Interviews with Dr. Wernher von Braun

Editor's note: The following are edited excerpts from two interviews conducted with Dr. Wernher von Braun. Interview #1 was conducted on August 25, 1970, by Robert Sherrod while Dr. von Braun was deputy associate administrator for planning at NASA Headquarters. Interview #2 was conducted on November 17, 1971, by Roger Bilstein and John Beltz.

These interviews are among those published in *Before This Decade is Out: Personal Reflections on the Apollo Program*, (SP-4223, 1999) edited by Glen E. Swanson, whick is vailable on-line at http://history.nasa.gov/SP-4223/sp4223.htm on the Web.

Interview #1

In the Apollo Spacecraft Chronology, you are quoted as saying "It is true that for a long time we were not in favor of lunar orbit rendezvous. We favored Earth orbit rendezvous."

Well, actually even that is not quite correct, because at the outset we just didn't know which route [for Apollo to travel to the Moon] was the most promising. We made an agreement with Houston that we at Marshall would concentrate on the study of Earth orbit rendezvous, but that did not mean we wanted to sell it as our preferred scheme. We weren't ready to vote for it yet; our study was meant to merely identify the problems involved. The agreement also said that Houston would concentrate on studying the lunar rendezvous mode. Only after both groups had done their homework would we compare notes. This agreement was based on common sense. You don't start selling your scheme until you are convinced that it is superior. At the outset, neither Houston nor Marshall knew what was the best approach. And the fact that Houston happened to study the lunar orbit rendezvous mode was purely coincidental. That mode didn't even originate in Houston-it was first proposed by John Houbolt of the Langley Center. The problem with Houbolt's original study was that his weight figures for the lunar module were based on certain operational assumptions that Houston considered absolutely inadequate for the mission. So, as Houston added realistic requirements to the Houbolt scheme it lost a lot of its original charm. In the end, everybody wondered whether the lunar orbit rendezvous mode would still look attractive by the time the necessary realism had been instilled in it.

Wernher von Braun in space suit and diving equipment in the neutral buoyancy simulator at Marshall, November 14, 1967. (NASA Photo, available on NASA Image Exchange: http://nix.nasa.gov.)

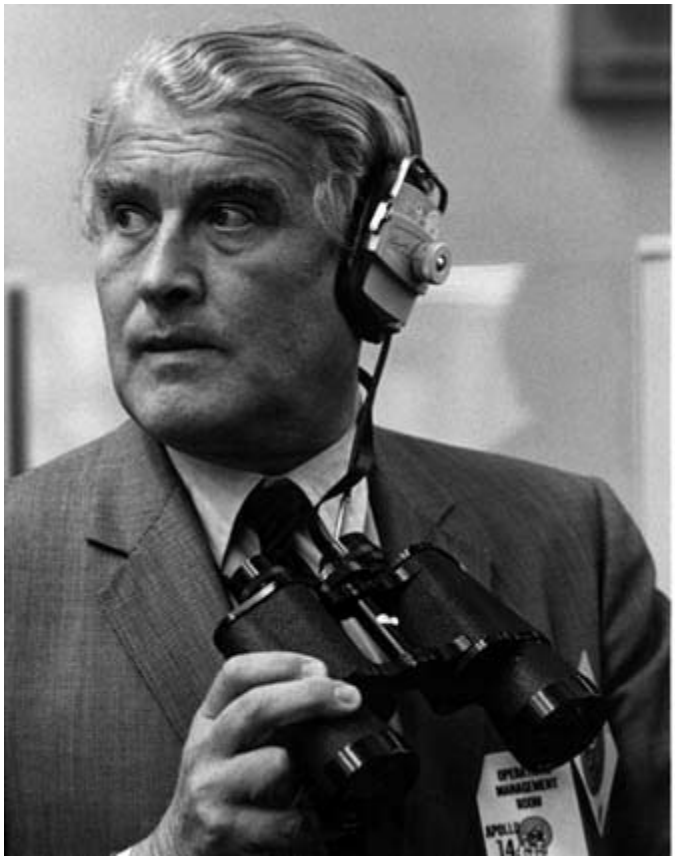
At that time, as I recall, you said the way it was originally presented by Houbolt, that the lunar module was not even pressurized. The two astronauts would simply fly down to the lunar surface in their space suits.

That is correct. The first lunar orbit rendezvous scheme that I was exposed to envisioned a LM without a pressurized ascent stage. The two astronauts were to ride down in their space suits and there was to be no cabin pressurization. This was the first item that Houston said was unacceptable, and so pressurization was added. As a result, the weight of the LM went up. The next thing was that the guidance system as originally identified was considered inadequate, both for the descent and the ascent. Somebody overstated the situation a bit by saying the original system consisted of a "recticle and a stop-watch." A very sophisticated guidance system was put in the LM to replace it. Then, another redundant guidance system was added. All of this, of course, further increased the weight of the LM. The [**46**] crux of the problem was this: John Houbolt argued that if you leave part of your manned spacecraft in lunar orbit and don't soft-land all of it on the Moon so you have to carry it up from the lunar surface again, you can save take-off weight on Earth. That was basic and challenged by nobody. But the question was, if the price you pay for that capability is one extra pressurized crew compartment, complete with life support equipment, two additional guidance systems to the one already in the command module, and the electrical power supply for all that gear, if you add up all this, will you still be on the plus side of your trade-offs? That was the real issue.

Some reporters told pretty fanciful tales that Houbolt had come up with an ingenious solution that everybody in Washington, Houston, and Marshall had overlooked. This is not true either, because special landing vehicles for the descent from and reascent to orbit of a target planet had been described in the literature before.

. . . It has been presented in some places as though this [von Braun's decision to switch to LOR] came as a great shock to everyone . . . including your own people.

It is correct that quite a few people at Marshall, who had worked on the Earth rendezvous system and convinced themselves that it was feasible, were disappointed when I sided with the lunar rendezvous mode that had been studied by Houston. But I would like to repeat once more that when I committed Marshall earlier to study the Earth rendezvous mode, I was not at that time saying that this was the mode we were going to embrace. At that stage, neither Bob Gilruth [director of the Manned Spacecraft Center in Houston] nor I were sure which way we should go. We had a charter to go to the Moon, and there were several feasible approaches and we simply agreed to study all of them. And we agreed that Marshall would analyze the Earth orbit rendezvous mode simply because we had already done a lot of work in that field in connection with space station studies. Houston would study the lunar orbit rendezvous mode and we would make a final selection only after both modes had been thoroughly wrung out.



Wernher von Braun, by this time the NASA deputy associate administrator for future programs, uses binoculars to monitor data on closed-circuit television screens in Firing Room 2 of the Launch Control Center during the final Apollo 14 launch preparations on January 31, 1971. (NASA Photo, available on NASA Image Exchange: http://nix.nasa.gov.)

[**48**] I convinced myself after hearing the Houston story that in spite of the fact that the lunar orbit rendezvous story didn't look quite as gorgeous as it was originally presented by John Houbolt, it still looked like the best choice. By the way, Max Faget, Houston's key systems man, was probably the most vocal with respect to the inadequacies of the original Houbolt proposal.

"Your figures lie," he said.

I don't know whether Max really put it that bluntly, but I am sure I never did. John Houbolt is a very capable and dedicated man, and the last thing I wanted to do then and now is run him into the ground. But when he presented his original story to Houston, Max Faget was pretty outspoken.

The discrepancy between the original Houbolt proposal and the real world is best shown by two figures. Houbolt's fully loaded and fueled LM was to weigh a little less than 10,000 pounds. By comparison, the Apollo 11 LM actually weighed over 30,000 pounds. That is a flat 20,000 pound difference in the payload the Saturn V had to inject into a lunar trajectory!

While the two studies were underway, we at Marshall were fully aware of the fact that before Houston and Marshall could really compare the pros and cons of the two modes they had to be put on a comparable level of realism. Well, when the studies had finally been completed, I came to the conclusion that lunar orbit rendezvous still looked awfully good, in spite of the tremendous weight increases over the original Houbolt proposal, even after it had been brought up to the same degree of realism that we thought our own study had. This, of course, caused some disappointment on the part of some of our guys who had thought that Earth orbit rendezvous would come out on top.

We've spent a lot of time on this, but it is an important decision because your swinging over to LOR [lunar orbit rendezvous] was the most important factor.

Yes; I still don't like the term, "swinging over to LOR." I had never [**49**] committed myself to EOR [Earth Orbit Rendezvous] in the first place. I've always taken the position, to repeat this again, that we in Marshall would investigate EOR and Houston would investigate LOR and that we would make a final decision on the mode after all the facts had been assembled. For that reason I never considered in any way that we were changing sides or anything like that. I just wasn't ready to vote at all until I had the facts and could make a meaningful comparison. Of course, some of our people at Marshall in the meantime fell in love with the scheme they were investigating. I guess that is only human.

Interview #2

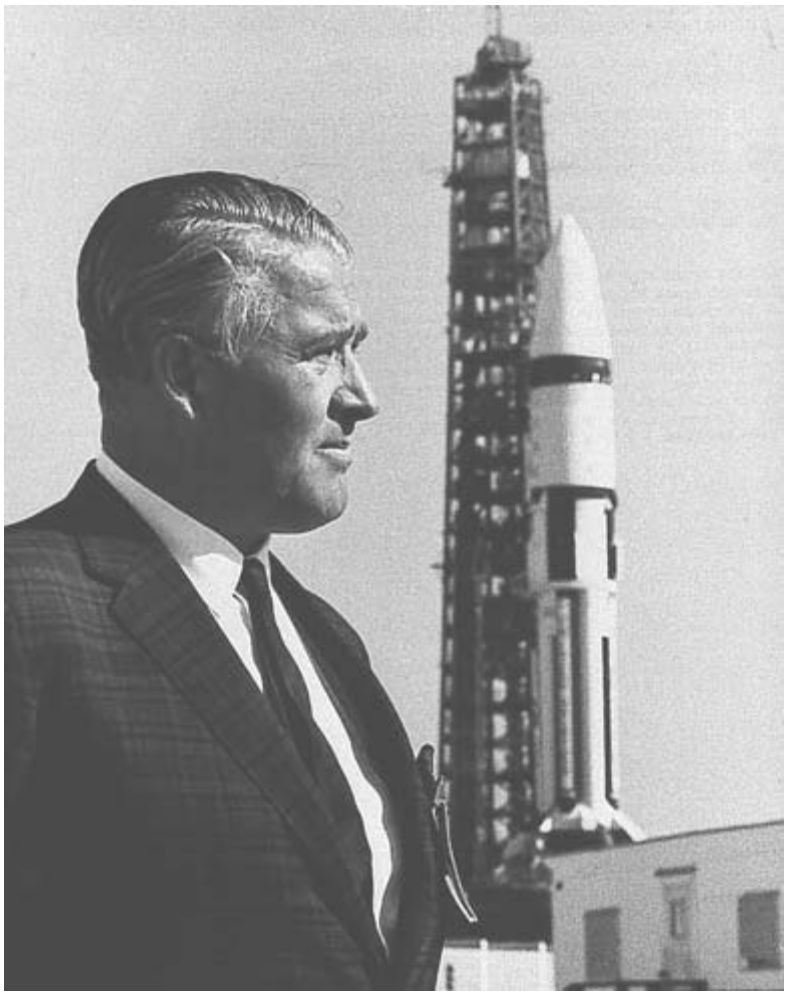
Would you recall for us your recollection of the ARPA [Advanced Research Projects Agency] request for a clustered-engine booster and the evolution of the Saturn I.

The head of ARPA at that time was Roy Johnson. He was visiting the ABMA [Army Ballistic Missile Agency] at that time and said something to the effect that there was an indication that the Russians are working on a very powerful rocket system with a total thrust far exceeding anything we had, even in our ICBMs, the

Atlas, and Titan II at that time, and there was also a widely held belief that they got this massive thrust by clustering a great number of engines. Would we be ready at ABMA to develop a powerful booster using existing rocket engines and clustering them?

Prior to that, back in about 1957, wasn't the future projects office working on this kind of clustering concept both with clustered H-1s and Redstone and Jupiter tanks, and with the parallel-stage concept which they were both developing?

Yes. But this was, I believe, already in response to an interest expressed by ARPA. I don't know whether we came forth with drawings of clustering rockets, or whether ARPA came to us. At any rate, it was pretty obvious that at ARPA there was interest in ....



Wernher von Braun stands in front of a Saturn IB Launch Vehicle at Kennedy Space Center (KSC) on January 22, 1968. Von Braun was Marshall's first center director (1960-1970). Under his leadership Marshall was responsible for the development of the Saturn rockets, the Skylab project, and getting the United States into Space and landing on the Moon with the Apollo missions. (NASA Photo, available on NASA Image Exchange: http://nix.nasa.gov.)

....high thrust systems. We were firm believers in the feasibility of clusters, and the question who made the opening statement is a little bit like who started a love affair . . .

Now there was another engine under discussion that was, however, only a paper engine, and I think it was called the E-1 which was halfway between the existing H-1 engine that came out of the Thor, and the F-1 which ultimately wound up in the Saturn V program.

. . . And so the early cluster studies involved a cluster of pure E-1 engines. But it was pretty obvious that we were probably more than $100,000,000 away from an E-1 engine in the funding environment that existed. This kind of money was beyond reach. So we ultimately settled on the idea of clustering eight H-1 engines to get that one and a half million pound thrust.

Going back a little further . . . several people have mentioned various paper studies made at Fort Bliss for large rocket motors using some of the Peenemunde technology and extrapolating . . . Was any application in mind for those large engines?

[**51**] No. I think the question ARPA asked was really much more down-to-earth. They said something like, "We have $10 million, or so, for this purpose. Do you think this is enough to get us going? And in this environment, anything involving development of nonexisiting engines was simply not in the cards.

But there was some effort at Fort Bliss along these lines, wasn't there?

That is correct. But these were always paper studies whereas the H-1 was really in existence.

Were large boosters the ultimate objective of the Fort Bliss studies or were any space programs considered?

We made, of course, studies in Fort Bliss on the space potential of rockets. And since all those rockets turned out to be pretty big rockets, the question was, "How do you get the thrust?" And the thrust was, of course, in clustering a number of smaller engines . . . it's a bit like airplanes. If you have an engine of limited horsepower and you want to build a big airplane, people have always reverted to the technique of saying, "Oh, gee, let's take six or eight of these engines. If you put enough on, it will ultimately take off."

When you got the initial order to test the clustering concept and then about three months later you got an order to make this a flyable booster, was any time lost in this interim? Would you have designed it differently from the start, or done a different program if you had been asked to design a flyable booster from the start or did you kind of know what it [the cluster] was going to fly when you put it together?

We had in mind right from the beginning to come up with a configuration that would inherently fly. Remember, here again we were governed by low funding aspects, so we said, "How can we put a cluster of tanks together on top of this cluster of engines to provide the fuel, the RP [kerosene] and the LOX [liquid oxygen]?" [**52**] And we had, at that time, tooling both from the Redstone and from the Jupiter . . . And we made some very simple-minded sketches, figuring out how one could fit these two diameters together and wind up just with the right volumetric tankage to satisfy the needs of the engine.

Weren't the first studies modular in that the tanks could actually be plugged together, or unplugged, and shipped to the Cape and replugged again, before the barge concept came along?

That was discussed as one possible advantage of clustering tanks. But when you look at all the check-out requirements of the complete system, you want to verify and so forth. We all came to the conclusion that it's probably a lot easier to do a good job in the shop and make good pressure tests, seal the unit and ship it in one piece, rather than take it apart and reassemble it at the launch site.

Interview #1

The committee suggested that a fifth engine be included in the Saturn V. I always thought that this was your idea. Didn't you say at one time, "It's crying out for another engine?"

Yes, I have always pleaded for it, but this doesn't rule out that Milt Rosen's committee may also have recommended it . . . The term C-5, which is used throughout for the Saturn V, shows that at the time when the mode studies were made-I mean this comparison between Earth orbit rendezvous and lunar orbit rendezvous-we were already thinking seriously of a five-engine Saturn V. The term C-5 implies five F-1 engines in the first stage. The four-engine version was called C-4, and C-8, which you find occasionally referred to, had eight F-1 engines in the first stage and could have carried the Command Module to the lunar surface and back, so no LM would have been necessary. So, the LOR vs. EOR mode studies were based on five engines in the first stage . . .

[**53**] We actually started with a launch vehicle with two F-1 engines in the first stage, then we studied one with four engines. And I figured, since all the performance and weight figures for the "front end" of the Saturn-Apollo vehicle were still extremely fluid-there were so many uncertainties about the LM, the

weight of the command and service modules-that it would be wiser to provide some padding in the performance in the booster. I said relatively early that to build a Saturn with four engines in the first stage doesn't make sense to me! This great big hole in the center is crying for a fifth engine. And I was glad that this position was also taken by Milt Rosen's committee. Whether they came out with this suggestion before or after I did, I do not recollect . . . I would also say in retrospect, had it not been for that fifth engine, we would have been in deep trouble. Because the weight growth in the front end continued for two years.

Interview #2

When did the lunar rover come in as an added payload factor?

The rover is not exactly a new idea, you know. People had been toying with the idea of providing ground transportation on the Moon for a long time . . .

At the beginning we had very little information on the suitability of the lunar soil to accommodate wheeled vehicles. I remember that even after the successful landing of Apollo 11, I talked with Buzz Aldrin about this. And he said, "Well, it's going to be pretty rough driving around on the lunar surface since there are lots of craters there. I'm not saying you can't do it, but it's going to be a pretty rough ride." But the bearing strength of the lunar soil was there.

In subsequent flights, it became more obvious when the astronauts came back and said, "We just have too little time on the Moon to do all of the wonderful things we could have done. It would vastly increase the scientific payoff had we had a little more time and a little more facility to move around freely. We were just too damn busy doing-staying alive there."

[**54**] After the first two landings on the Moon-Apollo 11 and Apollo 12-the question arose, "All right, we have not done even more than President Kennedy had promised in landing men on the Moon in the '70s. Here we still have a whole fleet of unused Saturn V Apollo systems and we have a substantial cadre of astronauts, competent, trained and eager to go. Shall we continue flying to the Moon?"

The scientific community, of course, had been at first a little skeptical about the scientific value of Apollo in the sense of, "Will the geological findings on the Moon really be so interesting that we ought to send man there?" . . .

After Apollo 11 and 12, and looking at the samples returned, they changed their minds completely. They came to the conclusion that the Moon really turned out to

be sort of a Rosetta Stone for the understanding of monumental cosmological phenomena. So they were, all of a sudden, pushing. And they said, "Of course, if you want to continue to the Moon, stop flying to the mares because they are not the most interesting things on the Moon. Go to the more exciting sites . . . And that, of course, brought in the question of flexibility of the movability radius of action and increased payload capability of the Saturn V.

That fifth engine in the Saturn V still allowed you to stick the rover in?

Without the fifth engine, it would have been out of the question. They came to us and said, "Can you extend the system? Everybody complains about having too little time on the Moon; everybody complains about not having enough mobility on the Moon. Can you provide us with that?"

Of course, with that fifth engine, we still had a comfortable padding with respect to rocket performance, and so we could now do it.

Although, let me say this: Even with the fifth engine, we could accommodate the larger LEM descent stage that was necessary to soft-land the rover by further jazzing up the F-1 engines. We had to increase both the thrust and the specific impulse, in spite of the [**55**] fact that we had five engines. So it was necessary to soup up the engines in addition to having five. With only four it would have been absolutely out of the question.

Interview #1

What do you remember about the C-prime decision-the Apollo 8 decision. I'll tell you, to orient you chronologically, it was on June 9, 1968, that Bob Gilruth called you from Houston and said, "We'd like to come over and talk." It was only that morning that George Low had first suggested flying an orbit around the Moon, and both George Mueller and Jim Webb had just taken off-

For Vienna-

For Vienna. And, as George Low says, or as Tom Paine said the other day, "It must have seemed a bit peculiar to them that the LM lost two months

immediately when they got on the airplane." What do you remember about this meeting in Huntsville on that afternoon?

Bob Gilruth's story was really very simple. The original plan, you remember, was to fly Apollo 8 as the first LM mission, pretty much as it later was flown on Apollo 9, in Earth orbit. Only thereafter were we to fly a lunar mission, pretty much on the profile of what became Apollo 10, the Stafford mission. Now Gilruth said, "No matter what we decide to do, that LM just isn't ready to fly. And, so if you Marshall guys say our Saturn V is only ready to launch this Earth orbit mission for a command module/LM rendezvous in Earth orbit, all we can tell you is we will have to wait three months. However, if we wanted to fly Apollo 8 as a mission with the CSM only, and without the LM, we could crank up pretty soon. And if we did that, we might as well swing around the Moon. Well, our position was that the Saturn V really didn't care whether it headed for Earth orbit or on to the Moon. We had reignited the SIV-B stage in orbit before. As far as the other potential problems with [**56**] the launch vehicle were concerned, we thought we had smoked out the problems we had in Apollo 6. Therefore, we would be comfortable with a decision to go around the Moon with Apollo 8. If I remember correctly, in his opening remarks Gilruth talked only of flying around the Moon, not of going into orbit around the Moon.

After the Houston fellows had given us their basic pitch, we debated at length the wisdom of just swinging around the Moon through a free-return trajectory versus going into orbit around the Moon. The Houston group felt the CSM was ready to go into orbit around the Moon as well. They felt they would learn a lot about tracking the spacecraft out there and really nailing down the entire flight profile of future Apollo flights, so it would really be worthwhile. There would be a tremendous gain in time if that portion of future lunar flights could already be exercised with Mission Control.

I still think the boldest part of the decision was to commit the launch vehicle just after you had had so much trouble with it on the previous flight [Apollo 6].

We didn't feel too concerned about the launch vehicle risk because we really felt we were on top of the Apollo 6 problems. Also, there is a built-in emergency return capability. For example, if we tried to inject the Apollo 8 spacecraft all the way to the Moon and 10 seconds before nominal cut-off the SIV-B would have acted up, there would be enough Delta-Vee left in the service module to bring the crew safely home. We had practically all the built-in abort options provided for the Apollo program available to Apollo 8. Of course, there was no operational experience with this sort of flight profile but the Delta-Vee reserve for contingencies was there. From our point of view, the risk difference between a

Saturn V launch to Earth orbit and to go from there on to the Moon was a relatively small thing.

We had a very good session there in Huntsville, and we thought the Houston people had a good and convincing story: The LM wasn't ready. We were up against the choice of waiting at least until February '69 to fly Apollo 8 through what later became the....

[**57**]

Wernher von Braun and Rocco Petrone, director of launch operations, talk during a lull in the preparations of a Saturn I vehicle launch at Cape Kennedy's Launch complex 37 Control Center on May 25, 1965. (NASA Photo, available on NASA Image Exchange: http://nix.nasa.gov.)

....Apollo 9 profile, or flying Apollo 8 without LM around the Moon. Of course, after we at Marshall had endorsed Houston's plan, the much more difficult problem was to convince our doubting bosses in far-away Vienna. Jim Webb and George Mueller must have figured that no sooner had they left Washington that we were trying to tell them by remote control how to run NASA.

Interview #2

Could you compare Russian boosters and their concept with the American system, the NASA system, and make some comments as to why the Saturn hardware was more successful, or why we got to the Moon first . . .

This is a very involved question. I think that the Russian launch vehicles have already proven to be quite reliable . . .

[**58**] There is probably less competition in the Soviet launch vehicle program than in this country. The relationship between the space people, the space program people, and the Soviet Union, and the rocket people, is probably best compared with the relationship we have between these two groups in this country during the Gemini program where, as you will remember, NASA built spacecraft but went to the Air Force to request Titan II launch services for Gemini spacecraft.

The launching itself of Gemini spacecraft was done largely by blue-suiters. And it was only in the Apollo program that we brought a launch vehicle into the process that had no military history at all. Remember, even the Mercury used Atlas launch vehicles, and the Redstone rocket preceded Atlas very early-Alan Shepard's and Gus Grissom's flights had a military history.

The Saturn V was really the first launch rocket that was a baby of NASA and not the military-a military child.

Now the entire family of Soviet launch vehicles up to this point was really developed under military auspices. They have the so-called Strategic Rocket Command in the Soviet Union, comparable to our Strategic Air Command, and they are really the sole owners of rocketry, you might say. And the space people go to them for booster service, just like NASA went to the Air Force for Atlases and Geminis.

The industrial complex-if that's what you want to call it-state-controlled economy-undoubtedly doesn't have as many facets as the American aerospace industry. In other words, they don't have their Boeings, and North American Rockwells, and Douglases, and so forth, to build competing systems. But it was, and I believe still is, a more monolithic operation.

With that I am not saying there's no competition at all. I think there's every indication that within that monolithic industrial structure there are some competing teams. You see that in their aviation industry . . .

Nevertheless, I think it is far more monolithic-and that also means that, shall we say, there are less checks and balances in this. In NASA, you could always tell

the Boeing people, "Look, the Douglas people brought something in here which, in our opinion, [**59**] greatly enhanced the liability of something," and vice versa. So the government was in the fortunate position that it could effectively cross-feed ideas that came out of these various pots.

When you have a very monolithic organization, that is one, shall we say, like a military establishment, you have less and less of that. There is, at the end, one man responsible for all these things. You know, the Russians always mysteriously refer to "the chief constructor," or "the chief engineer," whoever that man is . . .

We have never run the Saturn V program like that in NASA. I think we considered ourselves far more like a stock exchange of good ideas where we felt we picked the best things out of all these things and cross-fed them for maximum benefit of the whole.