

**Hugh L. Dryden, Oral History Interview – 3/26/1964**  
Administrative Information

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**Biographical Note**

Dryden, Deputy Administrator of NASA during the Eisenhower, Kennedy, and Johnson Administration, discusses space policy under the Eisenhower and Kennedy Administrations, and conferences in 1962 and 1963 with representatives of the U.S.S.R. about cooperating on space exploration, among other issues.

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Hugh L. Dryden

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Oral History Interview

with

Dr. Hugh L. Dryden

March 26, 1964

NASA Headquarters, Washington, D.C.

By Walter D. Sohier, Arnold W. Frutkin, and Eugene M. Emme

For the John F. Kennedy Library

SOHIER: This is the beginning of an oral history interview with Dr. Hugh L. Dryden, Deputy Administrator of NASA, for the John F. Kennedy Library, made on March 26, 1964. Present at the interview are Mr. Arnold Frutkin, Assistant Administrator for International Programs at NASA; Dr. Eugene M. Emme, NASA historian; and Mr. Walter D. Sohier, General Counsel of NASA.

To begin with, Dr. Dryden, I wonder if you might talk a little bit about the transition period from the Eisenhower [Dwight D. Eisenhower] Administration to the Kennedy [John F. Kennedy] Administration. For example, what kinds of contacts did you at NASA have with the incoming group?

DRYDEN: I'll begin a few days in advance of the Inauguration with the release to the press of a report to the President-elect by the Ad Hoc Committee on Space. This Committee was chaired by Jerome Wiesner [Jerome B. Wiesner] and the members were Kenneth BeLieu [Kenneth E. BeLieu], Trevor Gardner, Donald Hornig [Donald F. Hornig], Edwin Land [Edwin H. Land], Max Lehrer, Edward Purcell [Edward Mills Purcell], Bruno Rossi [Bruno B. Rossi], and Harry Watters [Harry J. Watters].

The release date was January 12, 1961. This version was unclassified, of course, and was an extract from a classified version of the report which we [at NASA] did see a few days later.\*

This report contained a number of rather sharp criticisms of the administration of NASA and indicated certain recommendations for changes to be made by the new Administration. One of the proposals was to activate the National Aeronautics and Space Council, which had been relatively inactive. In commenting on this, the statement was made that, "with its present organizational structure and with the lack of strong technical and scientific personalities in the top echelons, it is highly unlikely that NASA space activities can be greatly improved by vitalization of the Space Council.... NASA's staff has had to expand too rapidly and without

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adequate selectivity, so that many inexperienced people have been placed in positions of major responsibility..."

In particular, the Mercury project and the science program came in for some degree of criticism. With respect to the science program: "NASA has not fulfilled all of the above requirements satisfactorily. We believe, as previously stated, that the main obstacle here has been the lack of a strong scientific personality in the top echelons of its organization."

With respect to Mercury, there was a statement that, "a failure in our first attempt to place a man into orbit, resulting in the death of an astronaut, would create a situation of serious national embarrassment. An even more serious situation would result if we fail to safely recover a man from orbit.... By allowing the present Mercury program to continue unchanged for more than a very few months, the new Administration would effectively endorse this program and take the blame for its possible failures. A thorough and impartial appraisal of the Mercury program should be urgently made.... If our present man-in-space program appears unsound, we must be prepared to modify it drastically or even to cancel it. It is important that a decision on these matters be reached at the earliest possible date."

Finally, at the end of the recommendation is a statement that there should be, "provide[d] a vigorous, imaginative, and technically competent top management for NASA, including," Administrator, Deputy Administrator, and four Program Directors.

I mention the Wiesner Report because it was the only knowledge which President Kennedy on coming into office had about the NASA space program. These criticisms obviously worried him very much as we could see in the later weeks. He was sufficiently interested to telephone to the Control Room at the Cape in connection with the flights and wanted to be reassured as to the general conduct of the program.

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I do want to say that the proposed intense examination of the Mercury program did take place and, as a result, certain members of the Committee appointed to make this review, who, previously, had no contact whatever with the program, changed their minds completely after

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\* For unclassified report to the President-elect by the Ad Hoc Committee on Space, see NK-33 [NASA] microfilm roll 11, classified confidential.

they visited the factories and the laboratories and saw what was going on and talked with the people carrying on the work. The attitude taken was quite different, although there did remain a fear of the consequences of a failure before the public on the prestige of the new Administration.

SOHIER: You had known Dr. Wiesner in the past, hadn't you?

DRYDEN: I had known him for a long time but he had actually no physical contact with the program other than perhaps hearing briefings for short periods on some aspects of the program.

SOHIER: And no conversations with you, to your knowledge, or with other NASA people?

DRYDEN: No, not with reference to the preparation of his Committee report, which you must remember was the report of the task force set up by President Kennedy, while candidate for the Presidential nomination.

After the Inauguration, January 20<sup>th</sup>, there was a period, which turns out to have been six days, in which there was absolutely no contact with the new Administration. We made some attempts through our regular line channels, public relations people, without success. It was very important because there was scheduled on January 31<sup>st</sup> a shot of the chimpanzee "Ham" out into the Atlantic. We couldn't visualize the President reading about this in the newspaper and knowing nothing about it. We tried to get this information to him through the public relations channels but there was no success. Finally, on January 26<sup>th</sup>, I did manage to get into Wiesner's office to tell him about this so he could tell the President. We would have visited

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Salinger [Pierre E.G. Salinger]but he was out of town at that particular time. That was the first official contact with the new Administration.

We had no input to the Inaugural and State of the Union addresses. The general impression was that the new Administration was coming in and, until they had taken stock and looked around, the dealings with the people of the old Administration would be somewhat reserved.

We then moved to the appointment of the Administrator—the appointment of Mr. Webb [James E. Webb]. We had read in the newspaper that the President, even before his election, had indicated that he was going to name the Vice President [Lyndon Baines Johnson] as Chairman of the Space Council. The law said that the President was Chairman and this would require a change in legislation. Mr. Johnson would in the interim period have considerable responsibility with regard to the space program. From what we read, we inferred that the Vice President would essentially have the responsibility of naming the Administrator, although there were inputs from other persons, including Wiesner.

As I recall, although my memory is not too good, there were some general discussions with Wiesner about the new Administrator but nothing very specific.

SOHIER: Discussions between you and Dr. Wiesner?

DRYDEN: Yes, between Dr. Wiesner and myself.

SOHIER: Well, there were rumors we read about in the newspapers. Were these matters that you read also?

DRYDEN: Yes. Well, I believe Wiesner confirmed that there had been discussion of several candidates. I'm not sure that he implied that the position had been offered to one or two who declined. This was a rumor in the newspaper. But he did indicate that the matter was under discussion and would be resolved as quickly as possible. We were sort of floating in mid-air from January 20<sup>th</sup> until

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the appointment of the new Administrator. Actually, the period was only ten days, although at the time it seemed much longer.

EMME: You didn't resign?

DRYDEN: I had, of course, submitted the customary resignation and there was no acknowledgement whatever of this. I had also heard that Albert Thomas of Texas had written to President Kennedy recommending my own appointment as Administrator. Then, on January 30<sup>th</sup>, I was called by the Vice President out of a meeting; I forget where I was...

SOHIER: You were in the conference room in connection with the JPL [Jet Propulsion Laboratory] discussions.

DRYDEN: I don't remember. Well, anyhow, I was called to the Vice President's office and, in the anteroom met Mr. Webb and Mr. Frank Pace. By a coincidence it turns out that Mr. Webb had made the presentation of the award of the National Civil Service League to me in 1958, which in my absence had been accepted by my wife [Mary Libbie Travers Dryden]. So I had the picture at home of Mr. Webb presenting this medal to my wife. And we had some conversation. The Vice President arrived. He first talked with Frank Pace and then he talked with Mr. Webb and then he talked with me. He asked whether I was willing to continue to serve under Mr. Webb. I heard later that he had asked Mr. Webb whether he was willing to have my appointment as Deputy continued and had received an affirmative answer. To make a long story short, this meeting ended with a decision that Webb would accept that appointment as Administrator and that I would continue to serve.

Mr. Webb and I left the Vice President's office and went back to consult one of Mr. Webb's friend (whom I won't identify) in Washington, following which I returned to work and Mr. Webb went to the White House. The President announced the appointment of Mr.

Webb, and Mr. Webb made the announcement that I would continue to serve as Deputy Administrator.

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SOHIER: I'm not sure I understand what Frank Pace was there. What was his connection with this?

DRYDEN: He had apparently been one of the advisers of the Vice President who had recommended the appointment of Mr. Webb. Although I believe that the Vice President already knew Mr. Webb... and this was an independent check, so to speak, on the appointment. As I understood later, the selection of Mr. Webb had been discussed, for example, with Wiesner. As nearly as I can tell, the Vice President did have the responsibility for the selection of the Administrator and, after consultation with others, he did make the selection.

SOHIER: Is there anything to be told as to the role of the people on the Hill, Senator Kerr [Robert Samuel Kerr] and others, in this, or is this a matter of speculation?

DRYDEN: They certainly did not appear at any time in these particular proceedings which I have described from personal knowledge. I think I might interject for the record that Mr. Webb at that time was not a full-time employee of the Kerr-McGee [Gale William McGee] interests. He had for some time given a large amount of attention to other public service matters, many projects which appear in his biography. So I don't know from personal knowledge the role of Senator Kerr, although I have no doubt that he was consulted.

The confirmation of Mr. Webb by the Senate occurred on February 9<sup>th</sup> and Mr. Webb was sworn in on February 14<sup>th</sup>. I continued to serve without any formal action by President Kennedy. The immediate question which had been submitted to all agencies and which had been before other agencies for some time was the revision of the Eisenhower budget. They [Kennedy Administration] had a rather late start. I will later go into some of the prior activity in connection with the lunar-landing decision. But Mr. Webb was confronted very quickly with this problem... of answering the request of the Director of the Bureau of the Budget for recommendations, the first meeting with the Director being scheduled for the 16<sup>th</sup> of February. In the interval

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between February 14<sup>th</sup> and the 24<sup>th</sup> there were three or four internal NASA discussions, and other discussions with Dr. Wiesner, with Mr. McNamara [Robert S. McNamara], with the Director of the Budget, trying to come to some conclusion as to what should be submitted. I think perhaps this is enough to say on the subject of the transition from the Eisenhower to the Kennedy Administration.

SOHIER: Then I guess what we would like to have you talk about is how did we get from this period of transition to the lunar-landing decision which was incorporated in the President's message of May 25<sup>th</sup>?

DRYDEN: Here again I think you understand that properly it is necessary to retrace our steps, perhaps to begin as early as October 18, 1960, when there was a management conference of top NASA officials at Williamsburg. One of our concerns at that time was setting up a panel discussion as to where should NASA's program be headed.

The first subject on this program was the continuation of man's exploration of space beyond Project Mercury. You have to note that Mr. Eisenhower in sending forward his budget made the positive decision there would be no funds to proceed beyond Project Mercury until there had been some more precise justification of going further. And we had put before this panel the question of where should NASA be heading: "The continuation of man's exploration beyond Mercury will, within a year, lead to decision points on future goals, i.e., manned space stations in near earth orbit, circumnavigation of the moon, landing on the moon, military applications, etc. The necessary commitment of resources will be an order of magnitude greater than those for Mercury, so that the final decision will be made by the President and the Congress. NASA has responsibility for leadership. Where do you think NASA should be heading?"

The same question came up with reference to the Vehicle Development Program, the question of the big boosters, and so on through the other major elements of the program.

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There is a reasonably good account of their discussion in the Proceedings of the Williamsburg Conference for anyone who is particularly interested in that.

I will now pick up the threads of the technical aspects of the program and hope to illustrate to you that technical people change their minds as time goes on and as they learn more about some of the problems.

A picture of the status of October 26, 1960, which was more than a week after the Williamsburg Conference, is given in our presentation to the President's Science Advisory Committee of our ideas, I think it was called "Long Range Goals of NASA," using Saturn and starting on the larger vehicles. This presentation was of some interest because, at that time, it was still based on the planning during the Eisenhower period, when circumnavigation of the moon was the goal within the decade, with a manned landing on the moon postponed to some later date. And there had been studies, really a proposed program, outlined by George Low's [George M. Low] group, going through the Apollo program as it was then outlined: the development of spacecraft for circumnavigation of the moon. It was based on new vehicles quite different from those we now picture. It called for circumlunar flight by 1970, with lunar landing somewhere in the distant future beyond 1970, with the possibility of substituting for this circumlunar flight an orbiting laboratory, should we choose to go in that particular direction. As to the mission capabilities that were put down for a circumlunar flight, we were then thinking that Saturn could be used to launch, say, a 15,000-pound spacecraft. It's rather interesting that even then the modular concept had been put forward

with a command center, the two modules then called Propulsion and Mission Modules. Some schedules were laid out with cost estimates. The numbers that were talked about ran to the order of \$7 billion, at that time, through the end of the decade, with a peak of about \$800 or \$900 million per annum. These numbers, of course, by now look rather small.

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We were thinking of the possibility of going to the moon by two methods at that time: one by direct ascent and the other by rendezvous, and we were interested even then in the development of the nuclear electric systems for future use in planetary flights.

This program was based on relatively simple paper studies and without a great deal of background. The particular vehicle that was to be used was an advanced Saturn with two F-1 engines, each of 1,500,000 pounds thrust.

With the result of the election known, Dr. Abe Silverstein, who was then the NASA Program Director in this area, set up a manned lunar working group to do a somewhat more intensive job than represented by this previous presentation. This report was presented on February 7, 1961, to the top management. It was called "A Plan for a Manned Lunar Landing," and it talked about two versions of the Apollo spacecraft and with the same methods of approach, orbital operations, which we now call the "earth rendezvous method" (using the Saturn with a small number of F-1 engines), or the "direct approach method." The studies on which the plan was based were not very extensive. The method of earth-orbit rendezvous could be worked out about two years earlier than the direct approach method which would require a much larger vehicle to which the name "Nova" was given.

The date then talked about with the earth-orbit rendezvous method was in the 1968-69 time period. The moneys talked about, I don't have the total here, still look to me to have been in the order of \$7 billion. I might just say at this point that later studies, many more man-hour studies, showed that the estimates of the weights of spacecraft were much too optimistic and the capabilities of the launch vehicles were also too optimistic. The combination gave no confidence that this plan could be worked out on that kind of a basis.

SOHIER: These studies that were going on were internal NASA studies?

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DRYDEN: These were entirely internal NASA studies, and with the thought that perhaps the new President would reverse the decision of President Eisenhower which had stopped manned space flight at Project Mercury. We were trying to get in a position to make proposals.

SOHIER: Was there any basis for optimism that the decision would be reversed?

DRYDEN: No. A new group was coming in and NASA needed a new sales pitch, and so on. I think this was the attitude of the working level [NASA] boys.  
On February 7<sup>th</sup> [1961] (Mr. Webb was confirmed on the 10<sup>th</sup>) there was a presentation by John Sloop to the Space Sciences Board of the National Academy of

Sciences. This focused very largely around the question of launch vehicles. A Saturn program was outlined. In this particular discussion, we were talking about Saturn with the S-I stage we now have, with various combinations of upper stages. I've neglected to say that all of our computations have been based on the use of liquid hydrogen and liquid oxygen, as fuels for the upper stages. This decision was made very early, very early.

Well, this again was just another presentation of the thinking at that time. To divert for just a moment and pick up with the amendments to the budget—

On March 17<sup>th</sup> [1961], NASA proposed a revision of the Eisenhower budget that was sent to the Director of the Budget. This led to a White House meeting on March 22, 1961. The NASA letter to the Director of the Budget on March 17 submitted proposals for strengthening quite a large number of areas. This document is a matter of record which can be viewed at length, but I'll only mention the major policy decision what was put in for strengthening vehicle and propulsion capabilities by \$173 million additional, and to put \$48 million into Apollo, \$25 million additional into interplanetary, and so on.

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This was to provide an aggressive, well-planned space program and fund it on a realistic basis.

After that letter was written, there were many discussions again, both internally and externally, which led to the meeting the President on March 22.

In the preparation for that meeting, we had worked with the Bureau Budget to highlight the issues—in other words, to prepare the agenda for the conference. The agenda began as follows:

“The future direction and level of the civilian space program primarily depends upon decisions to be made by this Administration concerning the rate [at which] it wishes to undertake the following:

- (1) Increasing the rate of closure on the U.S.S.R.'s lead in weight-lifting capability;
- (2) Advancing manned exploration of space beyond Project Mercury.”

These were the two policy issues that were put up for decision, the idea being that guidance in these areas would permit the development of that program.

Under agenda item No. 1, to accelerate the work on large boosters or on the weight-lifting capability problem, NASA had proposed to increase the funding rate on the Centaur vehicle; no change in the recent funding of Saturn C-I (which is the Saturn which was recently flown), because that was at the stage when additional money couldn't do very much; to increase greatly the funding on what was then called the Saturn C-II which would be capable of placing 45,000 pounds in orbit at 300 nautical miles altitude. It would use the Saturn C-I stage but put still another stage on top. This

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vehicle was felt to be essential for manned circumlunar flights, unmanned planetary flights, and could be used for soft landings on the moon.

The first agenda item also included starting a prototype flight engine for the nuclear rocket and the development of a Nova-type vehicle utilizing the F-1 engine. At that time the Nova concept was one of using four to six F-1 engines. For reasons of avoiding confusion, at least it was thought it would avoid confusion, the name "Advanced Saturn" was later used for a while and it is this vehicle which we now call "Saturn" with the Roman "V"—or as Mrs. Lyndon Johnson [Claudia Alta "Ladybird" Johnson] christened it the other day at Huntsville, the "Saturn V" (pronounced like VEE). But the particular name "Nova" was being used for that particular booster in early 1961.

And on agenda item No. 2, we had talked about a multi-man laboratory in low earth orbit for up to two weeks, utilizing first the Saturn C-1 and later Saturn C-2, and then to execute manned circumlunar flights which in the 1962 fiscal year would not require additional funds beyond those provided for the multi-man orbiting laboratory, but would require \$1-1/2 billion from FY 1963 through FY 1968.

Then, to accomplish manned lunar landing based on this cluster of four to six F-1 engined launch vehicle, there was a cost estimate of \$2.8 billion over a period of eight years (FY 1963-FY 1970). This was the information that President Kennedy had at the time of deciding whether to step up the development of large launch vehicles to go beyond Project Mercury.

SOHIER: Could you tell us what happened at the meeting in some detail?

DRYDEN: Yes. There were two meetings of different people. There was a preliminary meeting, primarily for the purpose of briefing the Vice President, making a presentation

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so that he could go into the meeting with the President with some knowledge of what was going to be talked about in advance. I am not sure whether there had been any personal discussion of these matters between the President and the Vice President beforehand. I have to again go back a little and remind you that, although the President had said the Vice President would be Chairman of the Space Council, this could not in fact be accomplished until the law was changed. The law was not changed until quite some time later [April 25, 1961]. And in this period the Vice President was acting as an adviser on space without formal designation as Chairman of the Space Council.

There may have been some other discussions with the Vice President, but we wanted him to get a preview of what was going to be presented to the President. The first meeting was attended by the Vice President; by the Budget Director, Mr. Bell [David E. Bell]; Mr. Staats [Elmer B. Staats]; Mr. Webb, Dr. Seamans [Robert C. Seamans], and myself; Willis Shapley [Willis Harlow Shapley]; and Dr. Edward Welsh [Edward C. Welsh].

Now immediately afterward was a meeting with the President, at 5:15 in the afternoon, at which the new people coming in were Dr. Wiesner and McGeorge Bundy and

Glenn Seaborg [Glenn T. Seaborg] and one of the other aides to the Vice President whose name I didn't get. So this was a somewhat larger group that met in the Cabinet Room.

I don't recall specifically how the details went. I didn't take any notes on the progress of the meeting. I do have some notes about the presentation, the ideas I wanted to introduce into it, essentially related to the "why" of the space program. They are the familiar things now of economic return, of science, the airplane story, military benefits, insurance against military surprise and technical obsolescence. All of these items were discussed. The President listened very carefully. As I recall, he didn't take any prominent part in the discussion.

I believe it was at this meeting there was some discussion of Project Mercury and how the decision should be made as

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to when we would be ready to go ahead with the first manned flight [MR-3]. Dr. Wiesner in some of his earlier discussions had proposed that the President decide... and actually approve the mission before the man would be launched. There was some discussion here in which I suggested that this was not a problem that the President ought to be called upon to decide, because he could not have all the information before him. It was a decision for the people responsible for the program and if they got into trouble to make whatever investigation was needed, and to replace them if needed. The people who had the actual responsibility were at Cape Canaveral and were in the best position to know whether we were ready to go or not to go. We did have the policy of not taking any unnecessary risk. We had to do everything we could think of to ensure success. But finally the point is reached when the firing circuit must be closed. I thought that this was the way this kind of a decision should be made.

SOHIER: What were the role of the people there? Was the Vice President there as a proponent of this increase in the budget, or was he there listening, as the President was, to NASA's presentation?

DRYDEN: Well, he spoke up in support. The Budget people, of course, had prepared materials giving in a nutshell the objectives, estimated fundings subsequent to this fiscal year, and so on.

The President was obviously interested in what could be done to get out of this difficult position of being second place to the Russians in space, and he urged that every effort ought to be made to accelerate the program that we had. His interest was in knowing what could be done with respect to a three-shift schedule (work around the clock). Were we using overtime where practical? I would say that the President's primary interest was the difficult position he felt the U.S. was in internationally because of the Russian space accomplishments. He did not tell us his decision at the meeting itself. The Vice President has always supported the

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idea of moving ahead vigorously and he expressed himself. Wiesner had comparatively little to say. It was largely a discussion of NASA with the Budget Director with occasional questions trying to get the facts out.

The decision was soon made to go forward with the acceleration of the large rockets. The question of Project Mercury was reserved for more study, and this was assigned to the Vice President. There was actually sent to the Congress first a NASA supplemental budget increased by \$125,670,000. The principal element in this was the increase in Saturn by \$56 million, an increase in Centaur of \$26 million roughly, \$4 million nuclear systems, and about \$10 million liquid propulsion. Funds for construction of launch facilities were increased by about \$20 million. And, the President also bought the \$10 million acceleration of communication satellites—he was interested in that field also in the discussion.

So this was the budgetary revision that the President sent over to the Congress in March [1961].

SOHIER: Then we have from March 22 to the Shepard [Alan B. Shepard, Jr.] flight on May 5 and to the May 25 decision to get to the moon in this decade, which is an awfully short period of time to make these decisions.

DRYDEN: Well, here again, the Vice President was given the assignment. He still did not have the legal authority to preside over the Space Council.

SOHIER: Well, did any formal Space Council meetings take place in this period?

DRYDEN: No, not during this period. The Vice President operated by means of personally selected advisers taken from various walks of life. I have a record of two meetings with him, one on April 22 and the other on May 3. This is sometime after and it does not mean the Vice President had not been active in the meantime. He had been meeting the other people. There was collected around him a group of advisers

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who were present when I was there, and had been in other discussions. I did not make a record of the names of all of them—Frank Stanton was one of his advisers, George Brown [George R. Brown], General Bernard Schriever [Bernard A. Schriever] of the Air Force, Admiral Hayward of the Navy, Wernher von Braun. Wiesner was present. I believe, although I am not positive, that Edward Welsh was present.

SOHIER: Were they reacting to NASA's proposals, or was this their own examination?

DRYDEN: They were doing their own talking about what ought to be done. The question was formulated essentially on what can the U.S. do in manned space flight and still have the very good prospect of doing it before the Russians? What goals can be set? Of course, at that stage there was no talk about whether it was in this decade or anything of that sort, but what goal can be set and what about the time schedule and the cost?

So the Vice President was exploring public opinion from a variety of sources, people whom he had known personally and in whom he had confidence. And I do recall, I believe at this second meeting, that there were members of Congress also present. You might be able to get from Ed Welsh the list of those present.

EMME: Didn't the Gagarin [Yuri A. Gagarin] flight on April 12 affect the process?

DRYDEN: On April 10, the first budgetary increase was presented to Congress. I have another piece of paper which has the date of April 22 on it, which was our first meeting with the Vice President. This was something that we prepared in NASA as a talking paper and I don't believe that we actually left a copy of this with the Vice President at that time.

One of the things the Budget Bureau always wanted us to do was to try to get the full impact of what the decisions

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would mean, not just the current year, but a few years ahead. Particularly, how much more this would be than the program on the ten-year plan under Eisenhower, although this plan had no standing except within NASA itself. After Mr. Webb came in, we repriced the Eisenhower plan on the basis of our later NASA studies.

For example, the talking paper says: "1. Do we have a chance of beating the Soviets? (a) By putting a laboratory in space?" And the answer is "No." "(b) By a trip around the moon?" And we thought there was some chance of this. "(c) By a rocket to land on the moon? (d) By a rocket to go to the moon and back with a man?" We were discussing all of the possibilities.

"(e) Is there any other space program which promises dramatic results in which we could win?" I find the reply shows how poor prophets we are: "The current NASA program provides the possibility of returning a sample of material from the moon surface to the earth in 1964." We are still a long way from doing that.

SOHIER: Then we had the Shepard flight. What was the impact of this on the decision-making process? Did this sort of speed the thing up and give us confidence?

DRYDEN: Well, it helped, of course. We gradually won the confidence of the President by success in our programs.

SOHIER: Did you have any discussion with him in connection with the Shepard flight—anything that would tend to show he was getting a little more interested and confident?

DRYDEN: There was a little discussion after the ceremony out in the Rose Garden. A few fellows were in the President's office there and sat around and talked a little while. Of course, the President was interested in the opinions of the astronauts. I don't recall specifically what was said.

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SOHIER: Dr. Gilruth [Robert R. Gilruth] was in on that discussion...

DRYDEN: Returning to the discussions with the Vice President, he wanted to know how much additional would it cost. We had tables of figures that D. Wyatt [Demarquis D. Wyatt] had put together for the various plans. They were an outline of some of the things that were going to be done.

Were we working 24 hours a day, and, if not, why not? In building large boosters, should we use engines of the nuclear, chemical, or liquid fuel type, or a combination of the three? Are we making the maximum effort? Are we achieving the necessary results? These were the kinds of questions. And, what has the existing accelerated program already accomplished?

Well, we tried to preserve the posture before the Vice President and his advisers that there were a number of technical possibilities with varying odds on success and varying costs and schedules, and laid them out on the table. It was an invitation for higher authority to make a decision.

When we went back into the second meeting attempting to preserve this attitude, the Vice President became a little annoyed. He proceeded to tell us that we would get nowhere unless the space agency came forward with a proposal: "You're the people who have to initiate this. Say what you think ought to be done. You may not get all you want but we can't do anything unless you come forward with your proposals."

Finally, we said that we didn't know, of course, all of the competing requests from other parts of the Government for funds. We don't know all the obligations on the President. We can only answer from the standpoint of the space program. From the standpoint of the space program, we recommended the lunar-landing goal and told him it could be done within the decade and it could be done for about \$20 billion to \$40 billion.

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Now in this particular case, as far as I can recall, we of NASA were not involved directly with the President. He had given this to the Vice President for examination and recommendation. The Vice President wanted it [the proposed program] right away as soon as we made this proposal for presentation to the Director of the Budget, so we could move promptly with this. And in this meeting, as I say, there were members of Congress present. Of course, this didn't guarantee this proposal would be accepted; on the other hand, they were in the kind of mood at the time to do something to get the country moving, and to move forward vigorously in this kind of a program.

SOHIER: Did you participate in the drafting of that portion of the May 25 message to the President? Do you recall?

DRYDEN: I think that we saw this and had the opportunity to comment, but I'm not sure. I'm not sure because, you see, you mentioned the Shepard flight... that really

came subsequent to the May 3 meeting, and by that time I'm quite sure the Vice President had made up his mind.

SOHIER: That was in the fire at this point—it was a question of presenting it?

DRYDEN: By May 2 we were pretty sure that something was going to happen. On May 2, Dr. Seamans set up an ad hoc task group for a manned lunar landing study, in which there were set forth programmatic guidelines, the number of people to be assigned, and what the milestones of the study were. We knew then we were going to be confronted with a request for a detailed budget.

Actually, the final work of that group was not completed until a considerable time after the NASA presentations to Congress. I mentioned before that these cost estimates and the capabilities of the launch vehicles and the spacecraft, when they had been studied in detail, turned out to be too optimistic. A choice was made to base the next larger

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booster than Saturn on five F-1 engines. That made some difficulty for us because our Congressional budget was based on three F-1 engines (a decision of the preceding fall) and we didn't want to change the FY 1962 justification halfway through Congress. We really had a pinch that first year in the lunar program because as we got adequate time to plan the details, to study the details, we found that the costs went up and the character of the required launch vehicle changed.

SOHIER: I wonder if now we could move into another subject, which is U.S.-Soviet cooperation in space?<sup>†</sup>

DRYDEN: The Inaugural Address of the President, as I've indicated before, was something to which we had made no specific input. Now the chronology of U.S.-Russian cooperation under Mr. Kennedy, I would say, began essentially with the Glenn [John H. Glenn, Jr.] flight and the telegram which Mr. Khrushchev [Nikita Sergeyevich Khrushchev] sent to Mr. Kennedy congratulating the American people on this successful landing. In this letter Mr. Khrushchev led with his chin by saying that if our countries pooled their efforts it would be very beneficial and would be acclaimed by all peoples. On the following day, Mr. Kennedy sent a reply thanking him for this and saying that we, too, believed in cooperation and that he was instructing the appropriate officers of this Government to prepare new and concrete proposals for immediate projects of common action and the hope that at a very early date our representatives would meet.

Now Arnold [Frutkin], did you have anything to do with that letter?

FRUTKIN: I believe that we had been asked whether we could come up with concrete proposals. On the basis of our statement that we could, this went ahead.

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<sup>†</sup> See NK-33 [NASA] microfilm roll 8, classified confidential.

DRYDEN: Then they took from February 22 to March 7 to work up a second letter from President Kennedy which outlined some specific possibilities in considerable detail. I think

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these will be matters of record in the Library and I won't try to abstract them here.

SOHIER: Did we develop these in NASA primarily?

DRYDEN: Primarily. Really, entirely.

SOHIER: Who were the people in the White House that we were dealing with? The President, or the people on his staff?

DRYDEN: Through the people in the State Department primarily, Bob Packard and, at that time, Phil Farley who was head of an office devoted to atomic energy in space. The working level coordinated with Packard who was in Farley's office.

SOHIER: So if anybody was dealing with the White House in this it was the State Department and not us.

DRYDEN: Well, Khrushchev replied on March 20 with a pale echo of the suggestions we had made.

Now, just to get back in the time scale. Immediately after the second letter was sent outlining specific proposals on March 7, Farley sent, on March 9, a memorandum for the Acting Secretary through Mr. McGee on the subject of designating technical representatives for the U.S.-Soviet space cooperation talks. He referred to the letter to Khrushchev two days before saying that we were going to appoint representatives: "While no reply has been received from Chairman Khrushchev, it would be prudent to pick now the scientists who would represent us if a favorable answer be forthcoming. Through discussions by Mr. McGee and myself, and James Webb and Hugh Dryden of NASA, and Dr. Wiesner, it has been agreed that Dr. Dryden, Deputy Administrator of NASA, the responsible program agency in the U.S., should be principal representative. We propose that the President designate two associates and would also, of course, be free to bring in others if the discussants so require. Dr. Dryden has asked for guidance and support from the State Department which the Soviet desk

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and the Office for Atomic Energy will provide under the continuing supervision of Mr. McGee. Will you sign the attached memorandum?"

And this was a memorandum to the President from the Acting Secretary (I don't remember who the Acting Secretary was at that time), proposing specifically myself, John

Townsend [John W. Townsend], and Hornig, a member of the Science Advisory Committee, and, of course, other associate experts as progress might require. State would assist and Under Secretary of State, George McGee, would give general supervision. And this burned copy, this is all I've ever seen in the way of a formal document, has a penciled note on it, "Approved March 19, 1962, by the President per Briskey." I don't know who Briskey is.

SOHIER: That's how you knew it was approved and you were appointed?

DRYDEN: It was the first time I knew it was official. March 19 is one day before the reply was received from Khrushchev. It's just an interesting fact that the President approved it one day before the reply came.

Now events moved very rapidly. In fact, we knew that the Soviets were going to have some people in attendance at the U.N. Outer Space Committee in New York in March. So an informal meeting was held in New York – March 7 to 30, 1962. A formal and negotiating meeting with the Soviets was held in Geneva from May 28 to June 8, 1962. It was at that time that a press release was issued giving the nature of the agreement and that's a matter of record.

This called for further meetings to spell out in detail how the general U.S.-U.S.S.R. agreement would be implemented. These meetings were held in Geneva, March 11 to 20, 1963, and in May of 1963, and an adjourned session in Rome in June, following which there was again issued a press release giving some of the details.

SOHIER: Now you were representing the President in these negotiations. You had not talked to him about it. How did you know what his attitude about these negotiations was?

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DRYDEN: As far as the President is concerned, all that I know of him is through Mr. McGee, the Under Secretary [of State]. In fact, when it was apparent that we were going to do some negotiating, on May 18, which was before the formal meeting in Geneva, I did sit down with Mr. McGee. I asked him what general instructions there were, if any, and specifically whether this was intended to arrive in a true cooperation or whether it was propaganda, whether it was a sincere effort to get something going or was it merely something for public display. This would make some difference in the approach.

And he assured me the President had in mind real cooperation, that he was anxious to go just as far as the Soviets would go. We had that assurance through the State Department on several occasions, not just this single occasion.

But there were no direct meetings with the President, no telephone consultations, or anything of this sort.

I should explain that in all such negotiations we coordinate with the other agencies of the Government. In other words, before we went even to New York we had some meetings with the Weather Bureau, DOD, State, and many agencies which are concerned with the kind of arrangements we make with the Russians, including the intelligence agencies. For New York, we did not prepare a formal position paper. We did outline proposals that we intended

to make in some detail. Actually, in New York the Russians did not bring forward any proposals of their own and gave the excuse that Mr. Blagonravov [Anatoli A. Blagonravov] had not been in Moscow since the correspondence so he had no instructions. We did bring out our proposals and gave them to them to they would have something to react to.

And this has been true of all the meetings. We have not proceeded as individuals. We've had experts join us when the different subjects were under consideration. We have consulted the agencies that are involved here at home, but the President himself was not involved in any of this.

SOHIER: The idea of cooperative programs with the Russians seems to have been a theme of President Kennedy's

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beginning with his Inaugural Address. It went all the way though his administration. Was this something that was his idea, that he was promoting with us and asking us to spell out in detail, or was this something that NASA and other agencies were urging him to adopt? Who was pushing this concept?

DRYDEN: Well, at this particular time I don't know that we were pushing the White House. We had been pushing to see how far the Soviets would go for quite some time. You can answer this question, Frutkin, better than I in connection with this correspondence, whether any initiative came from here.

FRUTKIN: The initiative apparently originated in the White House, but where in the White House I don't know. Whether it was the personal initiative of the White House I don't know. It came to us from the Department of State. As Dr. Dryden says, NASA itself had on many occasions explored these possibilities with the Soviet Union.

DRYDEN: I think I should also make clear that Wiesner had promoted cooperation on many occasions, so it's possible that this arose from the discussions with Wiesner present.

FRUTKIN: There had been a committee that convened within the Science Advisory Committee to the President, earlier called the Rossi Committee, which prepared a series of proposals which President Eisenhower was planning to use but never did use. We participated in the formulation of these proposals.

DRYDEN: To continue on the subject of cooperation with the Russians, the next overt move was the U.N. speech of the President on September 20, 1963, in which he made a proposal for exploring the possibilities of increased cooperation including a joint lunar program.

This particular speech had been circulated for comment. In the form in which I saw it anyway, it did not have the particular paragraph in it which caused so much comment later.

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As I recall, I was away at the time of the President's speech and the few days immediately before. Mr. Frutkin tells me he had some information from the White House that a paragraph had been drafted by Mr. Schlesinger [Arthur M. Schlesinger, Jr.], and tried very hard to find out what was in this paragraph, without success. Evidently the White House did not want to lose the impact of this part of the speech. It was read, I'm told, to Mr. Webb, something on the order of 24 or 48 hours before the speech was given. It was read to him over the telephone. I don't know whether he made any comment one way or the other on it.

But the particular proposal going so far was not prepared by NASA. Some of our people on parts of it took public issue with it. We, I believe, on our own initiative tried to avoid people taking a position that seemed to be in conflict with that of the President.

SOHIER: I remember the day before the speech was being made, several hours before, McGeorge Bundy telephoned John Johnson [John A. Johnson], who was then Acting Administrator, and asked him to get in touch with every Director of every Center and ask them to make no comments.

DRYDEN: Well, I think, looking at it from some distance away, that some of the details of the wording were a little bit unfortunate. I think the general proposal to explore possibilities is one with which I personally have been in sympathy for a very long time. One of the new elements which may have contributed to this is a report of a luncheon conversation I had with Blagonravov in New York in which, for the first time, he had indicated there might be some possibility of discussing cooperation in this area after they had perhaps more information about the moon. On all previous occasions, any attempt to discuss this subject was dismissed by saying it was politically impossible. Conditions had changed greatly.

And my reporting of this conversation may have had a little something to do with stimulating this again. I think the President had always wanted, and I know Wiesner has always

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wanted, to really see if there was not some major program on which there could be cooperation. I know many of the scientists have said, "Well, if we can't get together on the moon, let's try to get together on the next step beyond that."

SOHIER: The aftermath of this, as I recall, had quite an impact on the Hill. What steps did the White House take when they saw these difficulties?

DRYDEN: The White House staff wrote a few letters to people on the Hill. Professor Lovell of Manchester, England, reported on a trip to Russia, in which his remarks were interpreted as meaning that the Russians didn't have any manned program. I think that was about the same time was the President's U.N. speech and

aggravated the situation. I see recently that Professor Lovell didn't intend this at all and hoped the U.S. wasn't letting up on its efforts.

But it did have an unexpected effect on Congress, thinking that President Kennedy was in effect changing his position in his speech calling for a joint lunar program. This was corrected by correspondence with members of the Congress.

I don't think any of us ever misunderstood what was intended. Unfortunately, many people get erroneous ideas of what is possible. Particularly the use of the term "joint expedition" gave rise to some of the difficulties.

I don't know any other aspects of the international program in which the President himself has taken a specific part. There were some occasions in which the Vice President was brought into the picture to execute the letters between the State Department and the Foreign Office of various countries. I remember Italy and Sweden in particular, letters which endorse agreements made between the agency of the country concerned and NASA.

Well, I think you ought to return now to the subject of the Mission Mode decision. Or did we finish with the President's message to Congress on May 25, 1961?

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Again, I think there was no real problem in the President's message as there was very little difference of opinion that I could see at that stage between the various departments. Certainly the DOD was supporting, at that time, work on large boosters. I don't remember any specific statement from DOD as to an endorsement or not. It was considered that this was a civilian program on which the President has made his decision and that was that.

SOHIER: In other words, NASA came in with what the decision should be and it was adopted by the President pretty much as is? Or were there some modifications?

DRYDEN: There were some modifications. I wouldn't like to give that impression. The general notion was presented to the Vice President and his group. The President accepted the general recommendations of the Vice President, and the Director of the Budget proceeded to discuss details. There were changes in the details but not in the essential decision to move forward.

What we got was a decision on the second policy question: Shall we go beyond Project Mercury; if so, shall it be according to the plans that NASA had in the Eisenhower Administration, or shall we move it more vigorously? What should be the specific goal? We got the answer to that question and I think the President made it very clear in his message that we were not talking about the few hundred million dollars required as a supplement to the Eisenhower budget. We were talking about the \$20 billion over a period of years. The language, again, is a matter of record. We must be prepared to see this through or we shouldn't start. If you stop in the middle you leave a lot of unfinished structures and pieces of metal that you can't use.

SOHIER: During this period, from what you say, the Vice President was playing a very key role. Did this continue on in the space program or did the President get

more involved?

DRYDEN: The Vice President was the key figure. I think the Vice President's influence in space matters continued

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throughout the Kennedy Administration. I think the President got a little bit more into detail in the decisions later. He couldn't delegate to the Vice President absolute or full responsibility. I think it probably is incorrect to say that the President approved in full exact figures that we had originally presented to the Vice President. I am not sure the numbers would correspond exactly because they were subject to the usual budgetary review and analysis. Some of the things for which we asked an increase in our budget were denied.

Now the Mission Mode decision. In this particular area I was not personally involved until it rose to the top of the NASA organization. We left the lunar-landing decision in 1961, you see, to the consideration of earth orbit rendezvous with direct ascent. This was the status back in early '61 when the President made these decisions.

Now our people were learning to and did essentially adopt the earth orbit rendezvous method. I left out of my account a very important exercise, I think, under the President's Science Advisory Committee, so-called Golovin [Nicholas E. Golovin] Committee, on launch vehicles, which analyzed for the Department of Defense and ourselves the matter of large launch vehicles. This was a factor in producing the first draft of the National Launch Vehicle Program where we and DOD agreed on all of the launch vehicles that would be used.

This Golovin Committee also was involved in the analyses of Mission Modes and did favor the earth orbit rendezvous. And this was the position of NASA on completion of the detailed studies initiated by Dr. Seamans' appointment of this group.<sup>‡</sup>

Now there were also contract studies with contractors about this whole business. I can't give the names of all those who participated. Contractors have preferences, too. The

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lunar orbit mode, which was finally adopted, was first proposed apparently by one of our Langley people, John Houbolt [John C. Houbolt], who was an enthusiast for the lunar orbit mode. He was not able in the early days of the program to win acceptance for this point of view. I recall at least one of the contractors came up with the lunar orbit rendezvous as the preferred mode. I have to say that the others came up with the proposal of sending a lot of equipment to the moon and sending a man on the one-way trip, hoping he could put the stuff together and get back. I didn't think very much of that method.

But it was not until literally thousands of hours of detailed analysis, preliminary design on what the vehicles looked like, how big they were, what their problems were, that people concerned began to see the advantages of the lunar orbit rendezvous.

Back in '61, when we were talking earth orbit rendezvous, we had a meeting between Mr. Webb, Mr. McNamara, Mr. Gilpatric [Roswell L. Gilpatric], and others relative to the

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<sup>‡</sup> For "Golovin Report," see Secret document from NASA, NK-33, February 1, 1962, NASA-DOD Large Launch Vehicle Planning Group Report, in three volumes.

National Launch Vehicle Program. We talked about a division of effort between NASA and DOD in the development of space rendezvous capability. At that time we were talking about doing rendezvous experiments with a Mercury Mark II, which is now called "Gemini." At that time we were thinking of rendezvous experiments in connection with earth orbit rendezvous. Instead of waiting to try it with very large vehicles, we were doing it on a smaller scale with a somewhat larger spacecraft. At that time it was contemplated that the spacecraft would be a grown-up version of the Mercury capsule without any change in technology.

Well, this led to the Gemini project which turned out to not be Mercury technology but new vehicles, new concepts. The rendezvous experiments are still there because they're needed in the rendezvous in lunar orbit as well.

My first contact with the conclusions came when I was at the hospital at N.I.H. in this period just prior to the final decision in July 1962. I had been absent from the

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office since June 18. Brainerd Holmes [D. Brainerd Holmes], Joseph Shea [Joseph F. Shea], and George Low brought out the models to use in the presentation. I must say my own prejudice had been for earth orbit rendezvous. I was viewing with a rather conservative eye the proposal to shift to the lunar orbit rendezvous. Looking at the models and comparing in scale and size what was involved backing down gently on the moon was almost convincing in itself. The presentation to me was the last step, since Webb and Seamans had heard it the day before. After hearing the results of the studies, I fully concurred in the selection of the lunar orbit rendezvous method. The day on which the decision was announced was the day that I went home from the hospital.

The White House involvement was solely that of Jerry Wiesner and his panels. They in general followed the results of the Golovin group. Golovin was by then working for Wiesner, and Jerry tried to make somewhat an issue of it. In other words, this was the advice of the President's Science Advisory Committee and he wanted NASA to take the advice of this group. They thought it had not been sufficiently considered.

As a result, the mode decision was for a time regarded as a tentative decision. Mr. Webb said there was still flexibility; it can go either way during the next few months. As time went on, we became very firm in our conviction that this was the right way to go and felt that we should not substitute for thousands of man-hours of detailed design and computation and study the results of a committee that met for a few hours each week.

SOHIER: It wasn't the President's decision, one way or the other?

DRYDEN: He [the President] looked to NASA to consider what Wiesner's group came up with and study it but the decision was NASA's decision.

SOHIER: Did the Space Council, the Vice President, get into this in terms of the decision or recommendations?

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DRYDEN: No. This was one element in the problem of the relations of an executive agency to staff advisers to the President. The staff advisers to the President did not have line authority themselves; they exercised it through the President. And if an agency believes it's correct in its view, the only person who can overrule that is the President. I'm not taking the position at all that NASA should ignore the recommendations of the Science Advisory Committee. In 99 times out of 100 we would adopt them. This is one case where we didn't, where we thought the background and study that had been put into it provided a different answer, and we were the ones that had to do it.

SOHIER: Was there any difference in dealing with people like Dr. Wiesner and the Science Advisory Committee in the Kennedy Administration and the Eisenhower Administration? Or was this a problem that would have to be worked out with each different group?

DRYDEN: It has to be worked out with each different group. I don't want to put on the record specific criticisms and comment on the way in which people worked. It is difficult, I think, for anyone working at the level of the Presidency to know how to draw the line between appropriate decisions to make at that level and those to be made at the lower level. This is characteristic of even NASA Headquarters and NASA Centers.

SOHIER: It wasn't a difference in philosophy particularly, it's a problem that always exists?

DRYDEN: The problem will always exist.

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Washington, D.C.

July 1964

HUGH LATIMER DRYDEN

Deputy Administrator  
National Aeronautics and Space Administration

Dr. Hugh Latimer Dryden has been Deputy Administrator of the National Aeronautics and Space Administration (NASA) since its creation by the Congress in October 1958. He is internationally recognized for his scientific contributions to fluid mechanics and boundary layer phenomena, and has been highly honored for his leadership of research and development associated with aeronautics and astronautics. He became Director of Research of the National Advisory Committee for Aeronautics (NACA) in September 1947, and was named Director of NACA in May 1949, serving until it was superseded by NASA in 1958.

Dr. Dryden currently holds a number of posts in addition to his responsibilities for the U.S. civilian space program under NASA. He is a member of several scientific committees advising government agencies, including the Department of Defense and the military services. He is Technical Advisor to the Representative of the United States to the United Nations Committee on the Peaceful Uses of Outer Space. Dr. Dryden is a consultant to the Science Advisory Committee to the President and a member of the Standing Committee of the Federal Council on Science and Technology. He is also a National Delegate to the NATO Advisory Group for Aeronautical Research and Development.

Born in Pocomoke City, Maryland, in 1898, Dr. Dryden earned a Bachelor of Arts degree in 1916 and a Ph.D. in 1919, both from Johns Hopkins University in Baltimore, Maryland. He joined the staff of the National Bureau of Standards in 1918, where he performed his distinguished research contributing to supersonic flight of aircraft and missiles. He became Associate Director of the National Bureau of Standards in 1946, having previously served for a short time as Assistant Director. Throughout World War II, Dr. Dryden served on numerous technical groups and task forces concerned with aeronautics and guided missiles for the Joint Chiefs of Staff, the military services, and NACA. In 1945 he was the Deputy Scientific Director of the AAF Scientific Advisory Board appointed by General H. H. Arnold to prepare a report to guide future Air Force research and development.

Dr. Dryden is Home Secretary of the National Academy of Sciences; Charter Member, Honorary Fellow, and former President of the Institute of the Aerospace Sciences; Honorary Fellow of the Royal Aeronautical Society, the British Interplanetary Society, and the Canadian Aeronautics and Space Institute; Fellow of the American Academy of Arts and Sciences; Foreign Associate Member of l'Académie des Sciences de l'Institut de France; and a member of numerous professional societies and organizations. He is a Trustee of the National Geographic Society.

Many honors and awards have come to Dr. Dryden, including the following:

- First American to deliver the Wright Brothers Annual Lecture before the Institute of the Aeronautical Sciences (1938)
- Sylvanus Albert Reed Award (1940)
- U.S. Army Air Forces' Medal of Freedom (1946), the second highest U.S. award
- Presidential Certificate of Merit (1948)
- Order of the British Empire (civilian division) (1948)
- 37th Wilbur Wright Memorial Lecture before the Royal Aeronautical Society (1949)
- Daniel Guggenheim Medal (1950)
- Wright Brothers Memorial Trophy (1955)
- Ludwig Prandtl Memorial Lecture of the Wissenschaftliche Gesellschaft für Luftfahrt (1958)
- Career Service Award of the National Civil Service League (1958)
- Baltimore City College Hall of Fame (1958)
- President's Award for Distinguished Federal Civilian Service (1960)
- Elliott Cresson Medal of the Franklin Institute (1961)
- Langley Gold Medal of the Smithsonian Institution (1962)
- First Th. von Kármán Lecture before the American Rocket Society (1962)
- Rockefeller Public Service Award (1962)
- John Fritz Medal (1963)
- Gold Medal of the International Benjamin Franklin Society (1963)
- First Annual Award Dr. Th. von Kármán Memorial Citation (1963)
- Dr. Robert A. Goddard Memorial Trophy (1964)
- Hill Space Transportation Award (1964)

## Honorary Degrees:

Polytechnic Institute of Brooklyn (Sc.D., 1949)  
New York University (D.Eng., 1950)  
Rensselaer Polytechnic Institute (D.Eng., 1951)  
University of Pennsylvania (Sc.D., 1951)  
Western Maryland College (Sc.D., 1951)  
Johns Hopkins University (LL.D., 1953)  
University of Maryland (D.Eng., 1955)  
Adelphi College (LL.D., 1959)  
South Dakota School of Mines and Technology  
(D.Eng., 1961)  
Case Institute of Technology (Sc.D., 1961)  
American University (L.H.D., 1962)  
Northwestern University (Sc.D., 1963)  
Politecnico de Milan (M.E., 1964)

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