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NASA LUNAR ORBIT RENDEZVOUS DECISION

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HEARING BEFORE THE COMMITTEE ON SCIENCE AND ASTRONAUTICS U.S. HOUSE OF REPRESENTATIVES EIGHTY-SEVENTH CONGRESS SECOND SESSION

JULY 12, 1962

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NASA LUNAR ORBIT RENDEZVOUS
DECISION

HEARING

COMMITTEE ON SCIENCE AND ASTRONAUTICS

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BRIEFING BY NASA

THURSDAY, JULY 12, 1962

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The committee met at 9:30 a.m., the Honorable George P. Miller, chairman, presiding.

The CHAIRMAN. The committee will come to order.

We are very glad to see you here, Doctor.

This meeting is for the purpose of being briefed by NASA on its recent decision that has been made relative to the lunar landing program.

We are very happy to have you here, sir. Will you proceed.

STATEMENT OF D. BRAINERD HOLMES, DIRECTOR, OFFICE OF MANNED SPACE FLIGHT

Mr. HOLMES. Thank you, Mr. Chairman.

I would like this morning to give the committee some of the background of the systems engineering study we have just completed. I will then describe, using these various models we have here, the various missions which we have studied in depth, the various mission modes to go to the Moon, and finally, in more depth, the particular method which we picked.

I think it will help in this description to use these models. It is much easier to get across the feel, I think, for the equipment involved than by a verbal description only.

We had previously selected as a prime mode, Earth orbital rendezvous, where we rendezvous two objects from Earth. We had also chosen, as a secondary mode, displaced in time about by a year as far as development is concerned, direct descent. Nevertheless, it was quite apparent last fall this mission mode question really had not been studied in enough depth to commit the tremendous resources involved, financial and technical, for the periods involved, without making perimetric analysis and detailed system engineering studies to a much greater extent than had been possible previously.

Further, at that time, as we testified before Chairman Teague's subcommittee, there was not unanimity within NASA, as to the method by which we should go to the Moon as a prime mode, and further study was necessary for that reason.

I think when one lives with a program in a program management capacity you develop a certain feel, of timing, as to when it is necessary to make a decision.

It certainly is true that if one looked at this as purely a pure research task, rather than a great endeavor for this Nation, one could continue

studying it forever. But at some point one must make a decision and say now we go. It has been really impossible for us to truly program manage—in the sense I like to think of program managing this mission—until this primary mode decision had been made.

I say that because as soon as one tries to schedule a booster development versus spacecraft development, as soon as one tries to balance funds, one finds you cannot do it until you have firmly established the mission.

Under Dr. Shea's overall guidance—and Dr. Shea is here with me—we made these studies. I would like to say here that I consider us very fortunate to have Dr. Shea with us. I consider him one of the outstanding men in the country, who has not only great technical competence and experience in this field, but also, which is somewhat unique, a tremendous amount of management ability. Under his guidance virtually all of the NASA centers have participated in this endeavor to analyze in depth the pros and cons, trade-off's, advantages, disadvantages, of going to the Moon by these three methods; that is, direct descent, which would require the Nova vehicle; Earth orbital rendezvous, which requires 2-C-5 or Advance Saturn vehicles; or lunar orbital rendezvous, which would require a single C-5 launch vehicle.

The major centers which carried the burden of the study load, in addition to Shea's operation, were the Marshall Space Flight Center at Huntsville, the Manned Spacecraft Center in Houston, and to some extent the Launch Operations Center at Cape Canaveral.

There were special studies made. These were paid studies by contractors, which were most helpful; and further, we received unsolicited studies which were made by contractors at their own expense.

It is most gratifying to me to be able to say that we have picked a mission—lunar orbit rendezvous—in a unanimous fashion.

I think I have described the management council, which is a fancy name to represent a group of men. The management council is composed of all the key people within NASA responsible for manned space flight, including myself and my directors, Dr. von Braun and Dr. Reese from Huntsville, Dr. Gilruth and Dr. Williams from Manned Spacecraft Center, and Dr. Debus from the Launch Operation Center.

This group unanimously came to the conclusion, after a tremendous amount of study, that this was the way to go, and it was our recommendation to the Administrator that we select this mode.

I think this unanimity is particularly significant because Marshall Space Flight Center had done intense early work in Earth orbital rendezvous and it was really on the basis of this work we had taken the somewhat tentative decision earlier that the EOR should be the prime mode.

By their further studies they changed this opinion to conclude that it should be lunar orbit rendezvous.

We concluded all of these methods are feasible. The advantages and disadvantages of them I would like to summarize for you after we describe what we are talking about for each one of these methods.

However, we concluded that lunar orbit rendezvous is the most favorable one for us to undertake today.

As I mentioned, I think timing is important in a program like this. I think it is equally, maybe more, important to get the whole team pulling together. The men responsible for implementing the program

must agree, not because they have been coerced into it, but because—by their thought processes, by the analyses which their people have made—they come to the conclusion this is the right way.

Now if I may, Mr. Chairman, I would like to stand up and describe for you the various modes with these models.

The CHAIRMAN. You go right ahead.

Mr. HOLMES. Thank you, sir.

Can you hear me all right if I speak in that voice away from the microphone?

The CHAIRMAN. Yes.

Mr. HOLMES. I will describe first the direct ascent mode, which would require the development of the Nova vehicle. Before discussing Nova I should refer to the Advanced Saturn vehicle, the C-5, which is presently under contract, the first stage with Boeing, the second with North America, and the third stage with Douglas.

Nova, which would be required to launch this object from here to here [indicating] in Earth orbit, would have three stages, none of which are under contract, other than the third stage. This is the same third stage as for Saturn C-5.

In its first stage, the Nova would develop some 12 million pounds of thrust. It would be able to take to Earth orbit something over 400,000 pounds, and to escape, 150,000 pounds, as compared to 240,000 to orbit and 90,000 to escape for the Advanced Saturn.

If you will assume this [indicating] is the third stage, this [indicating] is the top of the third stage of the Nova, so we go from here [indicating] down into the floor some 260 feet with these great stages sitting there. Now assume that Nova has fired—this is the direct descent method you recall—and put into Earth orbit this entire object, which is composed of the spacecraft and its propulsion units that will go to the Moon. Now we are in Earth orbit, and with a stage here [indicating] which is really the third stage of the Nova, we can accelerate the whole package from Earth orbit speed of some 18,000 miles an hour, to an escape speed of 25,000 miles per hour.

So at the proper time we would light off the engines and accelerate, and this [indicating] entire object will take off on its way to the Moon.

Now this object is composed of, first, this large stage at the bottom, which we call the launch or braking stage; then a lunar touchdown stage; the service module, which is the propulsion unit, used for getting back from the Moon; and the command model here (indicating), which is shaped like the Mercury, except it is 13 feet in diameter.

The heat shield is down in here [indicating], you see, which would be used for reentering.

Now as we approach the Moon after our 2½-day trip, we fire off this lunar braking module. It would slow the entire object down to get into the proper orbit around the Moon, and then further slow it down so that—as you approach the lunar surface—the entire craft would be going at something around 400 feet per second—maybe a little less.

I have been using miles an hour, but 25,000-miles-an-hour escape speed converts to 36,000 feet per second. We would approach the Moon at something around 6,000 feet per second, and slow down to this 400 feet per second. Then this braking module will be staged; that is, dropped off. It will hardland on the Moon.

We then have [indicating] this configuration. This engine lights in this lunar touchdown stage, and the ship lands softly on the Moon.

In this direct ascent method the astronauts would have a capability of staying on the moon up to 7 days. We plan in the initial flight to have them stay probably no longer than 1 day. They would move out of here (indicating) in pressure suits, do their exploration, and upon leaving, the three astronauts get back in here (indicating). They would fire off the service module, using this lunar touchdown stage as the launch platform, and head back to Earth.

Once again it is 2½ day flight back to the Earth. The crew must use the very precise guidance equipment, which will be on board. Of course they will also be in contact with the Earth. They must be very accurate since they must hit approximately a 40-mile corridor coming into the Earth.

Another way of describing it—they can't come into the Earth too steeply or they reenter too fast and burn up.

They can't enter too flat or they will skip around the Earth off the atmosphere. They won't reenter at all, but will go back into orbit—back toward the Moon.

The service module equipment is used for guidance on this route back. Just prior to reentry the service module is jettisoned, and we have this (indicating) forward end, the command module. It turns around, heat shield forward, enters the Earth atmosphere, and parachutes down. Or a paraglider may be deployed for Earth landing, if it turns out to be a better method.

One basic difference in that final phase from Mercury is that the Mercury has a lifted drag ratio of zero. We will have, in Gemini, as well as in this Apollo vehicle, lift over drag of something around point five. Thus by changing the attitude coming into this 40-mile corridor we will be able to localize the point on Earth at which to land. We hope it can be localized to maybe 10 miles on a side, a 10-mile square. With a paraglider we might be able to land on a large strip, maybe several mile strip.

That describes for you the direct ascent method.

Earth orbital rendezvous is similar. I will describe it next.

Here is the same spacecraft [indicating].

We would like to have all of this object enter Earth orbit. Since we wouldn't have a Nova vehicle for this mode, but a vehicle only five-eighths as powerful, the C-5, we would have to put it into orbit in two pieces.

Why not split it then? Unfortunately, it does not work that way even though in the early studies it looked like it would.

This [indicating] part weighs about 150,000 pounds.

This [indicating] part weighs more than 250,000 pounds. The C-5 at its maximum will take some 240,000 pounds. So one can't split it that way.

After many studies, because there are many ways to play this game, it appears the proper way would be to put up this [indicating] entire vehicle, just as you see it. The spacecraft and escape stage could be put up on a C-5 if we left the liquid oxygen out of the escape stage.

So under our Earth orbital rendezvous concept we would put this entire vehicle into orbit.

Before doing that, however, we put up a tanker that would carry the liquid oxygen. The tanker Dr. Shea has here [indicating]. It would be put on top of the C-5, which would carry it. It would be launched into a 150-mile circular Earth orbit.

Once that was done, and checked out, we would launch, without the liquid oxygen, this entire craft into a 300-mile Earth orbit.

Of course, as you see, the astronauts were not committed until we knew the tanker was successfully launched.

We now have two objects in orbit. The tanker going around the Earth in 150-mile orbit; the spacecraft in 300-mile orbit. At the proper time we would command the tanker to light off its engines so that from this 150-mile orbit it would move out to the wider 300-mile orbit and rendezvous with the spacecraft.

You can begin to see some of the operational problems as I describe this.

The tanker would dock here [indicating], transfer this cryogenic liquid oxygen into this stage, and then the tanker would be jettisoned.

Now, we have in Earth orbit just exactly what I described for you before. Except before we got there directly and here we got there through a rendezvous. The remainder of the mission is the same as for direct ascent.

The third method, the preferred method, launches directly to the Moon with one C-5 vehicle. C-5 will take to escape 90,000 pounds. We can, therefore go directly with the C-5 if we do not put such a large mass on the lunar surface. Indeed, of the 150,000 pounds we have been speaking of, a hundred thousand pounds was used just to slow down—to get to the Moon's surface.

The reason for that is because of the weight of the heat shield, the weight of other protection, the weight of the fuel which we need to put down on the Moon under the previous modes.

We can go on directly with the C-5 in the LOR mode because the only thing we put down on the Moon's surface is the so-called lunar excursion module, which I refer to as the bug.

The bug is housed in here (indicating).

This (indicating) is the same stage as we have seen previously. So, now we have from this part up, instead of from this part up (indicating). Now we can put it on the C-5 vehicle. This is a vehicle, you will recall, already under development. By direct flight, then, this whole object from here (indicating) up is accelerated to 25,000 miles an hour. You can see (indicating) that as part of the entire object we have this exploratory vehicle, the bug.

I think the use of the bug is quite analogous from a descriptive standpoint to having a ship going to an island; but you don't take the ship in all the way, instead you send in a small boat. This is precisely the way this works.

During this transit to the Moon and soon after we escape from the Earth we will have this fairing (indicating) jettisoned, and either mechanically swing the bug around in this (indicating) position, or, by use of very small amounts of thrust, mate the bug and command modules like this (indicating). We want to get the bug out of the way of the service module's propulsion unit which is used on the trip. There is an air lock in the command module—mate here (indicating) to allow access to the bug.

Having done this, the configuration on the way to the Moon is this [indicating].

We have done all this with a single C-5 launch vehicle.

As we approach the Moon we light off the service module, [the service and command modules are the same as for the other method] to slow us down into a lunar orbit.

Then we have this entire configuration as you see here [indicating] going around the Moon in a lunar orbit.

At such time as the men wish to actually land on the moon, two men climb into the bug and take off.

Now we have the mother craft remaining in lunar orbit with one astronaut. The other two have taken off. They fire this [indicating] engine in the bug and go into an equal period orbit. By equal period I mean the bug will arrive back at the same point as the mother ship once each orbit. Each takes the same time to go around the Moon, but the bug's elliptical orbit will allow a low point in its orbit of perhaps 50,000 feet. Thus the astronauts can observe the landing site. Then at the proper moment they will light off this [indicating] engine and go in in this manner [indicating].

Now they have a much smaller maneuverable vehicle, and as they approach the landing site, they can move down and hover for up to 1 minute. They can also move laterally in selecting the exact touchdown point. Also, during this entire period they can return to the mother craft before it has passed in its orbit.

They have that kind of an abort capability.

Should they choose to land they will land then on the lunar surface. They can stay from 2 to 4 days. As I mentioned earlier, in the initial flight we would not expect to stay more than 1. In taking off from the Moon after exploration we stage here [indicating]. This vehicle takes off in this manner [indicating], leaving any extra weight (extra tankers, and so forth). This part is used for the launch platform.

And, incidentally, the way this is planned, the mother craft will be over the horizon so they can be in radio contact when they take off.

They go up in this [indicating] fashion and rendezvous and dock.

If you don't rendezvous you are in real trouble up there, of course. So we do everything possible to have redundant equipment, both in the bug and in the mother ship. Thus if the bug can't dock with the mother ship, the mother ship could come after it.

Because it is an unknown, it is quite natural for people to focus on the rendezvous part, and worry about it. Nevertheless, all of our studies make us feel it will not be a difficult task to do.

And, of course, in studying the hazards, one has to consider each stage from taking off to landing. As you do this, as Shea's group has done, and put numbers on the various stages we come up with LOR as safe a mission as any one of them.

After the docking has occurred, the men transfer to the command module. We then jettison the bug in lunar orbit, and we go back to the Earth by the same route as I discussed earlier for the other modes.

I think it would be interesting to compare for you here, before giving you the pros and cons of why we reached our decision, what lands on the lunar surface.

Landing on the lunar surface, in one case it is this [indicating] bug and in the other case this [indicating].

Dr. SHEA. The landing gear will be a bit better designed.

Mr. HOLMES. This landing gear either sways or one leg comes off—one or the other has happened at every presentation.

I think we are going to make it here, however.

Now, advantages and disadvantages. Let's start with direct descent. Let me first compare them overall. As far as we are concerned our analysis shows mission success probability is about equal between direct descent and lunar orbit rendezvous. (I am not talking now about safety though I'll come back to that.)

There is only about half the chance of mission success if you go via Earth orbit rendezvous. The primary reason is you launch two C-5 vehicles.

Launching two C-5's would not affect the safety, on the other hand, because you would not put the men up until you had the tanker up. As far as safety is concerned, it appears EOR and LOR are essentially equal, if you put the hazard figures on each stage.

As far as time is concerned, direct ascent is the latest. It appears to us it will be at least 20 months later than lunar orbit rendezvous. Direct descent requires the most additional development. One must develop those modules which are not under contract, the braking stage and lunar touchdown stage, as well as the Nova vehicle.

Further, in considering this we really would not like to develop the Nova vehicle today on a rush basis. If developed as now discussed it would be only eight-fifths as powerful as the Advanced Saturn. In our total picture, the overall program of trying to gain proficiency in space, we would like to have a bigger step between the launch vehicles than this step of less than 2 to 1.

In the Saturn, for example, we have an order of magnitude advance of about 10 to 1.

Very nice step in that family.

If we push through and try to do the Nova fast, then 20 months later we would have between C-5 (the Advanced Saturn) and Nova, less than 2 to 1.

So our present thinking has the advantage of pushing off that Nova development so that it is farther behind this Advanced Saturn. We can then consider solids in more depth, and other propulsion methods, so that we can have a more advanced vehicle with a much larger step.

Further, when one starts to really look at the dollar requirements to do this whole task, moving this Nova vehicle out will flatten the peak.

Indeed, today we can't do, for the budgets we have—the kind of work we should do, and still carry these programs on in parallel.

Turning to still another criteria, the Earth orbit rendezvous has a disadvantage in complexity. The operational complexity of launching these two Advanced Saturns at the proper time is great, as I pointed out earlier.

EOR also has a disadvantage, as does the direct ascent, in that one must develop this lunar touchdown stage and the lunar braking stage which have not been developed. Also in EOR one must develop the tanker. Thus estimates for EOR vary from 6 to 15 months behind lunar orbit rendezvous.

In LOR the only requirement for new development is the bug. The other equipment is already under contract.

On a direct comparison between the three modes, we find Earth orbit rendezvous and direct descent come out about equal in cost, while the cost estimate for the bug mode, or lunar orbit rendezvous mode, runs 10 to 15 percent less.

It is for all of these reasons, minimizing additional development, minimizing time to our landing on the Moon, minimizing cost, doing the mission with equal success probability, and with equal safety, that we recommended to the Administrator this mode.

I would like to say, however, that a decision like this is not irrevocable. We do plan to continue our studies. Some of the studies we plan to continue involve a lunar logistics vehicle which could fit on the C-5. This might let us put a cache of material on the lunar surface which would support these men in case they did have trouble, or support them for longer stays on the Moon.

Along with that it has been suggested, and we plan to study a smaller capsule that might only have two men in it which could ride on the C-5.

The thing I would like to emphasize is, we have picked the mission mode and are going to go ahead full bore with this mode. To my mind, by doing this, in a few months we can have what we call a going program. By that I mean strict adherence to schedules and dollars, with people reviewing on very frequent periods just where they stand. They must know their spending rate, know the schedules, and know that—unless one stops waving his hands at the general problem and gets on with it—we just won't get there, but will just waste a tremendous amount of money.

That is our recommendation, Mr. Chairman.

The CHAIRMAN. Thank you, Mr. Holmes.

Mr. Teague, your subcommittee worked on this. Do you have any observations you would like to make?

Mr. TEAGUE. I think the subcommittee should have another meeting.

What does this do to the vertical assembly building at Cape Canaveral?

Mr. HOLMES. It does not appreciably affect it. We would still build a vertical assembly building.

Our studies show the need for an undercover assembly area where we can assemble the various stages and check them out as an integrated unit before moving them to the pad.

It might interest you to know that from the various transports Dr. Debus has been studying we have adopted the earth crawler mode. Vehicles exist in the surface mining industry, amazing vehicles, which carry weight of the kind we're talking of but are so carefully controlled as to give essentially complete stability. It appears these will provide the best means of moving these tremendously expensive vehicles to the launch pad.

Mr. TEAGUE. What about the Nova complex?

Mr. HOLMES. We would defer the Nova complex for at least another year and utilize the funds where we could—we would like to talk to you about that.

Mr. TEAGUE. How much of an effort will you make in Earth rendezvous?

Mr. HOLMES. As far as the Earth rendezvous technique is concerned, we feel it is of tremendous importance for this country, and the fact that it will be developed and practiced extensively was a significant element in our analysis.

We will be doing rendezvous in Earth orbit in Gemini, and between the command and service module and the bug later.

The thing we would not be doing is building a large tanking vehicle and transferring fuel in Earth orbit by the method we propose.

Mr. TEAGUE. Mr. Chairman, I would like to tell Dr. Holmes—and without having conferred with you—that I would like for our subcommittee to have a meeting with you before our conference on the authorization bill with the Senate.

The CHAIRMAN. We will discuss that later.

Mr. Fulton?

Mr. FULTON. I want to compliment you on your imagination and likewise having your feet on the ground in this presentation.

I notice that you did not have an escape tower on your mechanism for Earth launch.

Mr. HOLMES. There really is one. I misled you. It just isn't shown on the model.

Mr. FULTON. So it will be about the same as the Mercury escape tower?

Mr. HOLMES. Yes, sir.

Mr. FULTON. You will recall the committee reduced the \$10 million that you had requested on advance facility planning and design to \$5 million. Does that cut affect this particular program?

Mr. HOLMES. We have long felt, as we indicated to your subcommittee, that we would be much better prepared to come in and present to you with real detail our plans for the next fiscal year if we had that advance planning money.

We did feel we needed the \$10 million allotment to do that properly, particularly in this expanding facilities program.

I think the change in mission mode has little effect on that.

It is a sum of money which, as you know, we can spend so that we can study matters in enough depth, to come in to ask you for authorization with some assurance that we can talk intelligently rather than in very general terms.

Mr. FULTON. Our Subcommittee on Manned Space Flight, under the leadership of Congressman Teague of Texas—I will say to him—did a fine job, heard 98 witnesses and took 1,389 pages of testimony.

Our recommendation has been, after going through this work, both at Cape Canaveral and here, was that that Nova construction money, both facilities and planning money, be cut.

You would not overturn that recommendation, would you, then?

Mr. HOLMES. Well, in part, yes, Mr. Congressman. As you know, we have since that time resolved in our siting problem at Cape Canaveral that we need an additional area of land north of the present area and have asked that part of that \$69 million be reallocated. We have talked to Congressman Teague about that.

As far as the picture for the remainder of the fund, I think we should get together with you and discuss it. We are analyzing it ourselves.

When one considers the newness of this program, the fact it is not much more than a year since it became a national goal, we are only now I think getting in the position where we can say that is what we need and why.

I can't honestly say to you we were in that position when we put together our budget books for 1963. I am sorry.

Mr. FULTON. Do you need to have a test facility for Nova at the Mississippi test ground?

Mr. HOLMES. No; as far as the Nova facility per se, we do not.

We do not need it for Nova. That is true. A reallocation of the fund to do this work might be highly desirable.

Mr. FULTON. You don't need all of the money you requested for Mercury either, do you, because you planned a full number of flights and now you have been successful, you could leave one flight off?

Mr. HOLMES. As you, of course, recall, you deleted a million dollars from our fiscal 1963 budget for Mercury on that basis.

Mr. FULTON. As I remember there might have been a \$2 million saving on Mercury. The question is do you now need the full amount?

Mr. HOLMES. Actual costs as reflected to me for fiscal 1963 are higher than we had in our request in the budget. I don't have the details to justify that for you. I can state it as a fact.

Mr. FULTON. Let me end on this: When are you scheduling your first Moon flight now? Under the revised plan?

Mr. HOLMES. Our statements on this have been we will get there within this decade. We are now going to do detailed balanced schedules, so I can't give you a definite answer.

Even if I had a more definite answer I really think that the question has such import nationally that the Administrator rather than I should give the answer.

Mr. FULTON. When I subtract 20 months from the decade I get about 1968.

The CHAIRMAN. Are there any other questions?

Mr. Holmes is here to advise us of NASA's decision in this matter. I don't think there is much we can go into other than if you have some comments pertaining to it.

Are there any other questions or comments?

We want to conclude in 5 minutes.

Mr. DADDARIO. I agree with Mr. Teague, this should be looked into further, and I would like to add the comment, it is encouraging we have such a man as Mr. Holmes to come here and explain the program and candidly also bring forth the idea there are problems and to define our goals and set out detailed schedules in the future.

This is one of the things which has pleased me, because it has indicated good management, it has not been the idea of Mr. Holmes, or the men who have supported him, that they come before us with a program which is not a nonchanging one in such a changing set of circumstances.

I for one am encouraged, and I think that it portends good for our programs in the future. I think it is good management and I am sure that because of this candid approach that you will get better and stronger support from the Congress.

Mr. HOLMES. Thank you, Congressman Daddario.

Mr. HECHLER. I think this will go down as a classic in decision-making. History will tell whether it is right. But I desire to compliment you, Dr. Shea, and all those concerned with the NASA decision, which is soundly based in the reasoning you have presented. The important fact is that you have reached a decision and have weighed the alternatives carefully.

The CHAIRMAN. Mr. Riehlman.

Mr. RIEHLMAN. Mr. Chairman, the only thing I want to say this morning to Mr. Holmes is I concur in what my colleague Mr. Daddario has said. It is encouraging to see a frank and forthright discussion and one dealing with such an important problem as we have and at the

head of it Mr. Holmes, and he being willing to come up here and tell us frankly what decisions have been made, and willing to discuss at full length the problems that are confronting NASA and are so important to the Members of Congress.

It is encouraging, and I feel confident that it is this type of presentation that will assure you of closer cooperation with the committee and more favorable consideration of your request in the future.

I certainly appreciate having had an opportunity to hear this discussion.

I was a little late getting in. But it is encouraging. I want to again say it is heartening to a member of the committee to have you come in here and be as frank, and as forthright in your presentation.

Mr. HOLMES. Thank you.

The CHAIRMAN. Any other observations?

Mr. Roudebush.

Mr. ROUDEBUSH. I would like to say, Mr. Holmes, as a member of Mr. Teague's subcommittee, for the first time I am completely satisfied we are on the proper pad and I think it a fine decision.

The CHAIRMAN. If there are no other observations, the chairman will then exercise the prerogative that he didn't exercise heretofore, to say that I too am very happy to see you come here with this direct presentation. I think it evidences the good relationship existing between NASA and this committee.

We want to keep it on that very frank, firm basis, which means that we can then work for the completion of this program for the benefit of this country, its prestige, for the scientific data that can be obtained, that is invaluable, in the era we are approaching where science plays such a great part.

I want to thank you. Please convey my respects to Mr. Webb and to Dr. Seamans, whom I know had to be away, and I regret Dr. Dryden is in the hospital which makes it impossible for him to be here.

He sent two very fine pinchhitters and we are glad to see management in depth in NASA. That bodes well, too.

Thank you very much.

Mr. HOLMES. Thank you, sir.

(Whereupon, at 10:30 a.m. the committee proceeded to further business.)

