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AN ADDRESS

Honorable James E. Webb

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Reviewed by Col R.W. Bergamyer, USAF on 26 September 1963

INDUSTRIAL COLLEGE OF THE ARMED FORCES

WASHINGTON, D. C.

AN ADDRESS

13 September 1963

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Reviewed by: Col R. W. Bergamyer USAF Date: 26 Sept 1963

Reporter--Grace R. O'Toole

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ADMIRAL ROSE: Before we get on to the more interesting part of the morning, let me welcome General Griswold and the people from the National War College to the first joint talk that we have had in this auditorium. I trust that you will find the seats at least as comfortable as they are in Auditorium B.

This is also for our school, as I think it is for the National War College, the first talk we have had on one of the big, important, and somewhat technical subjects the United States has on its agenda at the present time.

We couldn't have a better man to start off this kind of talk for us. As you know from his biography, our speaker has been in many fields of endeavor--education, law, business, and government. When I was in the National War College he was the Director of the Bureau of the Budget, and he spoke to us on that subject. I am sure that money will come up again.

Without further ado, it is a great pleasure for me to introduce the Honorable James E. Webb, Administrator of the National Aeronautics and Space Administration.

MR. WEBB: Thank you very much. Gentlemen: It is a great pleasure to be here. It is not possible, I think, for anyone to live up to these billings when you have examined national policy issues from the period when aviation was developing in the 1930's. I did have a small part in the buildup there and went through the period which may seem strange to some of you in the Air Force, when President Roosevelt talked to the Navy about the strategic bombing mission and the Navy declined it, on up to the postwar period, when it was necessary to realine the Government of the United States and to try to form a system by which this large burgeoning country could meet the problems of the postwar world and to have that concept

which was well worked out in 1946 and 1947 forced to give way to the exigencies of the Communist drive for power, beginning with the Greek-Turkish Aid Program, which I remember so well in the Bureau of the Budget--it was $400 million--and which affected a rather precarious balance of the budget, on through to the Marshall Plan, which was submitted to the Bureau of the Budget as a program of $20 billion for 4 years, and which the Bureau of the Budget, after its not-so-gentle message, recommended at a level of $16 billion for the 4 years--and incidentally it came out just $16 billion.

I saw the very difficult decisions in implementing these kinds of policies result in success but also result in the fact that the governments who were to work with us and who were, in a sense, sharing the assets of this country to build a system that could resist communism turn out even with economic growth to be so weak internally that General Eisenhower told me in the Georges Cinq Hotel in Paris before the military aid program was put in that the Swiss Army could take Paris in 10 days.

I moved from those kinds of issue in the postward world through the time when atomic energy was considered as a great national asset, a great national resource, and debated in a vigorous way in the national forum, and I was seated in a commission that had the problem of being a manufacturer and designer for the military services of atomic weapons but also required under the law to develop the additional benefits which could be obtained in the medical field--and you have seen a marvelous development in the area of isotopes--and in the area of high-energy physics with its support of the educational programs of the United States, to the extent of some $300 million a year, and resulting in such great institutions as the Brookhaven National Laboratory, the Oak Ridge National Laboratory, Argonne, and so forth, which are in addition to the in-house laboratories, like Los Alamos,

and Livermore, and in-house capacities represented by Hanford, Oak Ridge, Savannah River, and so forth.

Now, the point I'd like to make is, in the period of this century, we have seen developed the technology underlying aviation. We have seen the United States lag in the early stages of each of these, except perhaps atomic energy. We have seen an effort to catch up, which began mainly in aeronatutics in 1915, with the establishment of the National Advisory Committee for Aeronautics to do research, and move on 10 years later to the recommendations of the Morrow Board and the other boards dealing with this and to a procurement system that would supplement the research and give us decisions at the government level based on technical quality rather than lowest price.

We moved on to see in the development of aviation a situation where, having used up 40 years to get from the Wright Brothers to the modern jet airplane, it only took us 10 years to move on to the X-15 which could give us the data necessary to develop the kind of system that would permit you to operate in space where you did not have the air for reaction material but could develop in the different types of controls based on reaction motors on the rocket principle.

So here is a development which we lagged in and on which we then instituted research. We then matched the research with procurement systems. We moved on to jet transport and then to the major research tools that lead to the next stage, and in the process we developed the technology by which we could use the air. How much of it do we use? Only about the amount up to twice the height of our highest mountains on this earth.

Let's look at space. Dr. Goddard in 1916 did the basic research work at Princeton which showed the capacity of the rocket engine to deliver its power in

a vacuum. He did the experimental model 10 years later, in 1926, which proved that a multi-stage, liquid fueled rocket could indeed deliver its power in space and in a vacuum, and he developed concepts which were so astonishing, concepts of the use of this, that he was afraid to put forth the full flavor of his thinking on it, and the original article in the Smithsonian Journal was so restrained that he later said he was regretful that it was so restrained. But the press, and interestingly enough it was the press, picked up the spectacular nature of it and played it from this Smithsonian article.

The Russians, and the Germans, picked up this technology and these concepts. They went to work, and we saw the result in the V-2 bombs that were dropped on London. We saw the result in the Russian development of the ICBM, and we made again a belated move to catch up, beginning with the ballistic missile program of the fifties, followed by a debate as to what to do about space, to the passage in 1958 of the National Aeronautics and Space Act, and the accumulation by the Government into a system divided substantially into two parts by the Act of 1958. One was to be research and development and a testing of the operating capability of space vehicles by a civilian agency, and the other was to be the development of weapon systems applications, research necessary to have weapon systems, by the military services.

Now it takes a while in this kind of government to shake down such very large concepts, such very large motors, because, while the long development of aeronautic principles and the marriage of these with a power plant capable of taking them into the air for useful work had to be followed along at every stage with very courageous research by men who would develop all the ideas which I shall not labor here with you that permitted airplanes to fly, it resulted in an organization that

I think I can illustrate the value of with one simple situation that many of you in the Air Force will understand.

I start out by saying that everyone in advanced research and technology makes mistakes. No one can foresee all of the problems that will come out in the development of a very advanced type of airplane or in a very advanced type of spacecraft or a very advanced type of booster. Take the 102 airplane. After the most careful work, the contracts were let, the airplane went forward to production, and the tests and examinations made in the aeronautical sections of the NACA showed after a period of time that this airplane in the transsonic range was not going to deliver the goods. It was inadequate for the purpose for which it was designed, and its performance was going to be very low.

The question came then: How can you move from that position to have a successful development? A great deal of theoretical work was done, and a great deal of wind-tunnel testing was done. The now well known coke-bottle design fo the transitional flight range from subsonic to supersonic was thought up. It was tested with the greatest of car. Two men from NACA went to California and sat down with the Air Force representatives--some of you may have been there, perhaps as junior officers--and General McNaughty, who was running the plant. After they had shown the hard-boiled managers that something really had to be done and that work had been done to back up the technical judgment required, the plant was closed down and 5,000 men were laid off. The plant was completely retooled, production was stopped, and the airplane was redesigned to a new configuration.

Now, the point I want to make is that that cannot be the matter of a committee judgment--that kind of thing. It requires great courage for men to say, "We will really come up with the answer, and we will stand up and be judged on the

decision to lay off 5,000 men. We admit we have made a mistake and we will take the consequences financially, publically, and otherwise."

I'd like to give you just one last idea here. We are going to have those same problems with every advanced system that we come up with. I don't think it is unfair to say that they are not absent from the B-70 program, and I think it is extremely important that the B-70 program is going to now be used as a testing method for work on supersonic commercial airliners and for joint operational programs with the Air Force and NASA, with the kind of instrumentation which NASA will pay for, in one of these airplanes, that will permit not only what the Air Force needs but what the flight engineers need to compare the actual performance of this great, big airplane to the wind-tunnel test and the theoretical work we have done before.

Why? Because this lays the foundation on which the next airplane can be built. That is exactly the process for the X-15. When you've gone through the theoretical work, you've gone through the wind-tunnel testing, you've gone through the design and experimental flight testing, you now have the actual flight data to put back against the theoretical work and the wind-tunnel testing. It is the process that this represents that I think perhaps is one of the most important elements in what Stock Draper has called the technological balance of power in the world.

I'd like to talk about that for just a moment. What are we dealing with when we deal with space? I am not an expert. I am an administrator, a lawyer. There are men here like Mel Rosson who are experts. So I will oversimplify mainly to show you that there are concepts here that administrators as well as technical men must deal with.

First of all, if you look at this question of how a nation has the technical capability to engage in a technical race with another system by which large-scale, organized efforts in research and development and technology are going on, you must look back to the time when, in World War I, there was an effort to fly a pilotless airplane. The group working on this remained together to some extent. A great many of the people concerned with gyroscopic control and various other problems associated with pilotless aircraft and guidance came together at MIT in the Instrumentation Laboratory. They did a lot of work in the 1930's and developed pilot models of various types of guidance systems. When we got into World War II we found that the Japanese could indeed, through the massive application of air power, sink ships--we saw that in Singapore when the Prince of Wales and the Renown, I believe it was, were sunk by Japanese air power--and found that the conventional system of protection of surface ships suddenly would not work when you had very large numbers of saturation-type attacks made on surface ships.

Now, this group at MIT had working models that permitted the United States to move rapidly, in about 4 months' time, to develop computing gunsights which could be manufactured and put on those ships and completely reverse that situation.

That is the capacity to have in being men with ideas, men who have tested those ideas and who have performed the necessary basic work so that you can then move right on to the policy of adopting this, of funding it, of putting out the contracts, installing the equipment on the ships, training the crews, and so forth. I had a small part in that, because I spent 5½ years as the Personnel Officer at Sperry and had then become the Financial Officer. Here was a company that had 1800 different government contracts, and with a relatively small equity in the company we were engaged in such large work that we had maybe 10 to 20 times the

equity in the company involved in subcontract obligations and in procurement obligations of one kind or another.

So it was a very difficult problem for this company to accept the responsibility to manufacture what was in essence the ideas and translation of a working design of Stock Draper into computing gunsights. My part was to approve it from a financial standpoint. We did it, and I think it was a tremendously important thing.

Now, what has happened? That same group emerging out of World War II stayed together. It did the guidance system and moved on to inertial guidance for Titan, Minuteman, and Polaris, and is now the group doing the guidance system for the Apollo lunar mission.

Now, if you look at the relationship between Russia and the United States and one in which we are struggling to develop power, power to enforce our own will with respect to how the world will be in the future, then these technological capacities represented by the Instrumentation Laboratory are extremely important, because these vigorous, research-minded men know how to develop the ideas and know how to put them into working models, and, very importantly, they know how to design the test and simulation equipment that will permit you to really prove out what it is you are trying to do in these types of equipment.

This is one of the keys which I shall return to in a moment to the NACA type of organization. I will refer to it briefly. This organization, NACA, now NASA, has always based its forward work on a few relatively understandable factors--first of all, that there will be men who are capable in the most advanced areas of research, that they will be permitted to work on the problems that they themselves consider are the most important and not be on the end of a string of some contracting

officer who wants some applied research done, that they will be permitted to make capital investments in the kind of research tools they know are necessary.

The full-scale wind tunnel I referred to last year when I was here as having not only added 15 to 20 miles per hour through the clean-up of every airplane we flew in World War II but also added substantial performance to the submarines that we use, because the full-scale testing was the final element in the clean-up. But it is the design of these tools, such as the full-scale wind tunnel, which was put in, I think, about 1928 or 1929, which had its effect some dozen years later in World War II, that I am referring to.

We have now going into physical shape all around the country the modern version of the full-scale wind tunnel. In the case of working with zero gravity, we have going in at Cleveland a Zero G Drop Tower that will give us up to something like 10 seconds of simulated weightlessness, a very ingenious method, by which you not only get the 5 seconds of the fall but you have a very interesting method by which you can reverse that and just double the Zero G experience, by some means that I don't completely understand. But this is the kind of thing that keeps the men working in these technical laboratories, and they are used not only for these various areas of research, of hitting the cutting edge of it, but they are also used to monitor the research contracts with universities where scientists are working on the energy relationships between the earth and the sun, where they are defining the space environment much more accurately, so that the engineers can come along and design spacecraft that will work better, and they also monitor the contracts with industry whereby these very advanced systems are manufactured by industry. In the space case 90 percent of the work of the agency is done by industrial contractors, but a large amount of the scientific work supported by the agency is

done in universities, on campus, in close association with graduate, and wherever possible postgraduate, education, so that the graduate students play a very important part of developing the ideas and increasing the resources of the country as these men move through this process and become available.

What is the difficulty of the task we are trying to deal with in space? I think if you oversimplify the problem just a little, you can say that, with the Delta, we can put payloads of a few hundred pounds into orbit. We have been able even to put the Syncom up into synchronous orbit at 22,300 miles. But it costs about $1,000 a pound to put something into orbit. You can with the Atlas put something like 2 percent of the weight you start with from the earth into orbit.

Your early Vanguard rockets would put about 1/10th of 1 percent of what they started with into orbit.

So we are dealing here with a very narrow margin between success and failure, a very expensive process when you go out into space. There is, however, in spite of the great difficulty of using energy and guidance and check-out systems, and worldwide tracing and data acquisition systems for space flight, under way a very large-scale effort running from the small boosters, the sounding rockets, the Scout, all the way through to the advanced Saturn, which can put 100 tons into orbit and gets the cost down to about $450 per pound.

I'd just like to leave this idea that there is nothing easy about rocketry. It is extremely expensive to build these big boosters. But there seems to be no other way to get there. Inertia and gravity both must be overcome. If you want to stay in orbit longer than just a few days, you've got to go straight up against gravity about 150 miles, and then you've got to speed up to about 18,000 miles an hour, and then, if you want to go outward as far as the moon, you've got to speed

up again to about 25,000 miles an hour.

This requires a tremendous control application of energy with all the associated equipment, and you are dealing here with a situation where you start out, let us say, on the trip to the moon, with about 6 million pounds on the launch pad. You end up in orbit with about 220,000 or so, and you head for the moon with about 90,000 pounds or so, about the same weight that Columbus's flag ship weighed when he came across the Atlantic, and you come back to the earth with about 12,000 pounds, or a little bit more.

So there isn't anything easy about space, and you are dealing with forces that are so powerful that even the best technology is required and you have to go beyond the state of the art in some of these areas. For instance, right now we are planning to use fuel cells for power in the Apollo and the Gemini. No fuel cell has ever been flown in space and operated under zero gravity conditions except for very short periods of time in flights that you can produce in an airplane.

How much in the way of parallel development of alternate systems of power should be involved when you are setting out to stake the prestige of the United States on accomplishing a mission that absolutely requires electrical on-board power and when you are relying on a fuel cell?

These are the kinds of problems that are involved in the money discussions down in the Congress, and they are the kinds of things that represent the difficulty of the technology, and they also represent something important to the public image. That representation, I think, perhaps could be passed over very quickly here with this group by saying that there isn't any doubt, I think, in the minds of those people who look at the world through cold, realistic eyes that the Russians, through their early development of an atom bomb and its explosion, through their showing

of the Mig airplane in the Korean War, through their work on the intercontinental ballistic missile, really, I think, did surprise this Nation, when they showed that they could do that as early as they did, and then their work with Sputnik, and then their proven ability to fly a 10,000-pound spacecraft at will, and recover it, manned or unmanned.

Now, these are tremendous accomplishments. Their impact, as indicating a very high level of technology which could be used for positions and for implementing national power, has not been lost on the world. I think, further than that, it is true that, as you see this kind of very real capability, you must constantly look at another factor. These problems are so difficult that no one can set a schedule 2 years, 3 years, or 5 years in advance, and say, "We will fly this rocket on this day. We will put Syncom into orbit on this day. We will fly the X-15 first on this day."

The X-15 is one of the most important projects we've had and one of the most successful. It has given a vast amount of information. It has proved the role of man in that some 16 of the 90 flights would have been failures or loss of the equipment if the man had not been on board, and yet this program was delayed in its first flight 2½ years from the originally scheduled date.

The Mercury program slipped between 2 and 2½ years. This fuel cell problem I have described to you will, in my opinion, inevitably cause a delay some years hence in some important part of this program, if some parallel developments are not instituted today--and they cannot be instituted at the level of funding which has been approved in the Congress.

Here is a rather difficult problem that a nation like the United States faces. What do you do under those conditions? I'd like to say, though, that the

point I am trying to make is that the image of a success such as the Russians have shown through all these things that I have described can also be looked at in reverse when the press says, "If you don't meet a date established 3 years in advance for the flying of a specific space mission, then you have had a major slippage and a great failure."

I think we must constantly bear in mind that, while the military services are looking for a production line with missiles coming off of it as well as a successful flying missile that will carry a warhead, in our agency we are looking at the research and development side to gain the knowledge that permits us to move on. The number of vehicles is very small. There are only 12 Gemini missions scheduled up to this time, so we tend to want to fly a mission, examine it with great care, fly again after we know everything there is to know about the first one and know what the next lesson to be learned is.

Every X-15 flight is preceded by a substantial number of hours of careful analysis and work and simulation of the flight that is to be performed. It is even more so in the case of the Mercury and the other flights. But the idea that, when you set a target date to crank up the effort and to drive the effort forward and to make schedules that many, many segments of industry and government and science must meet, and then are held to a public accounting as to whether or not you met that date and why not, and a presentation that there is a failure if you don't meet it, misses the point that 19 Deltas out of 20 have been successfully flown in this research and development program. The first one was a failure and the subsequent 19 have all been successes, whereas in no year up to 1962 did we launch as a nation more than 50 percent of our scientific satellites. Half of them were failures. In the year 1962, 100 percent of them went off and succeeded, with some

slippage of time, may I say.

Let me say that we can't say that for 1963, because we have already had one failure on a scientific mission this year. It was not an orbital mission, so I'll not characterize it as a scientific satellite.

Well, I want to move on now very quickly to use the next few minutes to show you where we have come, what the assets are that are being created within this framework, and give you some idea, I think, of what may be in the immediate future.

First of all, against the pattern of accomplishment of the Russians, which I have just described to you, in the first 7 weeks of this present Administration by President Kennedy, the Russians flew five spacecraft weighing over 10,000 pounds. One of them was up to about 14,000 pounds. It was the early Venus mission. The others were the Vostock series, the last one being the Gargarin manned orbital flight--a very orderly development process which any nation could envy, this system by which the Russians accomplish these flights.

I think it was clear that internationally and here at home, for military as well as other reasons, we could not be ignorant and without the tools to do this kind of work. So the question the President faced was: How do we crank up the tools to be better than we are, to be better able to match this new force? He took counsel from people who had made a lot of studies. He consulted with the political leaders, both Democrats and Republicans. He asked the Vice President to work with Mr. McNamara and with me and with our associates, in and out of uniform, and we were able then to put together a program which said in essence a very simple thing. It said, "The Russians have shown great capacity here. They probably will do multi-man orbital operations before the United States can do it," because the biggest

booster that was then under development was the Saturn I, and it was not very far along, and the basic funding in the budgets of the previous Administration did not include any large spacecraft that could carry anything bigger than the Mercury.

So we have to start with a situation where the Saturn was under development with an eight engine, a virgin cluster of the proven engines we had used in our missiles. We had an F-1 engine under development that had been under development since late 1958 or early 1959, and we had a 200,000-pound thrust J-2 engine, burning liquid hydrogen, under development.

Now, taking that situation in which, thank God, we had these engines already under development, we said, "What can we do that sets a goal difficult enough to mobilize real resources, imaginative enough to show the world that the United States means not to be second best, and which will set a target so difficult that we have some reasonable chance of being successful as against the Russian effort?" Knowing that the multi-manned earth-orbital operations were probably not within our capability before the Russians could do them, and knowing that a lunar fly-by by a man or more might not be within our capability as a nation, not desiring to stake the prestige of this Nation on something that could not be done, it was said that to build big boosters and to develop the power to operate in any way we needed we would set the lunar landing as an objective and crank the effort up aimed at this.

You simply are not able to develop boosters and spacecraft against a general requirement of, let us say, preeminence in space. You've got to have some specific mission, as I think all of you know, and I think also that the events of the last few years cast some serious doubt on the idea that you can put on the shelf a lot of building blocks and then just add them up and you've got for any space mission the capability.

The Vanguard was a use of the building blocks then available, but the efficiency went down to 1/10 of 1 percent of its weight in orbit. In order to get up to 4 percent of weight in orbit you really have to have tailored design carefully planned to each specific mission in question.

As a result of this effort over these 2 years, and with the President's commitment to advocate in the Congress an expenditure of $20 billion in the area of manned space flight, including the lunar landing and return, about $15 billion more in the area of advanced technology, of scientific work to understand the space environment, you had a situation where he was committing himself to about two-thirds of one year's military budget to be spent over 10 years' time and to develop the basic resource base that, in a period like 10 years, would give us the capacity to do anything we needed.

What's come out of it? About $3 billion of investment are going into ground-based engineering complexes which permit us to recognize the difference between the booster and the airplane. We have established a government-owned assembly plant at the mouth of the Mississippi River, and have told the aeronautical industry that all big boosters will be assembled there, that they can do the design, the manufacturing of parts, the procurement of the most efficient components, and so forth, anywhere they want, but we are going to require them to assemble them there so that we can transport them easily over to the Mississippi test facility and to Cape Canaveral for launching.

The Mississippi test facility permits us to clear people out of an area within a circle of 10 miles' radius. We have easements on 128,000 acres of land in addition to the land we own in fee there. So here is a great government-owned assembly plant capable of manufacturing the biggest of boosters, with the test area 35 miles

away, water transportation in between, through which such giant boosters as the Saturn V or the Nova can be tested, and a water transportation system around to Cape Canaveral, and a very large area on Merritt Island with very large complexes being built there, including a building in which you can erect four Saturn V's side by side and have two more in a horizontal position, in process of assembly. You can carry them a couple miles down on a giant earth trawler and launch them with perhaps one week on the launch pad instead of the very long periods of time we've had in previous missions.

All of this kind of thing has produced a new base on which government and industry can build boosters, can test them, and can fly them when needed around the world. There are two main networks. One is the system we use for man space flight, including the network that will permit us to control spacecraft outward to the moon. The other is the deep space network, composed largely of giant dishes at three locations that permit us to work with things like Mariner out to Venus and the deep space probes.

So you have this $3 billion going into facilities for the design, for the assembly, for the test, for the launch, for the large environmental chambers, and for the large simulators in which you can run a simulated mission of one month, and continue to produce what the astronauts said from their flights--you remember they said, "We didn't counter anything on the flight that we had not already seen in the simulator."

Now, this is what you are after, and this is a most difficult thing to do. In the Saturn V--I won't talk about all the boosters--a cluster of five F-1 engines can deliver 7½ million pounds of thrust, can put 100 tons into earth orbit, and with a nuclear stage can double that capacity. We are investing $4 billion,

roughly, into this giant booster. We are investing another $3 billion, roughly, into the Gemini and Apollo spacecraft, and have, I think, in these facilities the power, whatever it may be, for the United States to operate in space at least to develop the need and the capability for operations, whether for communication satellites, for military purposes, for weather purposes, or whatever.

I think it probably would not be out of order to mention just very briefly here the difficulty of maneuvering in space. There has been a large amount of propaganda saying that we need a harder killer capacity in space, and we need an ability to fly around like you do in an airplane. When anything is moving as fast as 18,000 miles an hour, it takes a lot of energy to change it. With the Gemini, with all of the capacity of the Titan II involved, you can change your inclination of orbit somehwere between perhaps 1 and 1½ degrees, or you might advance the altitude of the height of your orbit maybe a couple hundred miles, up to maybe 400 miles. With the Apollo three-man spacecraft, flying on the Saturn, you can maybe change your inclination about 15 degrees and maybe go up a few hundred miles further.

But the point I want to make is that the idea that you can maneuver in orbit after you have left the earth's atmosphere simply is not true unless you are going to have a massive amount of energy going along with you. Now, while the Saturn 1-B will give you more ability to orbit than anything that we have heretofore contemplated, and its ability to lift 32,000 pounds into orbit is what produces this, the Russians, with their present first-stage and lunic stage, both man rated, I believe, up to this time, can get up to about the same capacity at least with one man.

So that, for the next 2 years or so, they are going to have the capacity to maneuver to this limited amount, about 15 degrees and upward and downward about

300, 400, or 500 miles, and we will not have it until we get up to the Saturn 1-B. But once we move on to the Saturn V, which can put 100 tons into orbit, you really have got the capacity to do what you want to do. So don't have any idea that you can wish for maneuverability in space. If any of you have driven a car around a curve or a slight curve at 100 miles an hour, I think you can just extrapolate that experience to something going 18,000 miles an hour, and realize that the efficient use of energy is the most important problem we face in this Nation.

I'd like to stop on that just for one moment to say that, in the universities' scientific area and in non-profit institutions like Stanford Research Institute there are now working in this program under NASA grants and contracts between 4,000 and 5,000 scientists and engineers working on these basic problems of new materials, very advanced electronics, very sophisticated uses of energy, the marriage of the man in the loop and the life sciences with the physical sciences. This is a very great asset when added to the nine laboratories in which about 9,500 scientists and engineers are now employed in this program, as a segment of about 30,000 persons altogether, including the administrative persons that manage 90 percent of the work that goes out to industry.

Moving on now from maneuverability in man space flight you get to the space science program. Here we have moved from the small satellite or the small probe to where we have a family of unmanned observatories. The orbiting solar observatory, the first one, has been in orbit about 14 months. It is beginning to deteriorate but it has given us a vast amount of information about the sun and the relation of the energy transferring the sun to the earth. It is a vehicle which has a stabilized platform pointed continuously at the sun, and a rotating wheel on which

about 15 experiments go which give you constant measurements of these 15 or more items that scientists want to measure. Scientists can get their experiments on this observatory. We expect to launch it continuously for about 11 years of the solar cycle. We will retrieve the data through our worldwide tracking and data-acquisition network and feed it back out to the scientists in the universities, where this kind of work will be done.

I have serious doubts, from having been associated in one way or another with the Government for now over 30 years, that any person in government or any group of persons can fully understand this, whether civil service or military. I think you need to involve the whole range of our best brains in the area of science to understand, for instance, the chemical reactions in the upper regions of the earth's atmosphere, which were unknown and unsuspected just a few years ago, and their effect on the weather and the use of the high regions of the atmosphere for military, civilian, and whatever purposes we want to use them for.

In addition to the orbiting solar observatory, there is the orbiting geophysical observatory which accomplishes very much the same purposes for the geophysicists. It looks backward at the earth and carries a large number of experiments. These experiments are designed by scientists in universities. They are flown by the Government. The data comes back and the scientist does the analysis and pushes the field of knowledge forward.

The orbiting astronomical observatory will give us a vast amount of information about electromagnetic signals coming to the earth from the universe which could not be received through the earth's atmosphere on the surface of the earth.

Here is a family of observatories keyed into a complex, where the Government does the launching, the Government gets the data back and feeds it to the universities.

but the scientist himself selects that area of knowledge that needs expanding, that he is interested in, gets his graduate students working with him, collaborates with the other scientists and expands that area of knowledge. We are moving very rapidly to try to create a situation where the engineers in the universities, and the engineers in industry, shorten up the time when they can take this advanced, very sophisticated understanding of the space environment created by these scientists and translate it into improved spacecraft and improved instruments for further observation.

Now, there are lots of other facets, like the sounding rocket program, the deep space program, and this kind of thing that I simply don't have the time to cover. I will just add one thing to it, that, during the year of the international year of the quiet sun, we are going to use some pioneers. One will move backward from the earth and be measuring the solar wind and all the environment of space out behind the earth. Another will be out about 20 million miles or so in front of the earth. So you are going to have the earth in that year going along in between two pioneers that are going to be feeding this information back as to happening both in front and behind as the earth travels at 67,000 miles an hour along through space.

The industrial base being created here for advanced and sophisticated technology is extremely important. The Draper group at MIT is doing the guidance and control system for Apollo, but there are between $200 and $300 million dollars of contracts out with American industry to build the equipment and to follow right behind this advanced research. I'll just give you one quick illustration of what is happening.

Out in Wisconsin at Milwaukee A. C. Spark Plug has a group working on this

project, and I think it is fair to say that the group of men working for A. C. Spark Plug in that city on this project are probably the most advanced technical people in the area, or certainly one of the most advanced groups. This is happening all through America and, as the prime contracts go out--and 62 percent of all our prime contracts go to major airframe companies, because they can take the prime contracts--North American, Boeing, Douglas, McDonald, Grauman--you know the list--they in turn have to spend about 50 to 55 percent of those funds out with the best companies in America who can do these specialized tasks, from fuel cells to guidance systems, and all the things that are required, including very advanced electronic systems, and small computers. All through America there is this industrial base being created through a rapid assimilation of this advanced technology into industrial processes, and even a spin off into other areas of non-space, such as the infra red sensers being used to size the hot rod coming out of Republic Steel Mills in Chicago as it flows out at about 70 miles an hour.

Here again is a kind of transfer taking place that I think will be very valuable in terms of the total U. S. industrial power for competition commercially for the military base that we must have.

Now, I would like to close here with just two things. I spoke of the necessity for technical monitoring of the research contracts to universities, of technical monitoring of the industrial base contracts, and the system of management that we are following in this agency is to work very closely with all of the services in the Government. Twenty-two percent of all of our funds are spent through the Department of Defense, where they have relationships with industry and purchase and monitor the procurement of equipment that we get. We are working with the Weather Bureau on the question of the weather satellite system, with the new Communication Satellite

Corporation in connection with the setup of a communication satellite system, with the Atomic Energy Commission in the development of the atomic rocket, and we have industrial contracts with Westinghouse and Aerojet.

All the way through here you have a system of management keyed to technical direction. Now, this is not without its problems, as all of you who have been in these projects know. We have the terrible problem between centralization of decisions and freezing of the design and the desire to get competition and fixed-price contracts, owing to the feeling of the laboratory manager that, if you want that orbiting solar observatory to fly and do its work, you've got to get more latitude than that.

I can't take the time to look at the total structure of organization. This is something that those of you who want to study it can do. I'll only say that, as we have cranked up this effort, we have asked the School of Industrial Management at MIT to examine closely the lessons to be learned for large-scale, organized effort in science and technology.

They are operating on a grant of $400,000 from NASA, which I think is the largest that has been granted for this kind of examination of how a large-scale, organized effort is cranked up. I only say this--that you don't get all the scientific satellites launched in a year, you don't get 19 Deltas flown successfully, you don't get four Saturns developed and middle flights flown successfully, with a stumble-bum kind of organization. And NASA has the record that any government could be proud of.

There are all kinds of problems. This agency has doubled every year for the last 5 years, and it has, I think, done a job that will stand for a long time in building a system under which, over a period of about 10 years, this Nation will

become the leading nation, with all of the power necessary.

As to the future, I am going to take one minute to tell you that one of the most important things that have happened here, I think, is that, out of a massive dispersion of the Government's activities in 1958, has come a consolidation and a capacity to apply our best technical brains to the decisions ahead. This Joint Gemini Board that is looking very hard at what the military services can get from a research and developmental contract for a program of a two-man spacecraft is extremely interesting. The means by which you marry the best efforts of our best people to make decisions ahead has grown tremendously within the last year to 18 months, and very rapidly in the last 6 months.

I think, as we approach the question of a manned orbiting laboratory, that you are going to see perhaps more than has happened in the last 5 years of the Space Act a congealing of talents to decide what really is best to do, how best to do it, and the part that each agency can probably play.

None of us wants to have another aircraft nuclear propulsion--I don't want to say--fiasco, because a great deal was learned from this, but certainly it was not an example of how the Government ought to run its business. I think that there are extremely capable persons now available as the ballistic missile program begins to approach a phase when the completion of it is releasing some people who were in on the early design, planning, and so forth.

I think one of the most important questions we face is how all of this talent can be put together in a system. This is a subject that we are working on in very close association with the Department of Defense, to try to find out. There are many difficulties and troubles. The problem we face immediately is that, having put the base together on the ground, having created the ability to move ahead and

solve the technical problems, having stated that we would do the lunar job for $20 billion and the rest for $15 billion, and having a program that would peak out at between $5.5 and $6 billion in 1964, maintain about the level in 1965, and begin to drop off a little in 1966, we now are several hundred million dollars short of the capacity to do that as a result of the action of the Congress.

So you not only have the question of what new programs you insert--and each of these new programs from now on is going to cost somewhere between $3 and $5 or $6 billion dollars--like manned orbiting stations but how you are going to proceed from here on out. Are you going to stretch this program out 3 years and add several billion dollars to the cost of it, because the overhead goes on? Are you going to not do the parallel developments that will permit you to keep the commitments?

We in the agency are in the rather fortunate position of saying, "We said we would do it for $20 billion one side and $15 to #35 billion over 10 years. We still can do it if you give us money to fund it at the pace that we planned it."

Nobody seems to believe it. But that is a fact.

Thank you very much.

COLONEL SMILEY: Mr. Webb is ready for your questions.

QUESTION: Do you think that the first public and congressional reaction to the death of an American astronaut would slow our manned space effort?

MR. WEBB: This is a hard question. No one can put men on the noses of rockets and fire them off into space without realizing that it is a risky business. The risk in the Mercury program was roughly equated with the first test flown by a test pilot of a very advanced jet airplane--the first flight.

Now, whether we can maintain that kind of precise standard when you are going out to do a rendezvous and you don't really know what the risk is of collision or damage in efforts to join spacecraft and all this kind of thing. At the same time, we have here a situation where, as I mentioned earlier, the Russians are not through. They have a very orderly program. They have a big booster, and they've got a spacecraft that weighs over 10,000 pounds that they can recover, manned or unmanned, at will. This means they get back all of their equipment, and examine it, whether it's film, tape recording, or whatever it may be. We are using a few hundred pounds in orbit, with telemetry bringing the stuff back, except for the programs that the Department of Defense runs, which, as you know, are recoverable.

The real question here is: How does the public equate the total situation? I think, rather than how they might equate one death. I myself don't believe this country has gone so soft that it is going to fall apart when one or more men get killed. I don't think aviation has stopped by its accidents. You could see a pulling together and saying "We'll go ahead." We've done all we could to prepare the public for the fact. You remember the first TV appearance I made when Sheppard flew, I mentioned the statistics of the liability on these flights.

But, at the same time, it has come to look so easy for Gordon Cooper to just plop almost on top of that aircraft carrier, and be picked up and shown to the world. Few people realize that there were over 20,000 military people in the recovery forces around the world, and that it might have been different.

I am just not able to answer your question. We are assuming that, if you go on and do the job, ultimately the country will recognize it and give it support. Now, although we are having our troubles, and have got this marginal lack of enough

funds to do the job that we have to face, this is a matter that the President and his leaders are going to have to face between now and January. Even with that marginal lag, you still have in the 1964-65 program for defense and NASA in space somewhere between, say, $14 and $15 billion, and you've got a real challenge to allocate these things for those two years. Since Congress has delayed so long, you are going to have to consider both of them within about the same 3-months period, between now and January.

So the total situation on space, I think, is involved in the answer to your question, not just sort of a frenzied feeling that the loss of one life should cancel out the program.

QUESTION: Mr. Webb, about a week ago the New York Times reported that the position of the Administration on the military obligations has had an impact on the people as to the space program, the implication being that under the military requirement for space the spin off scientifically would be adequate to take care of any future military operations in space. Would you comment on this, please?

MR. WEBB: Yes. My first comment is that you ought to ask Mr. McNamara about that when he comes before you. I am not the proper spokesman for the military system. But I will say that there is at the present time a tremendous number of areas where you have got to develop the scientific and technological capacity to prove through experimental flight operations before you are going to make the investments of large sums in your military systems, in my opinion. That is not to say that, say, in a manned orbiting space station you don't have very important jobs to do, both scientifically and with respect to the use of a man.

For instance, our Gemini and Apollo are based on the ability of man to operate under weightless conditions over a long period of time, and the ability of equipment

to do the same. In a space station you could have a small centerfuge through which you could, for instance, let a man operate under zero conditions for a couple weeks, and then, if you are going to put him in a Gemini and let him reenter the earth's atmosphere, you could give him three days of conditions for the stress of reentry. If it turns out that zero gravity affects him quite adversely, you might find out how a tenth of a G or half a G--maybe you don't have to go up to full G--will affect him. All of this kind of thing has to be learned.

The real problem you've got here is that, in these large programs here, you have developed the capacity, including the Titan III, to get out into space. You do have a two and a three man space craft. Gemini can reenter the earth's atmosphere and have a heat shield big enough for any orbit that its propulsion can attain. Apollo can reenter with a heat shield big enough to come back from the moon.

Now, how much flying do you want to do with those where you have spent $4 billion for the booster to fly them on and $3 billion for those two spacecraft? How much flying with men do you want to do before you make another large commitment of $2 and $3 billion, which I firmly believe at this time would have to be for research and development? The idea thzt you just can maneuver around in space simply is a phony that is being put forward to the public, in my opinion.

I am not saying that publicly. You have never seen me make a public statement on these matters. I say this: We have over 200 military men in our organization, working thoughtfully and closely with us. We now have, after a number of months of sort of jockeying around a group from the Air Force at Houston working in intimate association with our program there.

We are entering a new period when the best brains in the military services and

in these research and development activities are going to consider this. But I have already told you that the source of power, the fuel cell, has got some doubts in it now. With the best of work that the great companies of America and the research talent could do, we have got some problems with the F-1 engine, which I think are now mostly behind us. We've got to really look with the greatest of care at a 200,000-pound thrust, the J-2 engine, burning liquid hydrogen. We've got all the problems of the storage and use of hydrogen as a fuel in space, and you've got tremendous problems with the use of reaction motors to give you precise control.

If we have learned anything from how to use energy in space over and above orbiting satellites and deep space probes and things like that, it is that it is very difficult to calculate precisely what energy to use when, and when to expect the effect. Where a pilot pushes on the throttle or pulls back on the throttle, or uses his controls, in space you've got to make a precise calculation almost of necessity with a computer, if you are any distance apart. You might have to wait as much as two hours for that effect to be manifest in what you might say is an eyeball type of recognition of the situation.

All of that has to be learned, and there is a real question, I think, whether or not you want to proceed with what might be called military systems until that basic knowledge is gained. On the other hand, I think, there is another area that is not well understood. There are certain requirements of the military, I believe, for sensing equipment and things of this kind that need to be developed and need to be tested in flight. There needs to be a parallel development of this kind of thing. It is in this kind of area that the military people on the Gemini Board and our own operations are working with the greatest of care.

But now, if I were to say this, it would be a great comfort to us in NASA and to the country if the military would go ahead and iron out the difficulties in the Titan II booster so that we can go ahead with the Gemini flight. We've got problems with Gemini but I cannot tell you today that the military services are doing all that they have promised to do to clear up the difficulties of using the Titan II for manned space flight.

So there are several sides to this question of how complex government operations and departments work together. There are many facets and many opinions, and lots of guys who impose their own personal predilections in one way or another down the line.

I think the country is moving into a better period in that regard.

QUESTION: Sir: Will you comment on the relative size of the terrestrial command and control, electronic systems on the ground? In other words, can you anticipate the cost of the terrestrial command and control systems?

MR. WEBB: I don't think anybody ever really anticipates the cost of even a simple system like the X-15 or the Mercury or the Gemini or the Apollo. But I'd like to tell you what the situation is. The situation is that we have used energy from using 3½ watts roughly to communicate back from Venus with the Mariner, on up to the very large amounts like the advanced Saturn which burns 900 tons a minute, or something like that, through five F-1 engines.

Now the control of energy here is extremely important. The ability to fly several flights simultaneously is extremely important, especially if you are going to find out what men can do in space and how important they are as against instrumentation. The best line of thought is that the man is going to play a very major role in the future.

You've also got to not only run a couple flights simultaneously but you've got to change the thinking of people to some extent who say that the United States can fly a flight there and in 3 months another flight and in 3 months another flight, and do this the way we did Mercury. You've almost got administratively to require a doubling of the number of flights.

Now, that means also a massive simulation activity. It means on a 2-week flight, let us say, for Gemini, changing every 8 hours on every station all the way around the world. You've got also the very interesting situation here with respect to the Boston laboratory, where almost all of the basic research in electronics now being used in space was developed for some other purpose. You've got certain areas where very little is known about this environment. Witness Telstar, which goes off the air and comes back on. Witness the research program with Relay where, when we first put it up, we had all kinds of trouble, but have now been able to perform not just the 500 experiments we put it up for but 1350.

What we are after in Boston is to create a competence, an in-house, government, civil service competence, of about 600 leading people in electronic research, closely related with guidance control, then expect them to work with the most brilliant minds all around the country in the universities, in the radiation laboratory at MIT, the people at Harvard, Cal Tech, and all around, and flux over the major new areas of research that ought to be done, and reach a decision as to where the money ought to be spent in very advanced areas of research, and then flux together with the best in industry, so that you get experimental hardware made, and then move on to production hardware.

Now, we are going to buy in this program between $5 and $10 billion worth of electronic equipment of one kind or another over the next 2 years. We are using

equipment produced on a research base made for other purposes. The question is: How to you move there? I would think you could at least take one hypothesis, that, in this kind of situation, as the country emerges from World War II, the crash build-up of the ICBM system, the rationalization and consolidation of the various space activities, a mission control center like Houston, as an experimental model of how to run long and involved space flights, coupled with a worldwide tracking and data-acquisition system that permits you to manage flights anywhere while the earth turns, outward at least to the moon, and control them, either manned or unmanned, to map the moon with an unmanned piece of apparatus, and this kind of thing, the experimental program to develop that, is of great importance.

No one can tell you today how to do it. We've had the guts to step out and say, "By golly, we are going to build that kind of mission control. We want to underline basic research to feed along with the experimental test program while we are flying the flight."

Does that answer your question?

QUESTION: What are the prospects for international cooperation in space research?

MR. WEBB: Well, I did not touch on that in my talk because I was so pressed for time. The United States adopted a policy during the Eisenhower Administration that it would cast an open invitation out to the United Nations that, if scientists around the world had experiments that they wanted flown that made sense, that would add to the scientific knowledge, the kind of things we would do anyway ourselves to fill a gap in our program if they didn't do it, we would fly them on our rockets, we would furnish them back the data, and we would give them the opportunity for the first publication of that data.

This has stimulated a good deal of interest among some leading scientists around the world, and you've seen Canada, now, prepare the Allouette satellite. They have committed $6 million now in the legislature there to go forward with an additional ongoing program.

The British instrumended a satellite which we prepared. They have now appropriated the money to go forward to prepare a complete satellite to carry experiments that their scientists want.

All this we would have done if they had not done it. Further than that, we have worked through the United Nations and have got the first international sounding rocket range agreed to in India for the use of all nations. Around the world in our tracking stations a great many nationals of other nations work and in some cases the nation pays the entire expense of the tracking station, because they feel this is their sort of foot in the door and participation in modern science and technology. These are some of the most enlightened and forward looking people in that country. They look on it as a great national asset to participate in.

In addition to that we have worked with other nations in the weather satellite, for instance. There are 35 nations cooperating with us in this kind of thing. We put the data out on an international meteorological network, and we are about to fly a satellite that has not only the picture-taking ability and the storage/equipment so that we can read it out over the United States and Canada but it now is going to be able to transmit the picture directly to the country that needs it as it passes over. So that that country can turn to the satellite and say, "What does it look like up there?" and match it up with the data.

That is called the automatic picture transmission system. We are about to

fly that. We have developed and offered to other nations, for about $30,000 to $50,000 dollars, ground equipment that will permit them to make this read-out over their own country.

We are going on with international cooperation. You do know that we have had discussions with the Russians for a long time, since the international geophysical year, and specifically with respect to possible cooperation. There has been a certain standoffishness through most of this, but over the last 18 months the Russians have shown a real interest in cooperation, and we now have agreed that we will launch a weather satellite and not tell them what is in it or the rockets that launched it, but will transmit the pictures we take to them over what we call the cold line. The hot line runs between Khrushchev and Kennedy and the cold line between NASA of Suitland, the Weather Bureau, and Moscow. They are going to fly a weather satellite, and we will not know what is in it, what kind of cameras, but we will get the pictures they take back over the reverse of this line.

So now you are going to have a continuous looking at the weather of the world by both of us sharing the job and both of us getting the data. We have inserted in those agreements a provision that, unless the data is roughly equivalent, then either one of us can stop. Most everybody seems to be assuming blandly that the American data will be better and that we will have to require them to come up to our standards.

I'll just leave you with the interesting question: When about the first of the year these pictures begin to come, suppose theirs is better and they break off by saying, "What you give us is not relatively equivalent to what we give you."?

We are in for a period of difficulty and surprises of which this is one that

you've got to think about. For about two years they are going to be able to fly big, instrumented spacecraft in ways we can't. It happens that our pictures of weather are about as good as we need. They give us the kind of thing we want. We could have taken more detailed resolution pictures but we found they were not as useful as the ones we are taking.

All of that is involved. At the moment we are now negotiating the details, this week, of another agreement, which is: How can we both study the magnetic fields of the earth by recordings and readings taken from their satellites and from ours, and correlated with data taken all around the world by scientists of many nations. They have agreed to do this, but there is a large gap between agreement in principle to do it and then working up the technical details of how you do do it. All of this is based on coordinated work, not cooperation. We don't know exactly how they get their data. We only know that they tell us, "Here is the data, and here are the margins of error in it, and you can correlate it with your own."

There is some possibility, I would say, and the next 3 to 4 months will tell a lot about this. Let me say it this way: Suppose in the next 3 or 4 months you see a Russian device working on the surface of the moon and sending back information as to scientific data from the moon, and they step in and say, "Now let's cooperate." I mean, you are going to be in for a period when there will be lots of discussion of cooperation.

We have in the Saturn V the basic power, and in these series like the Titan III and the Saturn 1 and 1-B, to do whatever this Nation may need to coming along, but it takes a long time to manufacture a big rocket like that, test it out, prove it, and so forth. But even so we are planning to fly a man on the tenth

flight of these big rockets.

Now, those of you who know rocketry can ask yourselves how many rockets have been flown and developed in ten flights to the point that you can put a man on them.

That's the vigorous program of the United States and in a sense they see that this Saturn V is going to be far beyond anything they may want to do. Let me caution you that it will cost $100 to $150 billion per shot for one of these big Saturns with a spacecraft on it. That's a lot of money. I don't know what an aircraft carrier costs, but it's like building a whole aircraft carrier and an AF system and sending it out on one mission and never getting it back.

COLONEL SMILEY: I regret our time has overtaken us. I express appreciation from all of us here, both Colleges, to you for being with us this morning and giving us a very interesting description of your organization.

Thank you very much, Mr. Webb.