prior to the start of the Gemini 9 mission. We have carried out missions lasting as long as two weeks. We have achieved rendezvous between two manned spacecraft and the actual docking of a manned spacecraft with an unmanned target vehicle. An American astronaut has operated outside a spacecraft for more than 20 minutes. We have learned to bring a spacecraft down to the earth's surface within a few miles of a target point. We have performed scientific experiments in space. We are learning the basic characteristics of space travel and how to operate in the space environment.

For example, in the Gemini 9 mission that began yesterday, Astronauts Tom Stafford and Gene Cernan have two primary objectives--rendezvous and docking with the unmanned target vehicle and activities by Cernan in free space. This mission had to be postponed from its original launch date of May 17 because of the loss of the Agena target vehicle. However, we were able to substitute the Augmented Target Docking Adapter, a simplified target vehicle produced for such a contingency, which was placed in orbit on Wednesday. A portion of the objectives was achieved yesterday afternoon when they made rendezvous with this vehicle yesterday afternoon.

In the remaining Gemini flights, we will continue to fly increasingly complex and sophisticated missions designed to further refine our rendezvous and docking techniques and to conduct additional manned activities outside the spacecraft.

Unmanned investigations of the moon are providing needed knowledge regarding the moon's surface. In 1964 and 1965, three Ranger flights supplied more than 20,000 close-up photographs that were transmitted to earth by television techniques before the impact and destruction of the craft on the moon's surface. These pictures verified that there are a number of areas on the moon where the surface slope and roughness are within limits that we have established for landings by the Apollo lunar module.

In the Surveyor program, information on the bearing strength and other physical properties of the surface are being obtained. As you know, the first Surveyor soft landing was accomplished just two days ago. Preliminary analysis of the information obtained on this flight is encouraging. We are also encouraged by the report given by the Soviets from their Luna IX soft landing in February.

These seem to indicate that there are at least two places on the moon where an Apollo landing is feasible.

We were interested also in the results reported by the Soviets from the Luna X spacecraft, which was placed in orbit about the moon in April. This information is consistent with our design assumptions regarding radiation and meteoroids on the moon's surface.

Incidentally, President Johnson has proposed a treaty under which all nations would agree not to claim sovereignty or conduct military operations on the moon or other celestial bodies. We are encouraged by the apparently affirmative interest shown by the Soviet government in its statement this week.

Returning to the manned space flight program we are proceeding on schedule in the activation of required major facilities. Southeast of Houston, on a former cow pasture, we have built the Manned Spacecraft Center, where we manage the work of industry in the development and testing of manned spacecraft, train flight crews, and control flight missions. Major spacecraft systems are tested at White Sands, New Mexico. At the Marshall Space Flight Center in Huntsville, Alabama, we have the necessary equipment for the development testing of large launch vehicle stages. Production is in progress at the Michoud plant in New Orleans.

Just this spring we completed the conversion of a delta marsh across the river in Mississippi and activated a facility for the ground acceptance firings of large launch vehicle stages.

At the Kennedy Space Center in Florida, we have established a complex for the assembly, checkout and launch of the vehicles for the lunar flights. A principal feature is the Vehicle Assembly Building, which in total volume is the largest we know to exist on earth. Standing more than 500 feet high, this structure provides protection from weather and salt spray for the space vehicle during the months required for its erection and checkout. When the process is complete, a crawler transporter carries it--in vertical postion together with the launch tower--to the launch pad more than three miles away. A little over two weeks ago, this movement was accomplished for the first time, verifying the design and manufacture of the ground equipment.

Development, manufacture and testing of the necessary flight vehicles is continuing essentially on schedule. The first phase of the Saturn launch vehicle development was completed last year when the two-stage Saturn I vehicle achieved its tenth success in ten flights. The major milestone of 1966 was accomplished on February 26, when the uprated Saturn I--the Saturn IB--and an Apollo spacecraft were flown together successfully on an unmanned suborbital flight. We are preparing for two additional unmanned flights of this vehicle in the next few months. The next is planned for the latter part of June. Three astronauts--Gus Grissom, Ed White and Roger Chafee--are in training for the first manned flight of the Apollo Saturn IB, scheduled for 1967. In these flights, we plan to test in earth orbit the flight equipment and procedures for lunar flight.

Also scheduled for 1967 is the first unmanned flight of the Apollo Saturn V. This will be employed in the lunar missions themselves. All three stages of the launch vehicle, the instrument unit and the spacecraft have been fabricated and are being checked out. Delivery of this equipment to Cape Kennedy will begin during the summer, in time for erection in the Vehicle Assembly Building following completion of the present series of tests. Manned flights of the Apollo Saturn V are scheduled to begin in 1968 in preparation for the manned lunar missions before the end of the decade.

At the same time we anticipate conducting other missions, in earth orbit with the uprated Saturn I launch vehicle and the Apollo spacecraft, to begin utilizing this capability for other scientific and practical applications.

We have high hopes of maintaining this schedule as we proceed. One of the things that has impressed me in this program is the almost unbelievable dedication and motivation of the 300,000 people working on manned space flight. They have mastered new and difficult working skills of lasting value. They have demonstrated a remarkable ability to do almost a day and a half of work in a day's time.

Now let us turn to the investment. The Government and industry have invested almost four billion dollars in permanent facilities and equipment for manned space flight. This includes about two and a half billion dollars by NASA, $760 million by the Department of Defense and $650 million by private industry.

An odd feature of the space program is that we begin to "go out of business" before we fly our first operational vehicle. The total manpower occupied on the program has already begun to decline a year before the first flight of the Apollo Saturn V and two years before the first manned flight. This is so because the engineering work must be done to a large extent well in advance of manufacturing, which in turn precedes the operation phase.

As we consider the resources committed to the space program it is important to keep in mind that ours is a growing economy, which permits the nation to do what is being done in Viet Nam and elsewhere. Even though the totals of Federal expenditures have been growing, the share of the gross national product represented by these expenditures has been relatively stable. In the last several years this sum has remained very close to 15 percent.

One way to look at the nation's activities in space is by totaling the Federal expenditures for the Department of Defense, the Atomic Energy Commission and NASA. The sum of these three has been rising in absolute numbers but declining as a share of our national wealth. This is true despite the substantial costs of Viet Nam. For example, twelve years ago this total was 13 percent of the gross national product. In the current fiscal year, which ends this month, the percentage is down to about two-thirds of that amount, or 8.9 percent. If the national economy continues to grow as anticipated in the coming year, the percentage will decline further, to 8.8 percent.

In view of these figures I for one believe that the nation can afford to continue to invest in the future through the space program and other major research and development activities.

Next, I believe it is worth while to consider what possibilities exist for future activities in space to employ the capability that has been created. With this equipment it is possible to travel on many kinds of flights in earth orbit, about the moon or to the moon. One of the more interesting possibilities is the stationing of a manned spacecraft so that it maintains its position over a fixed point on the Equator. To do this, the astronauts must steer the craft into a circular orbit at an altitude of 22,000 miles, in which its period of revolution is 24 hours--thus synchronized with the earth's rotation.

From an Apollo spacecraft in such a synchronous orbit men could use photographic and radar equipment for observations with a large telescope, unhampered by the distortion and absorption of the earth's atmosphere.

Another type of manned space mission would be to develop the techniques of resupply for a space station and to perfect the transfer of crew and materials between two spacecraft. A third would place the spacecraft in orbit about the moon for two weeks, where the astronauts could use cameras and other sensing equipment to survey the moon for potential landing sites and for study by land-based geologists. Fourthly, men could land a spacecraft at the same place on the moon where a landing has already been made, using some of the equipment left behind and staying for several days.

A number of potential applications could be tested on such missions. Equipment that could be orbited might bring live television to ordinary home receivers in all countries of the world. In your consideration of other papers at this meeting you might take note that these tests might lead to the establishment of control towers in space that would provide communications and all-weather navigation systems for aircraft and ocean-going ships.

Advanced weather investigations would be facilitated. In the last few months, several studies of long-range weather prediction and weather control have been completed. The studies have been carried out by very conservative groups established by the National Academy of Sciences and the National Science Foundation. Their import is that the time may well have come to lay out a serious, long-range program of action regarding the weather. In February 1966, President Johnson made such a recommendation in a message to Congress. Trained men using Apollo-Saturn flight hardware would be capable of aiding this effort.

Another kind of manned flight activity in earth orbit involves the use of photography and other forms of remote sensing. By this means it appears feasible to supply agriculture with the information it needs on the status of crops and forests on a continental and worldwide basis, to provide information relating to water supplies and air pollution, and to assist in the identification of resources that can be obtained from the oceans.

In addition to applications, there are scientific investigations. The summer study of the Space Science Board mentioned earlier recommends that large tlescopes and other instruments be placed in space. Another group of advisers has recommended a ten-year program of exploring the moon. These reports express the belief that man in space, close to his instruments, can greatly improve the ability of science to increase knowledge about the origin of life and the history of the earth, the sun, the planets, and the universe.

However, few of these benefits can be realized until we are able to operate routinely in space--until space travel and space operations are as commonplace as ship departures or aircraft takeoffs. We must investigate the conditions and the problems associated with operations in the weightless, vacuum environment. We can learn to operate effectively only by spending time in space. It may be useful to recall that Columbus dramatized the beginning of the age of exploration with his voyage to America. But it was not until many years later, after many ships had traveled regularly from Europe to America, that men really began to explore and exploit this continent. In similar manner, I think that men will have to live and work in the space environment for some time before they can begin to make full use of this new resource becoming available.

It is worth while to recall that the Wright Brothers' first flight at Kitty Hawk dramatized the possibility of flight. However it was not until airplanes were numerous and barnstorming had given way to commercial flight that aeronautics began to be profitable. There is another interesting fact worth recalling. Although the airplane was invented in the United States, Europeans first adapted it for practical use. In World War I this country had to borrow British and French designs and in fact no American-designed plane flew in combat. Similarly, the submarine was invented by another American, Holland, but was first exploited by Germany. And Dr. Goddard in this country proved that a rocket would work in a vacuum but the Germans first used rockets to propel ballistic missiles and the Soviets first achieved space flight.

I am confident that history will not repeat and this nation will not forego the challenge of space flight. Man has never turned his back to flight at extreme altitudes and tremendous speeds.

Now what are the implications for solution of problems here on earth, such as transportation? I think we have learned a good deal about the planning and management of large research and development programs. This country has proceeded in the last generation from the Manhattan Project to the ballistic missile programs and now to the Apollo program in which more than a quarter-million people in three government field centers, twelve prime contractors and 17,000 subcontractors are working together on a single program under the management of one office.

One of the things that characterizes a research and development program of this size is its multidisciplinary nature. It requires that scientists, engineers, physicians, and other technical people work closely with those educated in the social sciences, management, and the humanities. A most challenging aspect of such a program is to assure that everyone speaks the same language. I think you will find that this kind of experience applies to any large-scale effort to use modern technology.

Perhaps an even more important contribution of space flight is in promoting the application of modern technology. With astronauts flying above our heads at speeds of 300 miles a minute, I think people feel more strongly about the need of safe, efficient transportation for the rest of us, from home to work, from city to city, or from continent to continent. It is no coincidence that demands also appear to be increasing for clean air, fresh water and well-planned cities.

The explosive growth of science and technology in general appears to be more than coincidentally related to space flight. For instance, if we examine the growth of federal support for research and development in recent years we see a large jump after Sputnik and a further increase after 1961.

Let me again mention some interesting facts. A few moments ago we discussed the totals of federal expenditures for defense, atomic energy and space. Much of the rise in absolute figures resulted, of course, from increases in the national investment in research and development in these areas.

However, the federal government invests substantial sums for research and development for other purposes than those of these three agencies. This total, which we might call "Little Science," has been expanding at a phenomenal rate. In fiscal year 1954 it was $188 million or less than six percent of the total federal investment in R&D. In the budget proposed for fiscal year 1967, this total exceeds $2.2 billion. This is twelve times that of 1954 and more than 14 percent of the current total.

So it appears that the Apollo program has served as a focus not only for the space program but also for the entire spectrum of research and development. The effort to land men on the moon and return them safely to earth in this decade appears to have assisted in maintaining space support for the total national investment in science and technology.

What are the characteristics of Apollo that have elicited this general support? I think they are something like the following:

The goal is easily understood. It can be accomplished in a time that seems reasonable. It is a major commitment. It is a large step forward, requiring broad support of science, technology and other elements of the nation. Man participates, resulting in the personal involvement of people on the ground.

Finally, it is competitive. I think competition is healthy. We use it continually in our schools and colleges, to bring out the best in students. We use it in the management of large organizations, to gain the best performance from people. We use it in our government; political parties compete to serve the American people. We use it in the marketplace, to enable the consumer to select the best products. All of life is competition. What is wrong with peaceful competition between nations and systems of government?

In recent weeks we have been devoting much serious thought to the programs and goals for the period following the completion of the Apollo program. The time for decision is clearly approaching. For if we do not decide to begin follow-on programs in the fiscal year that begins July 1, 1967, we will have to phase down manned space flight activities and mothball some of our facilities.

As I have indicated, there are many possibilities. I have limited my discussion to those that grow out of the manned space flight program. Others develop from other aspects of the space program. And beyond the space program many other opportunities are emerging across the broad horizon of research and development.

In view of the factors that have contributed to the support for Apollo in this decade I think we might consider how another, more advanced, national goal for the next decade might perform a comparable function. Perhaps we should consider the same motivating factors in the selection of such a goal.

In conclusion, therefore, the space program is a response to the challenge of international competition. It is on schedule. Four billion dollars have been invested in facilities and equipment required for manned space flight. The national economy is growing so fast that we can certainly afford to carry on.

To accomplish the Apollo Program we have established a capability to do many things in space. The technology and management techniques are applicable to other large-scale efforts. And the goal and schedule provide dramatic focus for all of science and technology.

The time is approaching for decision on whether we want to continue to provide this focus. Do we want to select another goal for the period after American astronauts land on the moon and return safely to earth? If so, what goal should we choose?

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