To: MR. MILTON B. AMES JR.
From: MR. H. LEE DICKINSON

At the time he left Langley, Mr. John C. Houbolt turned over to Mr. Max Kurzyn at Langley one copy each of two letters he wrote to Dr. Seamans on rendezvous. John’s note to Max was as follows:

Max:
Here are the reports I sent to Seamans, and which seemed to produce some results. The first (May 1961) I think you saw, the second and important one I don’t think you did.

John.

Kurzyn, who was active in rendezvous research, made available 14 documents which were copied for your use. His copies are being returned to him.
Dr. Robert C. Seamans, Jr.
Associate Administrator
National Aeronautics and
Space Administration
1520 H St., N.W.
Washington 25, D. C.

May 19, 1961

Dear Dr. Seamans:

This will be a hurried non-edited and limited note to pass on a few remarks about rendezvous and large launch vehicles.

First, let me comment on the staff paper on rendezvous that was recently completed by Mr. Bernard Maggin. Bernie has done a fine job here and is to be commended. I share and back the viewpoints expressed almost completely. The main item not covered is the outlining of a specific and firm program on rendezvous, but this of course could not be covered without agreement throughout NASA. We have some definite ideas on what the program should be, and these will be forwarded as soon as some reproduction problems of the material are overcome.

With respect to launch vehicles, let me forthrightedly state that the situation is deplorable:

a. To be structurally sound the Saturn should undergo major structural modifications.

b. The S-IV is having serious setbacks which make it very doubtful that any time schedule involving S-IV can be met, and further there is no back-up to this S-IV stage in case it fails completely.

c. H₂, O₂ engines are not progressing nor developing as was so gloriously promised.

d. The F-1 engine is far from being developed.

e. There is no committed booster plan beyond Saturn C-1.

f. And even the existing but payload-limited launch vehicles, such as Atlas and Titan, which have had years of development and on which tremendous funds have been spent, are operationally poor.
In brief, our booster position is pathetic, but what is even worse, we have no jobs going on or even direct plans to remedy the situation. What should be done? It would appear that any consideration should include the following:

1. Give serious deliberation as to whether S-IV should have a back-up (whether propellant is RP, storable, or solid).

2. Firm up realistic and practical boosters that go beyond Saturn C-1 capabilities.

3. Establish parallel large booster programs involving solid rockets. The potentialities of large solids have been overlooked too long, and it may very well be that they can do Saturn jobs and beyond in a relatively easy manner.

In connection with these three items, let me also make this observation which I'm sure would sound naive to many. It would come as no surprise to me that we would now have a pretty good large booster if we had concentrated effort on the development of a very simple and reliable small booster, and that all we had to do to obtain various larger boosters was to "snap" these smaller boosters together in various arrangements, with no interconnections save necessary structural coupling members.

Now, let me revert back to rendezvous. I do not wish to argue which way, the "direct way" or the "rendezvous way", is the best. But because of the lag in launch vehicle developments, it would appear that the only way that will be available to us in the next few years is the rendezvous way. For this very reason I feel it mandatory that rendezvous be as much in future plans as any item, and that it be attacked vigorously. I would like, however, to make a few comments in connection with large booster desirability. For example, the argument is presented too freely and perhaps erroneously that the cost per pound in orbit is less through use of one big booster than by other means. Not enough attention is given to reliability and to probability of mission success. If the costs based on equal probability of mission success are compared, it may very well be that the cost per pound is larger by the big booster scheme. Charts of the type shown in the attached figure should be kept in mind. In this figure the probability of a mission success is plotted against number of mission attempts, for different probabilities of success for an individual attempt. Suppose that the probability of success of a big booster attempt is 0.4, and this low value may not be unrealistic (consider the Saturn S-I engines: I understand the probability of each engine functioning is 0.96; thus, the probability of all 8 engines operating is 0.72. This value pertains to engine only; the other components may add another factor of 0.72 bringing the probability down around 0.5. Now suppose, in addition, 6 - 8 - 10 or more engines had to be ignited aloft. Surely, if it is difficult to get 8 engines going on the ground, it is even more difficult while in flight.
Thus the 0.5 may even be cut in half, giving a fairly low overall probability. After this long side comment, let's get back to the 0.4 value. If 2 attempts at this individual probability level are involved, then the attached figure shows a 0.64 probability for mission success. In contrast, now suppose another but slightly more costly mission scheme were used which had an individual probability of 0.64. Then only one attempt is necessary to accomplish the mission with the same probability of overall success as compared with two attempts for the previous case. The net cost is thus smaller for the more costly scheme.

Additional factors which enter into big booster considerations include (1) are facilities available to construct them? (2) can they be moved about and transported? and (3) are launch sites practical and where will they be located? Although not specifically stated, one of the ideas I'm trying to bring out is that perhaps there is too much planning of projects that simply assume the existence of the type of booster needed, without asking honestly whether it really will be there, and at the right time.

I'll close now. Perhaps these thoughts may be of some use to you.

Sincerely yours,

John C. Houbolt
Associate Chief
Dynamic Loads Division

Encl.

JCH:fbm
Mr. John C. Houbolt
Associate Chief
Dynamic Loads Division
Langley Research Center
National Aeronautics and
Space Administration
Langley Field, Virginia

Dear John:

Thank you for your comments in your letter of May 19, 1961. As you probably know, the problems that concern you are of concern to the whole agency and we have some intensive study programs under way at the present time that will provide us a base for decisions.

You also probably know by this time that the recent Presidential recommendations for increases in the space program budget included funding for the Air Force to accelerate a large solid motor development program and an increase in the NASA budget to accelerate the rendezvous docking program.

Sincerely,

Robert C. Seamans, Jr.
Associate Administrator
Dear Dr. Seamans:

Somewhat as a voice in the wilderness, I would like to pass on a few thoughts on matters that have been of deep concern to me over recent months. This concern may be phrased in terms of two questions: (1) If you were told that we can put men on the moon with safe return with a single C-3, its equivalent or something less, would you judge this statement with the critical skepticism that others have? (2) Is the establishment of a sound booster program really so difficult?

I would like to comment on both these questions, and more, would like to forward as attachments condensed versions of plans which embody ideas and suggestions which I believe are so fundamentally sound and important that we cannot afford to overlook them. You will recall I wrote to you on a previous occasion. I fully realize that contacting you in this manner is somewhat unorthodox; but the issues at stake are crucial enough to us all that an unusual course is warranted.

Since we have had only occasional and limited contact, and because you therefore probably do not know me very well, it is conceivable that after reading this you may feel that you are dealing with a crank. Do not be afraid of this. The thoughts expressed here may not be stated in as diplomatic a fashion as they might be, or as I would normally try to do, but this is by choice and at the moment is not important. The important point is that you hear the ideas directly, not after they have filtered through a score or more of other people, with the attendant risk that they may not even reach you.
Manned Lunar Landing Through Use of Lunar Orbit Rendezvous

The plan.- The first attachment outlines in brief the plan by which we may accomplish a manned lunar landing through use of a lunar rendezvous, and shows a number of schemes for doing this by means of a single C-3, its equivalent, or even something less. The basic ideas of the plan were presented before various NASA people well over a year ago, and were since repeated at numerous interlaboratory meetings. A lunar landing program utilizing rendezvous concepts was even suggested back in April. Essentially, it had three basic points: (1) the establishment of an early rendezvous program involving Mercury, (2) the specific inclusion of rendezvous in Apollo developments, and (3) the accomplishment of lunar landing through use of C-2's. It was indicated then that two C-2's could do the job, C-2 being referred to simply because NASA booster plans did not go beyond the C-2 at that time; it was mentioned, however, that with a C-3 the number of boosters required would be cut in half, specifically only one.

Regrettably, there was little interest shown in the idea - indeed, if any, it was negative.

Also (for the record), the scheme was presented before the Lundin Committee. It received only bare mention in the final report and was not discussed further (see comments below in section entitled "Grandiose Plans").

It was presented before the Heaton Committee, accepted as a good idea, then dropped, mainly on the irrelevant basis that it did not conform to the ground rules. I even argued against presenting the main plan considered by the Heaton Committee, largely because it would only bring harm to the rendezvous cause, and further argued that if the committee did not want to consider lunar rendezvous, at least they should make a strong recommendation that it looks promising enough that it deserves a separate treatment by itself - but to no avail. In fact, it was mentioned that if I felt sufficiently strong about the matter, I should make a minority report. This is essentially what I am doing.

We have given the plan to the presently meeting Golovin Committee on several occasions.

In a rehearsal of a talk on rendezvous for the recent Apollo Conference, I gave a brief reference to the plan, indicating the benefit derivable therefrom, knowing full well that the reviewing committee would ask me to withdraw any reference to this idea. As expected, this was the only item I was asked to delete.
The plan has been presented to the Space Task Group personnel several times, dating back to more than a year ago. The interest expressed has been completely negative.

Ground rules.- The greatest objection that has been raised about our lunar rendezvous plan is that it does not conform to the "ground rules". This to me is nonsense; the important question is, "Do we want to get to the moon or not?", and, if so, why do we have to restrict our thinking along a certain narrow channel. I feel very fortunate that I do not have to confine my thinking to arbitrarily set up ground rules which only serve to constrain and preclude possible equally good or perhaps better approaches. Too often thinking goes along the following vein: ground rules are set up, and then the question is tacitly asked, "Now, with these ground rules what does it take, or what is necessary to do the job?". A design begins and shortly it is realized that a booster system way beyond present plans is necessary. Then a scare factor is thrown in; the proponents of the plan suddenly become afraid of the growth problem or that perhaps they haven't computed so well, and so they make the system even larger as an "insurance" that no matter what happens the booster will be large enough to meet the contingency. Somehow, the fact is completely ignored that they are now dealing with a ponderous development that goes far beyond the state-of-the-art.

Why is there not more thinking along the following lines: Thus, with this given booster, or this one, is there anything we can do to do the job? In other words, why can't we also think along the lines of deriving a plan to fit a booster, rather than derive a booster to fit a plan?

Three ground rules in particular are worthy of mention: three men, direct landing, and storable return. These are very restrictive requirements. If two men can do the job, and if the use of only two men allows the job to be done, then why not do it this way? If relaxing the direct requirements allows the job to be done with a C-3, then why not relax it? Further, when a hard objective look is taken at the use of storable, then it is soon realized that perhaps they aren't so desirable or advantageous after all in comparison with some other fuels.

Grandiose plans, one-sided objections, and bias.- For some inexplicable reason, everyone seems to want to avoid simple schemes. The majority always seems to be thinking in terms of grandiose plans, giving all sort of arguments for long-range plans, etc. Why is there not more thinking in the direction of developing the simplest scheme possible? Figuratively, why not go by a Chevrolet instead of a Cadillac? Surely a Chevrolet gets one from one place to another just as well as a Cadillac, and in many respects with marked advantages.
I have been appalled at the thinking of individuals and committees on these matters. For example, comments of the following type have been made: "Houbolt has a scheme that has a 50 percent chance of getting a man to the moon, and a 1 percent chance of getting him back." This comment was made by a Headquarters individual at high level who never really has taken the time to hear about the scheme, never has had the scheme explained to him fully, or possible even correctly, and yet he feels free to pass judgment on the work. I am bothered by stupidity of this type being displayed by individuals who are in a position to make decisions which affect not only the NASA, but the fate of the nation as well. I have even grown to be concerned about the merits of all the committees that have been considering the problem. Because of bias, the intent of the committee is destroyed even before it starts and, further, the outcome is usually obvious from the beginning. We knew what the Fleming Committee results would be before it started. After one day it was clear what decisions the Lundin Committee would reach. After a couple days it was obvious what the main decision of the Heaton Committee would be. In connection with the Lundin Committee, I would like to cite a specific example. Considered by this committee was one of the most hair-brained ideas I have ever heard, and yet it received one first place vote. In contrast, our lunar rendezvous scheme, which I am positive is a much more workable idea, received only bare mention in a negative vein, as was mentioned earlier. Thus, committees are no better than the bias of the men composing them. We might then ask, why are men who are not competent to judge ideas, allowed to judge them?

Perhaps the substance of this section might be summarized this way. Why is NOVA, with its ponderous ideas, whether in size, manufacturing, erection; site location, etc., simply just accepted, and why is a much less grandiose scheme involving rendezvous ostracized or put on the defensive?

PERT chart folly.- When one examines the various program schedules that have been advanced, he cannot help from being impressed by the optimism shown. The remarkable aspect is that the more remote the year, the bolder the schedule becomes. This is, in large measure, due to the PERT chart craze. It has become the vogue to subject practically everything to a PERT chart analysis, whether it means anything or not. Those who apply or make use of it seem to be overcome by a form of self-hypnosis, more or less accepting the point of view, "because the PERT chart says so, it is so." Somehow, perhaps unfortunately, the year 1967 was mentioned as the target year for putting a man on the moon. The Fleming report through extensive PERT chart analysis then "proved" this could be done. One cannot help but get the feeling that if the year 1966 had been mentioned, then this would have been the date proven; likewise, if 1968 had been the year mentioned.
My quarrel is not with the basic theory of PERT chart analysis; I am fully aware of its usefulness, when properly applied. I have been nominally in charge of a facility development and know the merits, utility, and succinctness by which it is helpful in keeping a going job moving, uncovering bottlenecks, and so forth. But when it is used in the nature of a crystal ball, then I begin to object. Thus, when we scrutinize various schedules and programs, we have to be very careful to ask how realistic the plan really is. Often simple common sense tells us much more than all the machines in the world.

I make the above points because, as you will see, we have a very strong point to make about the possibility of coming up with a realistic schedule; the plan we offer is exceptionally clean and simple in vehicle and booster requirements relative to other plans.

Booster is pacing item. - In working out a paper schedule we have adopted the C-3 development schedule used by Fleming and Heaton, not necessarily because we feel the schedule is realistic, but simply to make a comparison on a parallel basis. But whether the date is right, or not, doesn’t matter. Here, I just want to point out that for the lunar rendezvous scheme the C-3 booster is the pacing item. Thus, we can phrase our lunar landing date this way. We can put a man on the moon as soon as the C-3 is developed, and the number of C-3’s required is very small. (In fact, as I mentioned earlier, I would not be surprised to have the plan criticized on the basis that it is not grandiose enough.)

Abort. - An item which perhaps deserves special mention is abort. People have leveled criticism, again erroneously and with no knowledge of the situation, that the lunar rendezvous scheme offers no abort possibilities. Along with our many technical studies we have also studied the abort problem quite thoroughly. We find that there is no problem in executing an abort maneuver at any point in the mission. In fact, a very striking result comes out, just the reverse of the impression many people try to create. When one compares, for example, the lunar rendezvous scheme with a direct approach, he finds that on every count the lunar rendezvous method offers a degree of safety and reliability far greater than that possible by the direct approach. These items are touched upon to a limited extent in the attached plan.

Booster Program

My comments on a booster program will be relatively short, since the second attachment more or less speaks for itself. There are, however, a few points worthy of embellishment.
Booster design. - In the course of participating in meetings dealing with vehicle design, I have sometimes had to sit back completely awed and astonished at what I was seeing take place. I have seen the course of an entire meeting change because of an individual not connected with the meeting walking in, looking over shoulders, shaking his head in a negative sense, and then walking out without uttering a word. I have seen people agree on velocity increments, engine performance, and structural data, and after a booster design was made to these figures, have seen some of the people then derate the vehicle simply because they couldn't believe the numbers. I just cannot cater to proceedings of this type. The situation is very much akin to a civil engineer who knows full well that the material he is using will withstand 60,000 psi. He then applies a factor of safety of 2.5, makes a design, then after looking at the results, arbitrarily doubles the size of every member because he isn't quite sure that the design is strong enough. A case in point is the C-3. In my initial contacts with this vehicle, we were assured that it had a payload capability in the neighborhood of 110,000-120,000 lbs. Then it was derated. The value used by the Heaton Committee was 105,000 lbs. By the time the vehicle had reached the Golovin Committee, I was amazed to find that it had a capability of only 82,570 lbs. Perhaps the only comment that can be made to this is that if we can't do any better on making elementary computations of this type, then we deserve to be in the pathetic situation we are. I also wonder where we will stand after NOVA is derated similarly.

"Quantizing" bad. - One of the reasons our booster situation is in such a sad state is the lack of appropriate engines, more specifically the lack of an orderly stepping in engine sizes. Booster progress is virtually at a standstill because there are no engines available, just as engines were the major pacing item in the development of aircraft. Aside from the engines on our smaller boosters, and the H-1 being used on the C-1, the only engines we have in development are:

<table>
<thead>
<tr>
<th>Capability</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>15,000</td>
<td>13.3</td>
</tr>
<tr>
<td>200,000</td>
<td>7.5</td>
</tr>
<tr>
<td>1,500,000</td>
<td></td>
</tr>
</tbody>
</table>

The attempt to make boosters out of this stock of engines, having very large ratios in capability, can only result in boosters of grotesque and unwieldy configurations, and which require many, many in-flight engine starts. What is needed are engines which step up in size at a lower ratio. Consideration of the staging of an "ideal" rocket system indicates that whether accelerating to orbit speed or to escape speed, the ratio of engine sizes needed is in the order of 3. Logically then we ought to have engines that step in capability by a factor of around 2, 3, or 4. An every-day analog that can be mentioned is outboard motors. There is a motor to serve nearly every need, and in the extreme cases the process of doubling up is even used.
Booster program. - In light of the preceding paragraph, and taking into account the engines under development, we should add the following two:

80,000 - 100,000 \( H_2 - O_2 \)
400,000 - 500,000 \( H_2 - O_2 \)

This would then give a line-up as follows:

15,000 \( H/O \)
80,000 - 100,000 \( H/O \)
200,000 \( H/O \)
400,000 - 500,000 \( H/O \)
1,500,000 \( RP/O \)

with the 15,000-lb. engine really not needed. This array (plus those mentioned immediately below) would allow the construction of almost all types of boosters conceivable. For example, a single 80,000-100,000 engine would take the place of the six L-115 engines being used on S-IV; not only is the arrangement of six engines on this vehicle bad, but these engines have very poor starting characteristics. The 400,000-500,000 would be used to replace the four J-2's on the S-II. Thus, C-3 would change from a messy 12-engined vehicle requiring 10 in-flight engine starts to a fairly simple 5-engine vehicle with only 3 in-flight engine starts.

In addition, the following engines should be included in a program:

1,000,000 - 1,500,000 lb. Solid

5,000,000 Solid

and/or

5,000,000 Storable

The 1,000,000 - 1,500,000 lb. solid would in itself be a good building block and would probably work in nicely to extend the capabilities of vehicles, such as Titan. The 5,000,000 solid and/or storable would also be good building blocks and specifically would serve as alternate first-stage boosters for C-3, aiming at simplicity and reliability.
It may be said that there is nothing new here and that all of the above is obvious. Indeed, it seems so obvious that one wonders why such a program was not started 5 years ago. But the fact that it may be obvious doesn't help us; what is necessary is putting the obvious into effect. In this connection, there may be some who ask, "But are the plans optimum and the best?". This question is really not pertinent. There will never be an optimized booster or program. We might have an optimum booster for a given situation, but there is none that is optimum for all situations. To seek one, would just cause deliberation to string out indefinitely with little, if any, progress being made. The Dyna-Soar case is a good example of this.

A criticism that undoubtedly will be leveled at the above suggestions is that I'm not being realistic in that there is just not enough money around to do all these things. If this is the situation, then the answer is simply that's why we have Webb and his staff. That's why he was chosen to head the organization, this is one of his major functions, to ask the question, do we want to do a job or not?, and, if so, then to find out where the gaps or holes are, and then to go about doing what is necessary to fill the gaps to make sure the job gets done. Further, the load doesn't have to be carried by the NASA alone. The Air Force and NASA can work together and share the load, and I'm sure that if this is done, the necessary money can be found. Even if some project, say, for example, the 5,000,000-lb. storable engine has to be dropped for some reason after it gets started; no harm will be done. This happens every day. On the contrary, some good, some new knowledge, will have been uncovered, even if it turns out to be the discovery of the next obstacle which prevents such a booster from being built.

Nuclear booster and booster size.- Although not mentioned in the previous section, work on nuclear engines should, of course, continue. Any progress made here will integrate very nicely into the booster plans indicated in the attachment.

As regards booster size, the following comment is offered. Excluding for the moment NOVA type vehicles, we should strive for boosters which mak use of the engines mentioned in the preceding section and which are the biggest that can be made and yet still be commensurate with existing test-stand sites and with the use of launch sites that are composed of an array of assembly buildings and multiple launch pads. The idea behind launch sites of this type is an excellent one. It keeps real estate demands to a minimum, allows for ease in vehicle assembly and check-out, and greatly eases the launch rate problem. Thus, C-3 or C-4 should be designed accordingly. We would then have a nice work-horse type vehicle having relative ease of handling, and which would permit a lunar landing mission, as indicated earlier in the lunar rendezvous write-up section. From my point of view, I would much rather confine my spending to a single versatile launch site of the type mentioned, save money in real estate acquisition and launch site development necessary for the huge vehicles, and put the money saved into an engine development program.
Concluding Remarks

It is one thing to gripe, another to offer constructive criticism. Thus, in making a few final remarks I would like to offer what I feel would be a sound integrated overall program. I think we should:

1. Get a manned rendezvous experiment going with the Mark II Mercury.

2. Firm up the engine program suggested in this letter and attachment, converting the booster to these engines as soon as possible.

3. Establish the concept of using a C-3 and lunar rendezvous to accomplish the manned lunar landing as a firm program.

Naturally, in discussing matters of the type touched upon herein, one cannot make comments without having them smack somewhat against NOVA. I want to assure you, however, I'm not trying to say NOVA should not be built. I'm simply trying to establish that our scheme deserves a parallel front-line position. As a matter of fact, because the lunar rendezvous approach is easier, quicker, less costly, requires less development, less new sites and facilities, it would appear more appropriate to say that this is the way to go, and that we will use NOVA as a follow on. Give us the go-ahead, and a C-3, and we will put men on the moon in very short order - and we don't need any Houston empire to do it.

In closing, Dr. Seamans, let me say that should you desire to discuss the points covered in this letter in more detail, I would welcome the opportunity to come up to Headquarters to discuss them with you.

Respectfully yours,

John C. Houbolt

JCH.fom

Encls.
Dr. John C. Houbolt  
National Aeronautics and  
Space Administration  
Langley Research Center  
Langley Air Force Base, Va.

Dear John:

Thank you for your letter of November 15. In reading through your arguments and supporting material for Lunar Rendezvous, I agree that you touched upon facets of the technical approach to Manned Lunar Landing which deserve serious consideration.

I appreciate the vigorous pursuit of your ideas. It would be extremely harmful to our organization and to the country if our qualified staff were unduly limited by restrictive guidelines. In this case, however, I feel confident that we are approaching the question of Manned Lunar Landing fairly and frankly and that all views are being carefully weighed in our continuing studies.

To insure that this is indeed the case, I have sent your letter and attached material to Brainerd Holmes for his evaluation and recommendations. He will contact you directly if he requires additional information related to your ideas and concepts.

Thank you again for writing me on this matter.

Sincerely,

Robert C. Seamans, Jr.  
Associate Administrator  

cc Mr. Brainerd Holmes