ORAL HISTORY 6 TRANSCRIPT

GLYNN S. LUNNEY
INTERVIEWED BY ROY NEAL
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NEAL: And I'm going to give you a little voice slate right at the top. This is Roy Neal. We're speaking from the third floor of the old Mission Control, Building 30 at the Johnson Space Center [Houston, Texas]. Our guest is Glynn Lunney, G-l-y-n-n L-u-n-n-e-y. And if I misspelled it, he'd wince; so I know that that was the correct spelling.

LUNNEY: That's right.

NEAL: And we are literally sitting just a few feet away from a place where you once wrote a lot of history, Glynn. So, let's dive into that history if we can. As we ended our first interview, you had just discussed Apollo 13 in quite some detail. So, now we'd like to start by going into the other Apollo missions, and then we'll move on to Apollo-Soyuz [Test-Project (ASTP)] and Skylab, if you want to. Or we can go into Space Station. But we'll get to those things one small step at a time. So, let's begin with the other Apollo missions. [Apollo] 7 was the first manned flight, and it came after the Apollo 1 [AS-204] fire. Was there any warning that Apollo, before that fire, perhaps was an accident waiting to happen? Did anybody really catch up to the facts of life in the program?

LUNNEY: Well, there's sort of two backgrounds for your question. One is—one is, we were running that test in, you know, about 15 pounds per square inch—psi, of pure oxygen. And frankly, I think we had been somewhat lulled into a sense of security, or at least a sense of not quite so hazardous on the subject of pure oxygen because of the Gemini experience. We had done it over and over again on the pad in Gemini, and we just hadn't run into any kind of problem. And because I think we didn't recognize it for the hazard that it really was, there was also a commensurate lack of attention to the flammable materials in the cockpit. And those things combined with a electrical short of some kind—that is, an ignition source—to give us the fire that we had on Apollo. And in retrospect, it was in front of us; and there it was. And, it—it just had something we had gotten used to and didn't recognize it for the danger that it was.

NEAL: I'm tempted to ask, Glynn: Why was the spacecraft designed to take pure oxygen at 15 psi? That's a heavy concentration.

LUNNEY: Well, it was just—15 psi was just a few tenths of a pound above ambient. And the idea was to keep the spacecraft at an ambient pressure so you won't get any leaks in from the outside, but rather that it was slightly above the ambient pressure of the—of the outside world. But it was pure oxygen, as we had flown in the Gemini Program, and that is what really produced the environment in which a combination of an ignition source, like a spark, and then some flammable material, and in that kind of environment, it just burned like crazy.

NEAL: But in flying in space at that time, didn't the pressure go down to about 5 psi?

LUNNEY: Oh yes. Once in space, the spacecraft were, both the Gemini and the Apollo—were designed to fly at about 5 psi, about one-third of what it was on the launch pad. So, the risk was diminished in flight, but nevertheless still there. It was still 100% pure oxygen. But—but at 5 pounds, it's—it's less dangerous than it is at 15.

NEAL: I guess the point I was driving at is, the risk was greatest on the launch pad at that time.

LUNNEY: The risk was great right on the launch pad, where—that would be the place where we would see the maximum pressure of oxygen, the maximum pressure being an indication of quantity, if you will; how much quantity of oxygen, pure O_2, was in the cabin. Some people, I believe, had been concerned about that. I recall some discussion that said North American Aviation had—identified that as something to be concerned about. But it never did seem to get, you know, total visibility as the kind of hazard that—it really was. And it came and bit us.

The other context for your question, that I thought you might be getting at, is that: In building the Apollo spacecraft, the early ones had a lot of difficulty in the test phase. I mean, it was a—it was a new contractor, North American Aviation. He was building a very advanced spacecraft for the time. And I remember a lot of the tests that were conducted were difficult in the—in that things would go wrong, the test would have to hold, the crews would get frustrated, and so on. And there was a bit of that kind of environment also.

And the problem with that is that it induces people to try to solve the problems and get on with it. And, therefore, they probably did not want to spend too much time or consider all the other risks that might not have been identified; such as the pure O_2 environment. And it just wasn't dealt with as a real hazardous condition.

NEAL: Must we, as we look back, think of the Apollo as a similar spacecraft to the Gemini or the Mercury? It wasn't really, was it?

LUNNEY: Oh no. It was—quite advanced. We used—of course, it was much bigger all around. But we used fuel—well, we had fuel cells. I take it back. We had fuel cells in the Gemini spacecraft. But it [Apollo] was considerably bigger. All of the systems that it had onboard were larger, a bigger capacity. It had three crewmembers. And so on. Designed to do something entirely different than the Gemini spacecraft was designed to do. And—therefore, it represented a big step up for us.

I would say one other thing about the Apollo spacecraft, especially the command service module [CSM]. When we flew Gemini, if you remember, we went through flights where we had just multiple problems. We had problems with the—fuel cells liked to flood. I don't know if you remember that, but the fuel cells would kind of back up a little bit and start taking water. And we were always on the verge of having a problem with our power supply with those fuel cells. We also had a lot of problems with thrusters in that they would clog and—the combustion chamber and the igniters would clog, and then we wouldn't have—we'd have to shut a couple of them down. Usually, I can't recall the statistics, but on Gemini flights, we generally lost thrusters—several, certainly in the early flights, on each flight.

When we got to Apollo, for example, the point is that those systems worked very well. I mean, we didn't have much in the way of a fuel cell problems. We didn't have much in the way of thruster problems. We didn't have any problem with the big engine, the service propulsion system [SPS]. It was a model of reliability. So, besides the larger scale and the more complexity that was built into the Apollo spacecraft, I think the industry in the country had made a significant step up in terms of building high—a better quality from the lessons that were learned in Gemini and the general maturing that was going on in space hardware throughout the industry in the country. We really benefited from quite an improved reliability and operability of the Apollo spacecraft. But in the beginning, you know, the first few articles—when they were trying to take those through the test phases—it was difficult for people. It was difficult.

NEAL: Is that why Gus [Virgil I.] Grissom felt—what did he say? "This is a lemon." Something like that?

LUNNEY: Yes, there's a story—

NEAL: The—crew were very—

LUNNEY: ——there's a story that at one point Gus hung a lemon somewhere, perhaps on the spacecraft, when he was frustrated with one of the tests. And I think that was real frustration. And it was a bit of a condition that was in the program at that time in that Apollo was a big step, a lot of complicated equipment onboard, and it was difficult to make it work first time out. Actually, in a kind of a way that's sad, the Apollo fire probably contributed to not only the time, but perhaps a renewed sense of attention. And I don't mean to say that people weren't paying attention before. But a different kind of attention, perhaps, was applied to the Apollo spacecraft hardware. And it paid off. It paid off in that during the Apollo flights, Earth orbit, and going to the Moon, for the most part—except for Apollo 13—for the most part, the command service module performed extremely well.

NEAL: I've heard it said that the Apollo 1 fire, in a very peculiar way, actually had to happen before the Apollo spacecraft and the space program could go ahead. That it was an accident waiting to happen—

LUNNEY: Well,—

NEAL: —because nobody really saw that it was there. From an engineer's point of view, would you go along with that?

LUNNEY: I think—I don't know that it had to happen for Apollo to go forward. But, it was there; and it was just not paid—it just didn't pay enough attention to it. I don't know if I can say "overlooked," because I'm sure somewhere in the system people paid some attention to it and were concerned about it. But the flammability risk was there and just was not treated as significantly as it—nowhere near as significantly, I don't think, as a number of the other risks that were inherent in the program.

NEAL: It took about a year to redesign and rebuild that spacecraft. That's a remarkably short time, isn't it?

LUNNEY: It really is. When you go back and look at it: January '67 was the fire, and then in about October of '68 we flew the Apollo 7 mission. And that included not only an awful lot of redesign, but it also included then getting the—getting that redesign put into the spacecraft and getting the spacecraft ready to fly, shipped to the Cape [Canaveral, Florida], going through the checkout, and so on. So that's, what? Close to 20 months, 21 months. But the truth is, the redesign was probably done in half that time. And then the rest of the time was spent getting that redesign built into the spacecraft and tested.

NEAL: Was there any pressure, other than among yourselves, to get that job done as rapidly as it was done?

LUNNEY: The recovery from the fire that is?

NEAL: Yeah. To get that spacecraft redesigned, redeveloped, built?

LUNNEY: Well, if you remember at the time, we had the goal of landing on the Moon before the decade was out, and the fire in 1967 was running us pretty close, because we were experiencing a severe setback with the fire. And there wasn't that much time left between then and the end of the decade. So, I would say that people put—I don't want to—I don't know if I'd call it "heroic," but let's use that word—a heroic effort into the recovery from the fire and getting the program back on track. I think that was true, certainly, in the command service module—in the command module [CM], where we had the fire. But I think it permeated the rest of the system.

I think it permeated the lunar module [LM], because a lot of the things then changed in the lunar module. It also permeated, I think, the launch vehicle development program, the software, the ground systems. People just came back to work with a renewed sense of dedication and kind of a, "I don't want that to happen again, and I certainly don't want it to happen in the area that I'm working on, that I'm responsible for." So, I think a tremendous amount of rededication went on during those months after the fire.

At first it was probably strongly flavored by guilt. I think everybody felt like that, "Gee, there might've been something that I personally could've done to have avoided that." I think people felt that throughout the program. And then they gradually turned that guilt into a pressure, a motivation, to get things done not only correctly but even better than they had been done before. And it turned out to be a very powerful motivating factor.

I don't know if we talked about this the last time, but Frank [F.] Borman, I think, performed a tremendous service for the program. Somehow or another, and I don't know who made the selection, he was selected as the lead astronaut to work with North American Aviation in the recovery from the accident, from the fire. And Frank probably had several problems, but I imagine that there was a tremendous sense of emotional down at Downey [California, the North American facility], where the spacecraft were built. A tremendous sense of guilt, if that's the right word, or at least responsibility for what had happened. And I think people there first had to go through a kind of a healing or a recovery process in terms of their own recovery from the events of the fire.

But once through that, probably measured in a couple of months, people were just that much more high energy when they came back to work on all of the things that had to be done to get the spacecraft ready. Recognizing that the clock was ticking on the ’60s, and recognizing that our competitor, the Soviet Union, was still active and doing things that we didn’t all understand what they were but he was continuing to apparently press the issue of competition of getting to the Moon. And later on, of course, he started to fly the unmanned vehicles; and I guess they had some setbacks in their manned program, certainly with the large rocket that they were trying to build. But a lot of that was kind of unknown to us. So, we just felt this continued pressure from the competition in a sense that they were continuing to press on, and we had better get it right. And we’d better get it on track.

NEAL: Brings to mind the fact that there definitively was a race for space at that time.

LUNNEY: Yes.

NEAL: We, the media, tended to downplay that somewhat. We kept it up, of course; but basically we didn’t know that much about what the Russians were doing anyway.

LUNNEY: That’s true.

NEAL: They’d just do something, and we knew what was going on here. So we, to a great degree, tended to say, “Okay, NASA’s doing this,” and ignore what the Russians were doing. Until they had done it.

LUNNEY: Right.

NEAL: When, of course, is a bad time to have big news come to the fore. They went through, however, the failure of their big booster. They lost not one but two crews during a key period of time.

LUNNEY: Right.

NEAL: And there were decisions, which I'd like to get to in a couple of minutes, made by NASA, which generated the resurgence of the Apollo Program—

LUNNEY: Right.

NEAL: —and eventually—you won the race.

LUNNEY: Right. Right.

NEAL: So, let's get to that; and, as we move along—.

LUNNEY: And I think it was real. We felt it, and we were in the same boat that you were. We were not privy, most of the folks here were not privy, to any intelligence briefings as to what was going on. If indeed there even were some, and I have heard that there had been but I don't—I can't attest to that. But we had this sense of a big competitor who was continuing to do things; and sometimes they did things which seemed to us were a little hard to figure out, why they did them and so on. But nevertheless, they were continuing to press it. And we felt very much like we were in a race, a competition. And our competitor had the advantage of being somewhat shrouded in secrecy. That's also a disadvantage, we've come to learn. But that left us always feeling like he was ahead of us or breathing down our neck if we were ahead at any particular time. So, there was not a leeway, not any slack, in the sense of feeling any relief in that competition. It was there all the time. And I don't know that it was the first thing people thought of when they woke up in the morning, but it was an environmental background for us; and it was very real.

NEAL: Against that background, along came Apollo 7. And here came Commander Walter M. ["Wally"]…Schirra along with his crew. And they started getting the spacecraft prepared. You were lead flight director for that mission.

LUNNEY: Yes, I was.

NEAL: So, can we relive some of the preparation stage, right now, before the launch? Living through that phase when Wally was working with the spacecraft, and his crew were working with the spacecraft? And what you and your flight directors were doing with Mission Control to make it all happen?

LUNNEY: Yes. I think Wally was carrying a significant sense of wanting to get it done right based on—he had been backup to Gus's crew at the time of the fire. And I think that was a very powerful influence on all of us. But it was especially powerful, I think, for Wally because of his position as backup crew commander to the first one. And he was very tough about the acceptability of anything in the program. He was very tough about how the spacecraft was handled. He was very tough about the tests that were conducted. I remember—not the details of, but some times when, in the testing at the Cape, he objected to the way things were going in no uncertain terms—as Wally could do very well—and caused the testing to be redone, reshaped, modified, whatever. But he was very tough about that.

He also found himself in the position—and he talked to me about this one time—he found himself in a position where individual subsystem people would want something done and would be promoting it. Parachutes for example. Well, parachutes also had an interaction with the reaction control system, in that there was a certain amount of thruster firing and dumping going on the top of that while the parachutes were engaged. But Wally found himself in the position of engaging single—what we would call today in political terms "single interest group." Just a parachute concern when, indeed, he was trying to deal with a flying concern where he had to meld not only what he had to do—what had to be done with the parachute, but also what had to be done with the thruster system so that the parachute would not be impinged upon in any way by the reaction control system.

So, Wally felt like he was dealing with—as we in the flight business also felt—dealing with the total problem, and he was getting approached by these individual single-interest groups that might want to do something that, when viewed in the context of the total problem, might not be such a good idea. So, he found himself getting pressed here and there, and—but he had a way of just backing out of that and not dealing with it at the single-interest level but rather at the total mission level, and therefore, in many cases, won his argument.

NEAL: I'd heard it said that during this era—and perhaps best exemplified by the next flight up—which, if you remember, with Apollo 8 was a different ballgame entirely—but I've heard it said that one of the things that was happening was a transition between the responsibility for safety by the crew as opposed to the engineering groups that were concerned with Apollo.

LUNNEY: Well—

NEAL: Would that be a fair statement or not?

LUNNEY: ——well, I think—I mean, I think it's fair to say that everybody—safety is everybody's problem. And I think, in the flight business especially, people know that going in. I think the accident, though, the fire, caused the crews to be more vocal about concerns that they might have had in—prior to the fire but not as—expressed as—perhaps as strongly as they would have expressed them afterwards. So, I think the program saw a rededication, also, and a—more of an inclination to be vocal about things that the crews would view as a safety concern.

So, I think it was there all along. I mean, I think both the people on the ground, the engineering teams, the designers, the safety and reliability people, all tried to do the best they could at—before, and during, and afterwards. And I think what we saw, also, was that the crew became more vocal and more willing to jump into a subject and rattle it around in order to be sure that they were satisfied. But they didn't—frankly, that's a very healthy thing. I mean to experience.

NEAL: Some of that took place during the flight.

LUNNEY: Oh yes.

NEAL: On open air-to-ground.

LUNNEY: Oh yes.

NEAL: So, the world shared your problem, as the flight director—

LUNNEY: Yes.

NEAL: —with the crew as you were wrangling these problems back and forth.

LUNNEY: Yes, Yes.

NEAL: And I wonder what effect, if any, that had on the way in which that flight was flown.

LUNNEY: Well, I don't—in the end, I don't think it had any effect on the flight itself in terms of the accomplishments and what we were trying to do. I think it was unfortunate in that it left a kind of a sour taste in people's mouth. And certainly—certainly there's a way to make a point, especially when you're in public—or, in this case, in front of the whole world—there's a way to make a point that's less confrontational than some of the means that were chosen. But, you know, we are who we are, and we do what we think we have to do at the time. And, so I've sort of mellowed about it a little bit. But it was difficult at the time.

Didn't affect the mission. Didn't affect what we were trying to do, I don't believe. But it was an irritant. It was more than an irritant. It was a major annoyance and difficulty, and I mean it's like a marriage. When people get to shouting at each other, then the communications is really not what it ought to be and something is going to suffer for that, one way or another. In our case, none of the mission parameters suffered. But there was a kind of an emotional feeling to it that was unfortunate.

NEAL: The fact the crew had a bad cold—all of them, collectively—had something to do with that, too, didn't it?

LUNNEY: Yeah, it probably did.

NEAL: You had some of that here in Mission Control, I've heard.

LUNNEY: Probably did. Yeah.

NEAL: Some of your flight controllers had caught the same bug at about the same time.

LUNNEY: Yes. Well, that was an effect, I think, that caused them to be upset. So—.

NEAL: Did you learn anything from those problems that affected future missions and the ways in which they were trained, simulated?

LUNNEY: I don't think we did anything in a procedural sense to change anything. But if Apollo 7 could be viewed as a kind of a schism that was opened up between the air crews and the ground crews, I think the follow-on crews, starting with Apollo 8 and then on, fixed that problem by their performance and the way in which they cooperated with it all around—both prior to flights and during flights and so. So—and I think that got healed on the next flight, for example. And most of them felt like this was too important to let emotional baggage be a problem of any kind. We had to depend too much on each other; and, therefore, they worked very hard, I think. And, I mean, you followed the other flights, the follow-on flights. And the performance of the crews and the interaction with the ground was exactly as it had been in the past. So, in that sense, Apollo 7 was a bit of an anomaly on the front of the interaction between the ground and the air crews.

NEAL: Well, your next commander was [James A.] McDivitt.

LUNNEY: No, it was—

NEAL: No, it wasn't.

LUNNEY: ——it was Frank [Borman].

NEAL: The next was up to the Moon.

LUNNEY: Yes. Frank Borman.

NEAL: Perhaps the most daring choice of them all.

LUNNEY: Yes.

NEAL: Let me—let me get into that—

LUNNEY: Okay.

NEAL: —then, because now—now we are into a real ballgame. Here you had just had this troublesome flight, but it worked perfectly.

LUNNEY: Yes.

NEAL: As a matter of fact, I think Wally Schirra said, "We were 110% successful."

LUNNEY: I think we quoted that after the flight.

NEAL: Yes.

LUNNEY: I think we did.

NEAL: So, now you've had this tremendously successful event. And at that point, can you scene set as to the way in which the decision was made on Apollo 8 to go to the Moon, and the influencing factors?

LUNNEY: Yes. Let's see. Let me first say that I was not involved in that decision, and it was being done behind closed doors—the decision was being made behind closed doors. And I personally, to this day, don't know who all had what idea first. However, my sense is that George [M.] Low was a very key player. He was the Apollo Spacecraft Program Manager at the time. He was a very key player in that. And he may have been the person who initiated it. But—and—if he—and if it were not him, I expect that it was [Christopher C.] Kraft [Jr.]. But I'm not sure of that.

But when they came out behind closed doors, those two guys and everybody else in the management team were together on it. And I've forgotten whether I learned about it immediately before Apollo 7 or immediately afterwards. But when you thought about the stage of the program, we had the lunar module was kind of lagging. It was not quite ready to fly, and it was kind of off a couple of months into the future. We'd had the Saturn V flight, the unmanned—the second unmanned Saturn V called "[AS-]502", and it didn't go exactly right, we had some pogo, we had some engine shutdown early and so on. So, it was a problem. We did, however, have a command service module that, after a thorough review, was judged to be capable of going to the Moon.

So, we were in the position of kind of, "Well, we can repeat another Earth orbital flight. Or we can do something significantly different than that." And for most of us in the program, I think when we first heard—and certainly my reaction, and I heard about it from Cliff [Clifford E.] Charlesworth, my dear friend who was the lead flight director for Apollo 8—I heard about it from Cliff, either immediately before or immediately after the flight, I'm not sure which. But, at first it was kind of a shock. Say, "Wow! The second flight we're going to get on that Saturn V and go to the Moon!" And then the more you thought about it, it seemed like exactly the right step—given all the circumstances that existed in the program.

We had a Saturn V that we were going to have to fly. We had a command service module that was ready. There was a lot we didn't know about going to the Moon and getting back. On the other hand, we probably knew all we were going to do, short of going and doing it. So, we had all those kind of elements in the stew; and out of that came this, what I think was an absolute stroke of genius. And I wish I knew exactly who to attribute it to. But a stroke of genius on the part, I believe, of George Low and, in association with him, Chris in some way, that resulted in that mission being defined and brought forward.

The Saturn V. It was interesting to think about it. Sooner or later we were going to put people on top of the Saturn V. And the problem that we had on the previous flight, the unmanned flight, was at least—we didn't solve the problem. We sort of made it go away by a plan to shut the center engine down early, which got away from the pogo concern. We had five engines on the second stage. The middle one, the center engine, got to vibrating on the previous flight, but very late in the burn time of that stage. So, the idea was, "Well, why don't we just shut it down a little before we came to the time when that's a problem?" And time was significant, because all the weights were changing as you used the fuel to propel—.

NEAL: You know, I think we should pause for a moment to explain what a pogo effect is.

LUNNEY: Oh.

NEAL: There might be those that don't know.

LUNNEY: Pogo. Glynn has a kind of a layman's view of pogo, too. But the—what happened is, under certain conditions of engine thrust and the weights that existed in the stage and the flow through the lines—it's a little bit like the soldiers marching across a bridge in cadence. We learned not to do that, too, because it's hard on bridges and the people who fall down when they do! And stages could get to vibrating up and down, mostly longitudinally, and really destroy themselves. And in this case, the engine, as it was mounted to this frame in the center, the combination of conditions late in the flight—in terms of flow rates, mostly the weight that was left on the stage—were such that this center engine started to behave in this way where it was beginning to oscillate, called pogo. And it was defensible by simply shutting it down early, not getting into that. And by early I don't recall the exact numbers, but it was 10 or 20 or 30 seconds, perhaps, earlier than it otherwise would have been shut down. And then the other four engines just continued to burn the propellant, and we got the same amount of energy out of the stage that we otherwise would've gotten. We just got to it a little more slowly than we otherwise would.

So, at any rate, the point I was going to try to make is, once you decide you're going to get on a Saturn V—and this fix allowed us to consider that and avoid the problem that pogo brought to the table, rather than solve it, it was avoided—you're going to take it somewhere. You have to take it at least to Earth orbit. And then if you're going to burn the last stage, relight it, restart it in orbit, and burn it again—which you should do, because that's the way the mission sequence has to be to go to the Moon—you can either point it where you want to ultimately go, that is, to the Moon, or you could—you fire it out of plane or crossways or in some way that would not affect the orbit very much, and you'd end up still in Earth orbit. And from a—from the risk that you run when you operate a big rocket system like that, you're taking all the risk to do that as you would to take it to the Moon. All the risk from a launch vehicle point of view.

There's a new set of risk now for the spacecraft, but those got addressed separately; and the work that had been done in planning for the eventual lunar missions was all brought forward. And it was done well enough so that we could bring that work forward and be confident that we knew all that we could know going into the lunar sequence, the lunar flight sequence, the lunar orbit sequence. And all we had to add to that was whatever we were going to learn when we finally got around to doing it. So, the decision made a lot of sense to me. You're going to get on the Saturn V and fly it, and you can fly it sort of around and around and not go anywhere or you can fly it to where it's going or where you want it to go; that is, to the Moon. Either way, while you're flying around and around in that thing, you're taking as much risk as you are in terms of taking it to the Moon. So to me, it made a lot of sense. Especially with the state of planning for the lunar trajectories and the state of testing, qualification, and confidence that we had in the Apollo spacecraft that it could go do that.

NEAL: It's a duality here in my mind, at least. You know, the idea of that space race, well, for which this was certainly a tremendous step forward—

LUNNEY: Yes.

NEAL: —and the practical side of the house, which you've just explained very carefully as being a thoroughly practical mission, even though it seemed like a daring gamble at the time.

LUNNEY: Very. Well, that's why I think—I call it "a stroke of genius," which to me usually means someone comes up with a solution that really fixes a whole bunch of problems that everybody's worried about but they didn't know how to put it together and come to the solution. The solution came as the right answer to the conditions that existed within the Apollo Program. Now, I have heard and read various accounts, and maybe speculation, that there was some intelligence information about what the Soviets were doing that might've played a part in that decision. I have no knowledge—no personal knowledge of that and I don't know whether that was true or not. Nobody ever explained it to me, which was fine. I didn't necessarily feel like I needed to know that kind of stuff.

But just on its merits, within the program, it was almost immediately embraced by people after, you know, an initial reaction. Embraced in the sense that, "Boy, that seems like the right answer! Why didn't I think of that? It just fits everything that we have, solves it, and takes us a great big step forward! Rather than just tooling around and around in some other kind of a mission, it goes out and addresses a whole bunch of problems that we're going to have to learn how to solve and deal with before we ever do get to land." So, that was a—I think it was a breakthrough, genius class of decision.

NEAL: Right now, Glynn, we're sitting in a room that's filled with ghosts and memories. And I imagine one of the memories that's contained within this room that must be still in your mind would be the thought as first that spacecraft came around from the far side of the Moon.

LUNNEY: Yes. Yes.

NEAL: Can you go through that for us?

LUNNEY: Yes. I—as a matter of fact, I was on for that shift. We had all this strange nomenclature called "lunar orbit insertion [LOI]," and I was on for the lunar orbit insertion team where we had to use the service propulsion engine. And let me back up a little bit and tell you a story about getting to there during the course of the flight.

Early on in the flight, because we were going to use—because we were going to be so dependent on the service propulsion system to take us into orbit and take us especially back out of orbit at the Moon, we had planned a test firing—a small burn, of the service propulsion system—soon after we got on our way to the Moon. And I don't recall the exact details of it; but, as I remember, it had to be done kind of early and there wasn't too much opportunity to do it later. We would've perturbed the trajectory; that is, the trajectory that had us aimed for going into the orbit that we wanted around the Moon. And so, we had this test planned. And it was several seconds long, what we were going to, in effect, almost burp the service propulsion system, the main engine that we were going to use at the Moon. And we were doing that as a confidence thing, that we were going to be sure that it had—that the engine was behaving and it was going to be okay. Well, as luck would have it, the test did not go as expected.

There had been a significant amount of helium absorbed, or something, into the propellant. And at any rate, the chamber pressure measurements did not look normal. And I was on duty at that time. This was back right after we had put the vehicle on the coast out to the Moon and we'd performed this test. So, we were stuck with this quandary of, "Gee, we put this test in here to be sure the service propulsion system's working right and, lo and behold, it's really not working exactly right." And it wasn't anything obvious that we, as flight controllers or as—users and operators of the system could see that would tell us that.

But there was a man from North American Aviation named Harry Galinas, who was the subsystem manager for the service propulsion system. He came in and sat down here at this console and explained to me that, in the loading process at the Cape, which he was present for, there was some set of conditions that he observed that would explain the reasons why the chamber pressure didn't come up all the way to what we expected it to be. And in his mind, he was completely satisfied that that was explainable and that it was now, in effect, going out of the system. It had passed through—the gas had passed through the system—and the system was going to work fine.

And about the time I was dealing with this, at the console, was when we got a tape recording sent down to the Control Center and—with instructions from the crew, or suggestions from the crew, to go look at it and listen to it. Well, that was when somebody had gotten sick onboard. Well, what was interesting for me is that everybody else, all the management, [Dr. Charles A.] Chuck Berry and—on the surgeon side, all of our management went off to work on this problem of somebody being sick up onboard. And I was sitting there with this service propulsion system that, if we were going to do something about, we had to do it fast. That is, if we wanted to do another test, we had to do it real quickly. And I ended up being convinced by Harry Galinas that the service propulsion system was really okay. The gas had passed through and it was fine. It was just as good as it always was to do the mission to the Moon. So, I was there and decided that the story held together. We had a number of other opinions thrown into it to validate it. But Harry was the key player, and convinced me that the engine was going to be okay.

So then, several days later, I was on duty for the lunar orbit insertion. And we'd been through all kind of planning for, "What do we do if we get no burn, partial burn, this kind of burn, that kind of burn, this kind of condition?" and so on. And we'd been through a lot of simulations with the crew in terms of testing all that. We'd been through a lot of mission rules about how much redundancy we wanted in the spacecraft—basically, all of it—to go into the lunar orbit because we, of course, had to come back out. And that—for me, the background for the lunar orbit was that this problem that we had worked and dispositioned as being okay, back here three days before, right after we left Earth orbit. And we came to the Moon convinced that the service propulsion system was going to do fine.

And what we used to do in the room was calculate the time. In other words, if no—the time of reappearance on the other side of the Moon. So, if it went in on the left side, we had a variety of calculations set. If there's no burn at all, it's going to come out fast and it'll be at this time. And if we have a successful burn, it's going to come out at this time. And somewhere in between would be less than successful. But we knew exactly what the times were for each condition; that is, no burn at all or a completely successful burn.

And for us, it felt a little bit like a countdown to the time. Because clearly, there was no signal from the spacecraft for—for no—at the time that would go with no burn at all. So, it became increasingly apparent that we had indeed made the burn; and then as we got closer to the time that would go with the nominal burn, it felt more and more confident. I felt a little more confident that, indeed, the burn had gone well and was on track. And then, indeed, the crew came around the corner telling us about that. And we could tell from the time we picked up the signal that the burn had gone very well. But they came back and gave us a report about how well it had gone, and so on and so on. And a big sense of relief. But not—[Recording interrupted.]

NEAL: And as we pick up again, Glynn, you had just achieved lunar orbit. What an achievement!

LUNNEY: Yes, it was. And a tremendous sense of, "Wow! We've really got here." But overshadowing it all was the sense that in, whatever it was, 20 hours or so, we were going to have to do it again and get on our way home. So, it isn't like just getting to lunar orbit, you know, was home free. It wasn't like that. It was like we had this big shadow hanging over our head about, "The engines have got to work again. We've got to come on back," and so on and so on. But nevertheless, being in lunar orbit first time: a tremendous sense of accomplishment for this team.

A tremendous sense of being there. And the whole period, 20 something—I think it was 10 orbits, wasn't it? 20 hours or so that we were in lunar orbit—went by very quickly. But Christmas Eve the crew came around the corner, did their reading from Genesis [in the Bible]. I mean, it just seemed to me that it was a perfect choice of commentary, if that's the right word. But a perfect choice of material to use in the kind of an environment we were in, Christmas Eve. I mean, it was just—I don't know how those guys thought of it. But I have to admire that as another stroke of genius. And it had a powerful effect in the Control Center here. I mean, people felt genuinely moved by the reading; genuinely moved by it. And a sense of, as that would conjure up a sense of thanksgiving of sorts for the fact that we had been looked after. We had been looked after. And that things were going well, and they gave every indication that they were going to continue to go well, etc. But a great deal of comfort in how that lunar orbit period played out.

And then the crew's comments about the Moon, and their comments about the Earth. And the Earthrise coming from behind the Moon. All of those were just—it's kind of an emotional things that were almost like we had been planning for it, not exactly in this form, but we'd been planning for it in our minds. But perhaps more importantly, in our guts, in our heart, for 10 years. Not quite but almost. The best part of that decade. And have everybody involved knew what kind of blood, sweat, and tears had gone into getting there. And it was like, it came out just perfect. I mean, it was like we had reached it. And, of course then, the rest of the Apollo 8 flight went by the book. The propulsion system was used again 20 hours later for the transearth injection [TEI]. A couple of midcourses [correction burns] on the way back, and a close to target point landing. And the sense that I had was that it was the turning point in Apollo.

It was—once we had done that, yes, we needed to get the lunar module. Yes, we needed to get it. Yes, we needed to get the descent done. And so on, and so on. But it was like we were going downhill. In other words, we had—we had gotten over this thing about getting to the Moon, and now we were going back with another piece of space hardware, called the lunar module. And we were going to be able to do—we were eventually going to be able to do the landing. It turned out to be on Apollo 11, after another rehearsal on Apollo 10.

But Apollo 8 was kind of, one—just a stroke of genius to—for the decision to run that kind of mission. And then it just felt—to a lot of the people in the program, certainly to me, it felt like it was the breakthrough or the gate opener or the part where we started to slide downhill to what we could foresee as the potential for the lunar landing mission to occur well within the decade that we had been struggling hard—so hard for, for so many years.

NEAL: Practically a textbook mission. Except for one thing that you mentioned a few moments ago. One of the crew was definitely uncomfortable, shall we say? What was it? Motion sickness?

LUNNEY: Well, I think we found, since that time, that there's something—it's not—it's like motion sickness, I guess is the closest thing that we would relate it to on Earth. But there's a sense of stomach awareness and perhaps even going beyond that, that people experience when they're just released from any of the gravity. They get sensitive to how quickly they turn their head, and so on; and they—and that can induce a sickness. And so, the closest thing we have to it that we can talk about and experience is motion sickness. You know, when you're on a boat or something.

But it's real for crews. And the problem that we had had was, we hadn't experienced. I didn't know that we'd experience any. We may've experienced some in Gemini, but I didn't know that we had. And if we had, the crews didn't say anything about it. And—but the Mercury spacecraft and the Gemini spacecraft were physically very, very constrained. The crews were, in effect, strapped into a couch the whole time they flew, and there was not a sense of floating around. I mean, the seats and the cockpits were such that there just wasn't a sense of that.

Then we got them into this Apollo volume, which was fairly large, where they could, indeed, float around and so on and so on. And I think it was that, that all of a sudden made us more sensitive to it. And I don't know the exact numbers, but I suspect that some fairly significant percentage of people continue to be affected by it today. I mean, the docs have struggled with countermeasures and so on and so on. And they've probably done some good with it, but I think people still experience it. It's just such a different kind of environment for the body.

NEAL: In the Shuttles, where there's lots of room, to float around, they experience it.

LUNNEY: Lots of room up there, yeah. And—but it was our first tripping over it in flight, especially when the crew called down and asked us to pay some special attention to what's on the recorder. And the fact that they reported it indicated that it was significant to them. And so, off we went beginning to learn that, indeed, some of these things could happen to even our most fearless, toughest fighter pilots that we could find.

NEAL: That's what's really amazing, that—

LUNNEY: Yes.

NEAL: —they're pilots!

LUNNEY: And of course, they were. And—but it shows the human body can be affected by things, and we're all subject to some of that.

NEAL: Along then after this marvelous and spectacular mission came Apollo 9. And essentially, this one was terribly important within the framework of Apollo. But to the public at large, it was almost ignored. It was a very quiet mission.

LUNNEY: Yes, it was. Yes, it was.

NEAL: And I—

LUNNEY: As a matter of fact, I did not work—I wasn't assigned to a shift on that flight. But it was a very significant flight for us, because it was the first time we really had a chance to operate the lunar module with the astronauts doing that. We had a previous unmanned flight of the lunar module. It was difficult, by the way, when we didn't have the pilots in. So, Apollo 9 was a necessary flight. I mean, we had to get both vehicles. We chose to keep them in Earth orbit, because it was the first time out with the lunar module. We had to get an exercise of all the systems onboard the lunar module. We wanted to be able to test the rendezvous techniques and separation, and so on and so on. And all of those got a good ring out, including the fact that it was the first time that we had people onboard the lunar module. So in effect, it was the Apollo 7—it was like an Apollo 7 for the lunar module. But it passed with flying colors.

And, yes, I would say that it probably didn't get a lot of attention. And it might've been because of Apollo 8, you know, on Christmas Eve; and then looking forward to Apollo 10 and Apollo 11, or whatever the landing sequence was going to be. So, something that we were doing in low-Earth orbit to test the command service module in conjunction with the lunar module probably didn't get the kind of attention, it didn't have quite the same pizzazz as Apollo 8 or the landing mission was eventually going to have. So, I think it was a natural sort of set of conditions that we had. But for us, it was a necessary set of conditions that had to be satisfied and fulfilled in order to get on with the job of using the lunar module out around the Moon and eventually on the Moon. It was necessary.

NEAL: I've heard it said that McDivitt, as the commander on that mission, did a marvelous job of scene setting to put the astronauts into the loop of flight control to a much higher degree than they had been before. Would that be a fair statement or not?

LUNNEY: I—

NEAL: You weren't working the mission.

LUNNEY: I don't relate to that, so I don't—I mean I don't have a sense of anything that would address that.

NEAL: Oh okay. Well, let's—let's move on then—

LUNNEY: Okay.

NEAL: —perhaps rightly so, to Apollo 10 where you had a very strong commander and a very strong crew. And basically, you were going in for a full dress rehearsal of the real thing.

LUNNEY: Right. Right.

NEAL: Where were you for Apollo 10?

LUNNEY: I was the lead flight director for Apollo 10. I had worked Apollo 7 as lead and Apollo 8 as a shift guy, and skipped 9, and then I was working Apollo 10. And what was interesting for me was that I had worked as the lead flight director for Gemini IX—Tom [Thomas P.] Stafford and Gene [Eugene A.] Cernan. And, of course, John [W.] Young was added to the Apollo 10 crew, with the three-man command module. So, I was involved in all of the planning for the Apollo 10 mission. We had the debates that you could expect like, "Well, if we're going all the way there, why don't we go ahead and land?" But it basically became a—kind of a, "How much of this rascal do you want to try to bite off at a time?" kind of a discussion.

And the descent itself and then the EVA [extravehicular activity]—the surface work—was a significant addition to all of the other things we were trying to do with the lunar module in the Apollo 10 mission, which involved all of the navigation, guidance work around the Moon, and then conducting the rendezvous exercises to be sure that that worked in the lunar environment the way we expected it to, too. So in retrospect, you know, it was the correct thing to do. But we had some debates early on about, "Well, why don't we go all the way on Apollo 10?"

NEAL: Why didn't you?

LUNNEY: The idea was that, "Let's bite off a reasonable amount here. And then let's leave the next big bite, being training for the descent and training for the surface work, as an add to the next mission. So, let's build a set of stairs here, where we don't have to skip a step." In a sense. Although we did that on Apollo 8. We skipped several steps. But, "Let's bite off the pieces that seem like we can digest them and execute them in a reasonable fashion in the time allowed. The time available. And then add the next step for the Apollo 11 mission." And that was the logic for how we got to where we got on Apollo 10.

I had a good time with it—with the flight, because I had worked, and worked well, with Gene and Tom, as I said, on Gemini IX. And we went through all the training exercises and all the what-ifs, and all the getting readys, and all the struggles with the simulations, and so on and so on. And we were comfortable. And Apollo 10 did its job. We had some exciting moments here and there, especially in lunar orbit when the vehicle kind of spun up because of a configuration problem onboard the lunar module, but that got handled fairly quickly and was settled. And it was—it basically paved the way for, then, the Apollo 11 crew to add to the inventory of what they had to know and what they had to train for. To add the descent part of it, and the surface work part of it. And I think it made Apollo 11 a little more assured and a little bit more solid for the crews to train for, and so on.

NEAL: Without overemphasizing the importance, I know when they ran into their troubles in working with the LM—"they" being, in this case, Stafford and Cernan—it sounded pretty hairy to us on the outside listening in.

LUNNEY: Yeah.

NEAL: They were even using some language that was a little unusual for astronauts.

LUNNEY: Yes. It was unusual, yes. But it—you know, that was just a reflection of the fact that they were completely surprised. And I can't remember the exact details of it, but I think what happened is: they either switched into—they probably—I think they switched into a mode that had been set up to do something that they were not expecting. It was set up to go someplace else in terms of the attitude of the vehicle. This was not affecting the trajectory of the vehicle in any way. It was affecting the attitude of the vehicle as it coasted around in lunar orbit. And they switched into this system that they thought was going to do *this*, and it turned out doing *that*. And it surprised them quite a bit. But they rather quickly got the vehicle back under control. You know, a good reaction on the part of the crew. Certainly not the—the spinning of the vehicle was not something that you wanted to propagate very long, or that in itself can induce some physical problems for people—including blacking out. But, they caught it pretty quickly and got it back under control; and we were fine.

NEAL: From the standpoint of world at large, too, we were looking over your shoulder on that mission. And for the first time, we were getting literally hours and hours of color television.

LUNNEY: Oh yes.

NEAL: They shared that whole mission with us.

LUNNEY: Yes. Yes.

NEAL: Mainly because Stafford and Cernan felt that they should.

LUNNEY: Yes. Yes.

NEAL: But did that mean anything to you here in Mission Control?

LUNNEY: You know, when we first got started with this—the television onboard the spacecraft—there were mixed views within the Control Center here, and the people in the

Control Center within the program, as to whether that would be a good thing. A lot of us started off viewing it as basically a PAO [Public Affairs Office] or a public relations kind of a thing. And to some extent, it always was that as we went through the program. But it also created a kind of a sense of us being with the crew, being in the cockpit, and we learned that we could watch something on television and not get unduly wondering about what was going on, and asking them a bunch of dumb questions that had to do with what was going on because we couldn't tell.

And it turned out to be a—I think, a tremendous add to the program all the way through to today. And I think, being able to visualize with TV what's happening upstairs and what the crews are experiencing and how they're dealing with it, just makes it a lot easier for the people here in the Control Center to interact with them. That's especially true on things like EVAs. Because it's difficult to put in words all of the things that are going on, all of the places that you are, what you're holding on to, how big it is, and so on and so on. And yet by observing that with the TV camera, you eliminate a whole bunch of sort of somewhat irrelevant, maybe dumb questions that you might—or conversations that you might otherwise be provoked to have with the crew. Because, of course, when you just have the radio, and whenever something's not being said, you just have to imagine what's going on and so on. But with the television added to the audio, you can see it. And so our sense of anxiety, if that's the right term, for how things are going is diminished because we can see how things are going, and we're not unduly alarmed.

As a matter of fact, I would say the same thing about the recovery television. For a while, we didn't have recovery television. We sat in this Control Center and it seemed like hours, you know, and we'd get this occasional radio report on what was going on [during the recovery phase]. But it just seemed like such a long time to not know how things were! Then once we started putting a television in the carriers and in the helos in the recovery area, we could see what was going on and there was no need for us to be anxious or to be asking anybody any dumb questions. We could just monitor what was going on and relax—in effect, relax about it, because we could see. And it was easy to judge progress. It was easy to judge, "Well, they're here now. So it's going to take so and so long." So, the sense of, "I don't know what's going on so I'm going to get anxious about it" kind of got taken off the page with the TV, both in the cockpit and TV on the lunar surface, of course, and TV in the recovery area. It was a big help.

NEAL: And, you know, it's funny: Apollo 8 was spectacular television. The best television was the stuff they brought back with them in terms of their still pictures.

LUNNEY: Oh yes.

NEAL: Apollo 10 really was the first pioneering effort on the part of a crew to deliver to Mission Control, and through Mission Control to the world at large the television that we saw.

LUNNEY: Yes. Yes. I would say that probably all the crews, if they—if the right timing and the right circumstances, would have stepped up to that. But in this case, Gene and Tom were naturals for it. I mean, they had a strong desire to make that available, to share it in effect. But share it for more than just sharing purposes. It actually was of help to us in the Control Center. And to provide that and to support that. Because sometimes the initial arguments about getting a television onboard the spacecraft were somewhat heated. Some people didn't want to do it at all. And once we started using it, it was hard to imagine getting along without it. Right? It was hard to imagine that. "Why could—why have we waited to so long? Why have we waited so long to get these cameras onboard? We can see what's going on!"

And today the—the folks use it—use them in a very interactive way in terms of diagnostics, troubleshooting, etc. It's even gotten to the point where they have a digital still camera that they can show very high accurate—high-definition pictures of. And all of that stuff is a tremendous assistance. As a matter of fact, today, when you envision the Space Station, and something that large with crews doing things with it—EVA or otherwise—the television is just going to make it so much easier for the ground controllers to know what the crews are doing and to appreciate it. And for them to contribute to whatever the crews are trying to do at a given point.

NEAL: Now when you say EVA, in the time of Apollo an EVA was a walk on the Moon.

LUNNEY: Yes.

NEAL: And I think we're about ready for that right now as we're coming up on Apollo 11.

LUNNEY: Yes. Apollo 11.

NEAL: So, here we go. What is your memory of that flight?

LUNNEY: Well, let's see. The sequence we were on, Cliff Charlesworth was the prime flight director for Apollo 11. And we brought a number of us over from the other missions that had been doing different things. I worked on Apollo 11 for both lunar orbit, which I had done on Apollo 8—lunar orbit insertion—and then I worked on—the other significant shift I had was for the takeoff from the Moon and the rendezvous because I had done Apollo 10, where we had done something pretty close to that. So the past couple of flights that I had participated in made those natural assignments for me. Cliff was the lead and kind of orchestrated the whole thing. Gene [Eugene F.] Kranz spent a lot of time getting ready for the descent phase, because he had kind of focused on the lunar module per se as a vehicle and was much involved with the procedures and the planning for what the descent was going to be like. So, it kind of all fell out naturally and easily for us as to what we were going to focus on for the particular flight.

But you know, today, and I must admit, I feel inadequate in terms of trying to capture for people the sense and the emotion and the feelings that we had at the time. I guess we engineers are never very good at expressing this feelings thing. But it had been such a long struggle, and with high cost—dollar cost, yes, but with other cost, including accidents, and other cost to the program, none of which was a deterrent in any way to us—but nevertheless it had—we'd paid a price over the years. But we had also had a tremendous number of achievements on all the precursor flights, precursor programs and the flights within them.

So, we were building towards this thing, sort of, all of our young life. I mean, what was I, 32 or something at the time we landed on the Moon? And we had been working on that for a long time. And it was part of our being, you know. We were going to do this thing. And we'd been through all the early difficulties. The problem that we had, also, was that things happened so quickly. We have been talking about Apollo 7 in October [1968]. Apollo 8 in December. Apollo 9, which I didn't work on [1969]. Apollo 10, May/June [1969]. Apollo 11 in July. I mean, it was like we just got through one major set of accomplishments and before we had time to savor and enjoy the accomplishment that the mission we were on represented, we were off working on the next one. So—but Apollo 11 was such a special one because it was the convergence, the endpoint, the goal, the "end game," as people—the term they use today, for what we had been involved in for so long.

And the buildup to the flight was good. Late in the series, in terms of getting ready for it, the team had found out about these alarms that—they had occurred either in a simulator or a test somewhere. So, people had begun to delve into this business of these alarms and what they might portend in terms of the performance of the guidance system. The alarms came from the guidance system, the guidance computer, and were an indication of kind of overload. It's like, "I'm getting too much work to do here, people!" And they were not very black and white in terms of, you know, a signature that—where you could absolutely conclude that this signature means "It's bad and I got to stop" or the signature is "Acceptable, and we can continue it." It was kind of murky because there were a number of circumstances that could produce them. And the frequency of them had something to do with how serious they were, too. So, in the end, the guys that worked on this problem—the lunar descent team—and all the other people around the flight software recognized that they would—they might be faced with some judgment calls as to what these alarms might be telling them. If they even occurred during the course of the flight. And, of course, they did. But I get ahead of my story.

Each step of Apollo 11, you know getting to the countdown, getting the crew in, getting to ignition, getting to Earth orbit, each one of those was like a major step on the ladder; and each one was, you know, today it feels like it was sort of inexorable. I mean, it just ground on, on its preplanned path. But at the time, there was a great deal of uncertainty and concern and anxiety about how each one of these things was going to turn out. So, we were in a constant mode of looking at everything that was displayed in this Control Center and trying to be sure that, indeed, things were going as well as all this data—telemetry data and tracking data—was telling us that it was. And sort of pins and needles, I would say.

The coast out to the Moon was fairly quiet, as they usually are. A sense of the crew sort of gathering themselves for the challenge that they had when they get to the Moon. And in general, the communications from the Control Center sort of slacked off quite a bit in those—in the coast out to the Moon. Kind of, I don't think we ever talked about it exactly, but it was kind of in deference to what had to be a "gathering oneself" kind of a thing that was going on with the crews onboard the vehicle. With the challenge to be faced at the

Moon. So, that was fairly quiet. And then some of the things that we'd already done. The lunar orbit insertion. Done that before. It went just by the book. And then we got into the descent module—again, to the lunar module for the descent phase.

By that time, all three shifts plus more of everybody that had been on this thing were here plugged into the Control Center. There's usually four jacks at each console, and we were all plugged in following it. And the descent phase to the Moon is one of major propulsion activity, so therefore it has all the risks that go with the propulsion activity. We had some abort modes, which basically amounted to if the descent engine went bad, just getting off that stage and going with the ascent engine back up. In effect, doing the rendezvous very early. But the going down to the Moon is a race against the clock because the lunar module was designed with a certain size, therefore a certain amount of propellants, and they're being used up at a seemingly great rate as we go down towards the Moon. And the idea is to get to a landing point before you—before you run those tanks dry.

Neil [A. Armstrong], of course, had to do some looking around to find a place that he was satisfied with, and frankly, I was a little bit surprised by that. Because my impression from all the discussion of where we were landing was that, "Pusht!" you know, there was nothing there and it was going to be a piece of cake. It was just a flat, sandy field. It turned out it really wasn't quite that way for him, and he had to do some searching around. The whole time, in everybody's mind, you know, there's this "tick-tock" going on about the propellants going down. And Neil picked the spot, took it in.

I would say, I mean, this—I would make this comment about most of the astronauts. I mean, people would have confidence that almost all of them could do that mission. We viewed them as somewhat interchangeable. They had different personalities, and some were more or less fun to work with. But they're more or less interchangeable. I wouldn't say that across the board. But we felt that most of them were more or less interchangeable. And Neil, of course, had flown this crazy thing we had out here at Ellington [Field], this lunar landing test vehicle [Lunar Landing Training Vehicle (LLTV)], and actually had to eject out of it at one point. So, people had a lot of confidence in Neil throughout the program. But they always had a lot of confidence in him. And in the Control Center, there was a sense of, "He's looking for the spot. He knows where he is on the fuel," so we just "Shut up and leave him alone." And, indeed, that's exactly the case. And then he landed with, I don't know how many seconds, but not very many seconds of fuel left. You probably know the number, Roy.

NEAL: I think it was 6.

LUNNEY: Something pretty thin—

NEAL: Yeah.

LUNNEY: —in terms of propellants left. But he found a place he liked, and got down. And Charlie [Charles M.] Duke [Jr.], the Capcom [capsule communicator] at the time, probably expressed our view here in the Control Center very well in that we—he really did have a bunch of guys about to turn blue. But, there we were. And then the images from the Moon, you know, with them walking, going down the ladder, and then going out on the lunar surface, kind of grainy, black-and-whitey, almost otherworldly. And I guess it was otherworldly! Eerie feeling to me. Just an eerie feeling to watch this go on and to still have in my head the background that we still had a long way to get home for all this. But, nevertheless, a sense of, "Boy, oh boy!" you know, "We've thought about this, planned for it, and so many thousands of people have worked so hard for it for so many years. And here it is. It's happening right in front of us in this Control Center. And we can see it from the Moon." So, it was kind of riveting the whole time. But also kind of eerie for me to watch it.

It just seemed different than I expected, whatever that was. But I think everybody here was—and associated with the program—was very moved by the whole sequence. And then, of course, back in the ship. And the rest of the mission went fine back here. And then they had to spend so many—how many days or weeks were they in those funny uniforms [Biological Isolation Garments (BIGS)], locked up in a cave [Lunar Receiving Laboratory, Manned Spacecraft Center, Houston, Texas] while we were sure that nothing bad came back with them? A reasonable precaution. I make light of it, but it was a reasonable precaution to take at the time.

But seeing their faces. And the interesting thing for me was that so many people had worked together for so long. A lot of people don't get much visibility. The planners for the mission—all the mission planning people, the flight control team, the flight crews. But then all the people who built the vehicles. The launch vehicle people, spacecraft people, and the people at the Cape who got these things ready for launch. They did a similar piece of work to what we did here in Houston. They did a lot of it preflight. We did a lot of it after liftoff. All those people. All of them. You know, a million cogs in this machine worked so hard and then it worked. A tremendous sense of accomplishment, I think, for everybody. A tremendous sense of achievement.

I remember after the flight, sometime somebody came around and they were interviewing people—those of us involved in the program—for what we thought was most significant about it. And a variety of people had given, you know, what were reasonably standard answers at the time. You know, the competition with the Russians, technology, political, and so on and so on. For me, though—and maybe this is back to my eerie and otherworldly feelings when I was watching it—it was the first time two people from this planet had lived and worked on another, not planet but, heavenly body. Left this place! Left this place! And went to one of those. And, you know, it makes me think of how, as a race, you know, people sat around little fires or poked their head out of caves and looked at the stars and wondered what they were. And here we were, being part of something that—two people from this human race left it, left the planet. Spent a couple of days in another place, living and working, and came back to tell us about it. A tremendous feeling.

NEAL: And after all that, I guess Apollo 12 was almost anticlimactic. Or was it?

LUNNEY: Well, no. You know, at the time—I've said this in other places—at the time, you know, I was young enough where my sense was, "This is going to go on forever." I mean, we were having so much fun. It was wonderful stuff. It was just going to go on forever. And Apollo 12 was, by the way, just a natural part of my thinking at the time was, "It's just going to go on and on." I hadn't thought about how it was going to end and what we were going to do after that, and so on. And Apollo 12 had some specific plans for the mission. But let me digress for just a moment. Because what—I think a significant thing was happening in the program just as we made that transition.

The people who represented the lunar sciences had a set of priorities and things that wanted to be accomplished, and they were less than pleased with what we did on Apollo 11. Their view was that we should be doing a whole bunch of scientific things on Apollo 11, and the view in the program was, "Hey, look, you know, we need to land and, yeah, do what we can. But we need to land and then get out of there, and make it successful. And then, later, we will undertake all these other things that want to be done." And I would say that at the time of 11, it was probably true that there was a science camp and then an operations camp, and they were indeed separate camps. For the most part.

But then as the rest of the Apollo sequence began to lay out, we began to realize—we, in the operations business, began to realize that we were really going to try to get as much science as we possibly could from however many missions we had yet to go. And there was a moving together, a coalescence of the two camps, so that by the time we got to, oh I don't know exactly what—maybe Apollo 14 or certainly by 15 there was a complete convergence of the two camps into one team. And we were all comfortable with each other, and had had a number of experiences together that made us, as operators, sensitive to what the life science folks wanted to accomplish. And had a general idea of why they were trying to do what they were trying to do. So, we became much more sympathetic and empathetic to what their objectives were.

And I say that because there was a strong press by the science community that we need to get on with doing some science on the Moon. And one of the keys to that was going to be, we needed to be able to land somewhere that was reasonably predictable. By that I mean, we needed to be able to land with a set of—with an accuracy so that traverses could be planned that would accomplish most of what the scientists wanted. But it didn't mean you could just randomly land anywhere on the lunar surface and expect to get the same kind of scientific return as you would if we landed exactly where we had planned to land because they could do a lot of research on a particular location. And so on and so on.

So, Apollo 12—to me the major challenge that it had was demonstrating that we could land in a specific place. And we picked a—so as not to confuse one set of gray rocks with another set of gray rocks—we picked a Surveyor site, where there was a Surveyor that had landed there earlier on in the '60s, as part of the unmanned lunar exploration program. And there it was, sitting there. So, again, I got off Apollo 11 and here are all these guys talking about a pinpoint landing by a Surveyor on the Moon. And you know, my brain was having the same problem comprehending that that I did when we first heard about Apollo 8, and so on. I said, "My God! How can we possibly do that?"

But it turns out that this planning group that I talked about here in Houston, run by Bill [Howard W.] Tindall [Jr.] and some others, but Bill was, I think, the genius behind that activity, although there were other players in it, too. But, Bill had—Bill's team had developed a set of techniques for measuring what was happening to the orbits as we ran around the Moon well enough so that we could update the guidance as we went on down, in the descent phase, so that the lunar module knew where it was all the time and knew where it was relative to where we were trying to go—that is, the landing site. And, this problem was compounded because we found out that the Moon has these mass concentrations [mascons] close to the surface, probably from big things hitting it and being buried in the Moon. But they could perturb the orbit. So, we had to develop techniques for sensing these perturbations, and then factoring them back in. Because those perturbations could be large compared to the missed distance that would be generated from a particular landing site, or a targeted landing site that we were trying to make.

So, had to figure out how to do all that stuff. And these planning guys figured that out! I mean, it's just—it's amazing! Analyst sheets are in other people. Quiet, studious, analytical kind of guys can come up with these things you could do and, you know, little corrections you could put into the guidance system that would allow us to land at a particular target. Which is, of course, what ultimately we did on Apollo 12, right at the Surveyor site. But I got there awful fast for you, because I stepped over a couple of big parts of Apollo 12. The major one in my mind being the liftoff from the Cape.

VOICE OFF CAMERA: Tape change…. [Recorder turned off.]

NEAL: So there we were, Apollo 12 time. [Charles C. "Pete"] Conrad [Jr.], [Richard F. "Dick"] Gordon [Jr.], and [Alan L.] Bean. What a combination. They blew their doggone television camera practically after they got to the Moon do you remember that?

LUNNEY: Oh yes, they did! They pointed it at the Sun.

NEAL: Yeah.

LUNNEY: Yes. Burned it up.

NEAL: But let's go back to the ascent stage, and let's get them there first I guess.

LUNNEY: Gerry [Gerald D.] Griffin was the lead flight director for Apollo 12, and he was on duty for the liftoff from the Cape; and the weather was kind of ratty. Clouds and probably a little rain. And, frankly, we—another one of these things we didn't get ready for as much as we should have, perhaps—definitely as much as we should've—was the risk of lightning. Or lightning discharge. So, lo and behold, you know, everybody thought it was okay at the Cape to launch this thing; and we're sitting back here waiting to receive it when it got handed over to Mission Control; and off it went, you know. A typical hurrah when we got a liftoff. But shortly thereafter, this huge lightning bolt—I mean, a lightning bolt but discharge, came out of the back end of the ship down to the ground and set all the instruments just crazy inside—inside the command module, you know. Fuel cells popping off the buses and on and on and on.

There's a attitude indicator that we call an eight ball—it's kind of round with a black part for the horizon and white part for above the horizon, and the crews use that for attitude reference and to know where they are, kind of, flying; and we call it an eight ball for short. This little eight ball was apparently just spinning around wildly in this cockpit from the effects of the strike. Fortunately, the effects were essentially all confined to some of the systems in the spacecraft—that is, the command module—and it didn't seem to affect the lunar module at all, which was relatively unpowered at the time. And it didn't affect the launch vehicle at all.

So, here we were going uphill, on the Saturn V, this big bolt having decided to release itself and come down out of the back end of it. And it was still working okay—and, you know, the launch vehicle was still working okay and everything was hanging on. But the spacecraft instrumentation and the reports from the crew indicated it was just Christmas trees, you know, inside the cockpit in terms of warning lights and so on, going on, and it was hold your breath time. I mean, the launch phase on a Saturn or any other rocket is a hold-your-breath time. But this was really accentuated because we just didn't know what it is we had experienced and how it was going to manifest itself, if at all. But fortunately, the launch vehicle just tooled right on up and we got into orbit fine.

And then we're sitting over here with Gerry on the console, and we're looking at everything on the telemetry; and by that time we had got the spacecraft reset, powered better, kind of made all the connections, got the attitude indicator and the platform behind it that drove it, got it aligned and got it behaving right. So, we're spending a couple of orbits going around in Earth orbit, looking at the data, saying, "Gee, everything seems to be working well. But we had this terrible thing happen back there, and we don't know." For example, the parachute system and some of the separation systems have these little devices called pyrotechnics, which are like fireworks, and any one of them could have gone off for all we knew. And they're not—it would not be apparent in—for example the parachute pyros could've gone off and the parachutes could have been sitting up there on the deck deployed or severed, you know, released! We didn't know any of that, and there was no way to know.

So, out of all the things we could look at on the launch vehicle and the spacecraft, they were all nominal. There were things that we couldn't see. But there were things that had to work when we reentered, so we said, "Well, we can reenter and see if they work, or we can go on and do our mission and then reenter 10 days later and see if they work." And, it was kind of a peculiar thing, because we got to looking at it and saying, "Well, everything seems to be working fine." And we were prepared to find some things that maybe weren't working fine because of the jolt. But eventually we decided, "Well, looks okay. So, let's go do it." And off we went for the burn, the S-IVB burn, that would put us on the coast out to the Moon.

And off we went. Let's see.—and then as I said, the mission was kind of designed around this idea of a landing at a pinpoint location, landing at the Surveyor, and all of the things—as I recall, going out to the Moon and getting ready to go down were pretty nominal, as I recall. And we'd solved the alarm problem in the lunar module computer by that time. I can't remember. Is that the problem with—is that the flight we had an abort light problem on Apollo 12?

NEAL: Not that I remember.

LUNNEY: Well, anyway, you know, it kind of went on to watch how things were going. And just went nominal. The crews had a great time, you know. The—Pete and Alan Bean bouncing around on the Moon, they had a wonderful time visiting that Surveyor, taking some—

NEAL: They brought pieces of it back.

LUNNEY: ——some pieces of it back. Cutting them off and bringing them back proved that we could, indeed, land at a particular point. So, that set the basis for the scientific planning for the traverses that was in work and was going to be accentuated over the next couple of missions. And came back, and essentially had a fairly normal flight from their point of view of all the standard phases that we worry about. But landing by the Surveyor was done. And it was a set of techniques that had been developed to help these planners, that would, you know, convert it into things that we could actually do with ourselves and with the ground crew—with the air crews and—and get the vehicle knowing where it was and where it wanted to go, and get there properly. So, it worked fine and set us up for the later lunar exploration missions.

NEAL: Set you up, also, for what was going to happen next, which we've covered in a prior interview. Set you up for Apollo 13.

LUNNEY: Apollo 13.

NEAL: Because by the time 12 had come and gone, you'd been through two lunar missions that had been very successful.

LUNNEY: Right, right.

NEAL: So, it was—it somewhat took people here by surprise when 13 ran into trouble, didn't it?

LUNNEY: Oh! Well, yes.

NEAL: To say the least.

LUNNEY: To say the least. Not only that, certainly the extent of the trouble—

NEAL: Yes.

LUNNEY: —how it played itself out. But, you know. Yes, it was quite a shock to all of us. And this had been a lot of—there was a lot of talk about how the coverage of the Apollo flights had decreased over time. And there was a noticeable drop off in the coverage that went with Apollo 13.

NEAL: You're talking the television, the media.

LUNNEY: Yeah, well, it was the media coverage here at the Center. And some people struggled over that and, you know, were distressed by it in some ways or another. Distressed may be too strong a term. But I sort of felt it was natural; because, indeed, there we had it. We had two lunar landing missions. They went pretty well. People seemed to—there was sort of a sense that people felt that we could do this, and it was going to be okay, and we kind of had the risks managed, and we knew what we were doing. So, there was every expectation that we could do it again, several more times, and that it would be okay.

But Apollo 13 turned out to be—not delay—not that case. And, you know, various people have said various things about it. But, you know, to me it was a very, very special mission and, in terms of its effect on people—and I hearken back to the comment I made a little while ago about two members of the human racing exploring this distant planet, or at least a distant celestial body—here were three members of the human race, you know, at risk of being stranded or worse, killed, on Apollo 13. And it seemed to have a tremendous galvanizing effect on people all around the world.

I mean, I just remember seeing clips of the people watching the little tickertape things that go around buildings. The little lights things [scrolling message boards]. And there were people watching that all over the world, in Europe, in Africa, in the Far East. And, you know, again a sense of, the whole human race was concerned about the safety and return of these—just these couple of representatives of the human race. Three of them. A tremendous sense, to me, of involvement in the urgency and the risk of the mission that people were picking up on. So, I think, in a sense, it's still—it was—that to me sure showed that people still had a tremendous feeling for this activity in their hearts and in their guts. But in terms of the day-to-day coverage of it, it had been—gotten, you know, two successes in a row, which is a string, of sorts. And there was just less interest with all the other things that were going on in the country at the time that were competing for the same resources, media resources, for attention and so on. So to me, it was kind of natural. But I was frankly somewhat overwhelmed at the response of people around the world during the course of the Apollo 13 mission. I mean, it was really gratifying.

NEAL: Well, for purposes of this interview, of course, you've covered 13 very carefully and very well at an earlier time. So, now let's take us a step beyond 13. 14. What comes to mind?

LUNNEY: Well, 14 was a flight that I did not actively work on. But what came to my mind was how, after these many years since, as a matter of fact, the Redstone launch that kicked it off, Alan [B.] Shepard [Jr.] was on a crew going back to the Moon. And in the case of both Deke [Donald K.] Slayton and Alan, who both had different kinds of problems but nevertheless it affected their flight status and their ability to get a seat, you know, other people would—might have left the program. But both Deke and Al remained in the program, played very significant roles in terms of the—representing the flight crews, the flight—getting the flight crews ready, the flight crew involvement with the management processes, and so on and so on.

And, you know, looking back on it, you have to really admire the way they recovered, if that's the right word, from what had to have been a very strong emotional blow to guys of that type. You know, fighter pilots who get bumped for medical reasons. And you had to give him credit for sticking with the program, and then for not only just being here, but for making the contribution that they did the whole time. Both of them. And so—[loudspeaker interruption]

LUNNEY: So, you know, my view was that after the contributions that I would say represent almost, by both what Deke and Al did, I was really very pleased to see that Alan got an opportunity to get back on flight status and to get that flight. I'm sure that there was a set of crew assignment things that affected a lot of people in the crew office. But as I said before, to me a lot of these folks were interchangeable in terms of their talent and their abilities, but because of the one—this kick start that Alan gave the program with his—with him being himself on the first Redstone, the first Mercury flight. It just seemed to me fitting that he did have an opportunity to go back and land and walk on the Moon. And then, of course, he added his own style to that by fashioning a golf club out of one of his tools and whacking a few golf balls around the Moon—with claims of extraordinary distance, I'm sure. But, anyway, for me, it was kind of pleasant and seemed appropriate somehow that Al had the chance to get back and fly.

NEAL: There was a pretty good chance that he would've flown Apollo 13.

LUNNEY: Yes. I gather that there was a set of things that occurred in terms of the crew assignments that could have been the case.

NEAL: Probably just as well it worked out the way that it did.

LUNNEY: Probably. But again, as I said, to me the crews were relatively interchangeable. I think either crew could've ended up with either mission, and it would've come out about the same.

NEAL: As you moved into Apollo 15, however, here was a different matter. Now you began seeing the science side of the house exercising itself.

LUNNEY: Yes.

NEAL: Dave [David R.] Scott was the commander.

LUNNEY: Dave Scott and Jim [James] Irwin and—

NEAL: Al [Alfred M.] Worden.

LUNNEY: —Al Worden. Thank you. And, as a matter of fact, Apollo 15 was the first of what was called the "J" series, which was an arbitrary designator for a set of enhanced capabilities that we put—built into the spacecraft—both of them—that would enable and enhance the amount of science return that we could get while we were at the Moon. On the lunar module, we were able to stay longer. We were able to support more EVAs, traverses. We had the lunar rover [Lunar Roving Vehicle (LRV)] that allowed the crews considerably more range in getting around the Moon. We had advanced science exploration packages that we were able to deploy and leave on the Moon. And, in general, the missions starting with Apollo 15 were all the result or the consummation of the concern for the lunar research, the lunar science, that got—manifested itself in a set of quite a bit of new hardware, and quite a bit of new capability that we had, with the lunar module, starting with 15, and with the command service module.

We had built a thing called a SIM bay, which stood for scientific instrument modules. A whole set of different kind of sensors that were like Earth resources sensors that were built into the—one of the bays of the—of the service module. And then those were used all during the lunar orbit stay, while the command module pilot was up there and the other guys were down, to conduct another set of measurements of the Moon from 60 miles or so. So, in both vehicles, there was a substantial enhancement to what could be done. All of it targeted at pinpoint landings, now that we had those under our belt, and then traverses that could now be planned with the range that went with the lunar rover, and with the number of EVAs that could be conducted. We were up to three, I think, at the time of Dave's flight.

So, getting ready for that flight was again the continuation of this blending of the operations people—the air crews and the ground crews—with the scientific community. The crews had been joined with the scientific community probably longer than the folks here in the Control Center. But by the time we got to—well, really Apollo 12, Gerry Griffin spent some time with the lunar surface planners, and that continued on 14 and accelerated even when we got to 15 because of the significant more capability that we had. And I got to go on a couple of those geology field trips with the crews. And it was—I mean, I don't know that I learned a lot of geology, but I learned to be empathetic to what people were trying to accomplish. And off we went with Apollo 15, with a significant amount of new capability and a significant amount of equipment that would allow the scientific return to be considerably enhanced.

NEAL: And 16, along about the same way, wasn't it?

LUNNEY: 16 and 17. All in the same class in terms of the capabilities. I—by the time—15 was my last flight as a flight director in the Control Center. I guess it was obvious that I was having too much fun, so it was decided that I should be promoted and learn to deal with some other things like budgets and contracts and stuff like that. But it came at a unique time, and it was time for me to make a change, anyway. It was one of those things where it was time to start doing some other things. And then I watched 16 and I watched 17 as they unfolded. And they were, you know, remarkably successful. Great flights. Great performance by the crew—by the crews. And all in all, you know, just a follow-on to everything that had happened before in the lunar series.

NEAL: Looking back over it, what stands out in your memory about Apollo? You take—taking the whole series now as an important step in man's maneuvering into space. What stands out to your mind?

LUNNEY: Well, I—it's a difficult question. Because if you have so many—

NEAL: It's a huge field.

LUNNEY: —ways to come at it. But to me, I guess it was a demonstration of what can be done when the circumstances are right and the proper decisions are made. And, for example, President [John F.] Kennedy somehow was able to see this competition in the—and, by the way, the fear that that generated and the concern that that generated in the American people. And out of this sense of worriedness that was going on about where we stood with respect to the Soviet Union, especially in this new frontier, he was able, with the help of other people I suppose, to generate this goal that was an answer to this fear. And so on. So, that's what I meant by right. It wasn't arbitrary. But it really resonated. It was the right kind of decision with people. And then when that kind of choice is made by a political leader, that's the—that's right and feels so right to people, and then the support is provided, it just is amazing to me what we were able to achieve!

I would not say to you that we were, you know, geniuses of any kind. We were just regular folks who happened to come along when this thing occurred, and happened to join it.

We were not selected like the astronauts were, for example, with a national screening of all the pilots in the country, you know, and a very rigorous sort of a process. This was sort of like, people showed up because they wanted to do this work. And we were, you know, quick and medium and some maybe even a little bit less than medium. But the combined talents of that group kind of energized by the motivation that they all had, and the dedication they had, made it work.

It impressed me that human activity and human endeavors are probably generally underestimated in terms of what can be done when the circumstances—when it's the right kind of a program, the circumstances are right, the support is there, and then you let people do the job. The situation doesn't repeat itself a lot, probably, especially in one single endeavor; but probably opportunities like that pop up all the time, but they pop up in different fields. So, they're not seen as the same sort of thing, perhaps, when indeed they are. But, I was impressed at what this country was able to do. And it was not a given that we could. I mean, there were just a tremendous number of, certainly, technical unknowns going into this and probably a lot of other unknowns, too. But certainly a lot of technical ones that I could relate to. But, you know, it's amazing what we were able to do.

Amazing what we were able to do in this Control Center with a lot of very young people. When we were doing the Apollos, most of us were in our 20s. Late 20s, perhaps, but some middle 20s. A large number of very young people had an opportunity then to do something that was much larger than ourselves. And it worked! It somehow called out the best in people; and somehow people showed up at the right time, when they were needed. And it just all kind of gelled. And it's amazing what can be done when the circumstances are right, the leadership is right, and the support is there. Oh yeah. Lots of things can happen. Lots of good things can happen.

NEAL: Now Apollo ended with Apollo 17. But then it went on into other phases. Did you ever believe, in a million years, that you'd see something like Apollo-Soyuz?

LUNNEY: Well, no! You know, I was involved in that; but, you know, the '60s was just dominated by the sense of the Soviet Union. I mean, we perceived them as a threat and they did the same on their side, I'm sure. But, you know, we just perceived them as a life-and-death threat to—not only life and death, but almost national survival kind of a life-and-death kind of a thing because of the proliferation and the lethality of the weapons, the ICBMs [intercontinental ballistic missiles] and so on, that were in existence. And threatened occasionally, and so on. So, it was a very high kind of tension in those fields. And it played into everybody, I think, in America. Everybody felt it in some way or another. And, of course, there were many other things that were happening in American society in the '60s, both domestically and with Vietnam and so on. And all of those things had a play on what Americans were thinking and how they were feeling and so on. But, quite a time. Quite a time.

NEAL: What did you do with Apollo-Soyuz? What was your role?

LUNNEY: Well, that's interesting because I became the, what they called the U.S. Technical Director. I was basically the Technical Director, the Program Manager for the Apollo-Soyuz Test Project [ASTP]. And, it was an interesting assignment because, you know, I got to go to the Soviet Union in October of '70 on our first exploratory meeting. And, you know, it's kind of spooky. I was frankly intimidated by it. I mean, it was kind of gray and dark and snowy; and people, you know, seemed a little bit—the people you met on the streets weren't friendly. And there was this place, Red Square, you know, that we had seen so many clips of and associated with generally a threat of sorts.

So, it was quite an eye-opener for me. I was—whatever I was at the time, 33, 34 years old. And within a year or so, I was the U.S. Technical Director for this project that was bridging this—was one of the bridges that President [Richard M.] Nixon and Henry [A.] Kissinger, Secretary of State, were trying to arrange to—to help change the complexion of this competition that had been so fierce between the Soviet Union and us. And who knows what—what the effects of that were? I leave that to the historians, not just of ASTP but of just the general approach that the United States government began to try. And we were a piece of that. And I recognized, going in, that that was the case. That we were a piece of this much larger effort to kind of change the rules of the game somehow, so that it wasn't as threatening or as hostile as it was before. And that didn't happen overnight, and probably other circumstances later on contributed to other things that changed it dramatically here in the last—in the '90s. Changed it very dramatically compared to where it was in the '60s.

And in one sense, if that were a—a competition or a crisis or a conflict—I leave the word "war" out of it, in terms of, perhaps, a Cold War the space race was an important part of that. And, you know, we won our part. There were a lot of other parts that a lot of other people contributed to, but this was the part that I had something to do with. And we won our part. And then we went off to do this thing called Apollo-Soyuz. As a matter of fact, Tom Stafford was the commander for it. And I had worked with Tom, of course, on previous flights in a flight director capacity, and now I was working with him as a American leader for this activity.

It was quite a different thing for me. And at my age, probably still not, you know—still I had a very American orientation in terms of the way I thought about things. It was quite an interesting thing to go through to go to another place and then begin to try to occasionally put yourself in the other person's shoes. In other words, in trying to make some accommodation or understand what was going on or why it was going on. To kind of consciously try to work at putting myself in the other guy's shoes and trying to understand what he was doing, or what they were doing, and why they were doing it, and how we could respond to it in the most constructive way. It was quite a—I mean, it was a learning experience for me.

When I went—got involved with things, I mean, the relationship with media was—is entirely different over there than it was over here. They could not believe, you know, what the goings on were between we representatives of the U.S. government and the American media. And they had quite a difficult time in understanding it. I mean, their basic problem was that, as they stated to me—was their—they like the way theirs was because they knew who was in control of the media. In our case, they didn't know who was in control of the media that they ran into. As a matter of fact, the media all seemed to be kind of different to them. But they had this problem with not understanding who was behind the media and, that is, in control of them. So, they didn't quite know how to deal with them. They weren't—they clearly weren't in the same camp as, in our case, the U.S. government. And over there they, the media's, just an arm of the government. So, they understood very clearly who was control of them.

NEAL: Alexei [Arkhipovich] Leonov turned out to be a very skilled practitioner—

LUNNEY: Oh very.

NEAL: —of handling the media.

LUNNEY: Very good. Very good at that—

NEAL: Of course, being the Russian commander.

LUNNEY: ——very good at that, and I would say in other things. Very good at being a capitalist probably. And probably in America would have been a gangbusters capitalist. But that's an accident of where we're born, you know, and we don't have a heck of a lot that we can say or do about that. We just are born in one place or another; and actually for me, having spent years dealing with people there, ultimately, you know, on a fairly personal basis, where you get to know people pretty well and their families and so on, they became human beings for me. Not stereotypes. And you know, today, I've been struck with, because of the difficulties that the—that Russia is going through—economic difficulties—that reflects itself in so much hardship on their people, an awful lot of people over there are suffering because of some decisions and actions that people took 75, 85 years ago and played out through history. And it's just amazing how many hundreds of millions of people, in that country alone, have been affected, adversely now, by bad decisions, bad implementation, and so on. And I feel for them. I mean, I feel sorry for them. No fault of their own.

They were born where they were born. They did the best they could, probably, or tried to survive in—with the rules of the game as they were laid out for them. Like filling out your IRS [internal revenue service] forms. I mean, we don't make them, we just have to comply with them. And, you know, most of them are in the same condition. And they're just trying to take care of themselves and raise their families and so on. And—difficult for them. I mean, they're in a difficult situation, and it's going to take them a long time to recover from it.

NEAL: As you moved into that arena, for the first time you really had an opportunity to study the Russian hardware—

LUNNEY: Oh yes.

NEAL: —which had been an enigma, from your own description of it, until that time. So, how would you describe what you discovered once you started looking into it? And how would you compare the Russian technology and the U.S. technology in this arena?

LUNNEY: I—let me answer that question in two ways. Number one, in terms of the people that we met. We found them to be very competent at what they did. They're very good at it. They tended to live in a world where they were more compartmentalized than we were. But, by that I mean technically compartmentalized. But they're more like an engineering department, you know; there's docking specialists and radio specialists. In our operation, we have a lot of people like me who were sort of operations oriented so that we got us across all the different departments within all these compartments. So, we had a chance to see that. But I would say I was impressed by the technical people that they had. And, frankly, what they achieved.

I was impressed at their perseverance. I was impressed at—they had an ability to do what they had to do with the tools that they had. They did not have the fancy computers, the analytical models that we are so fond of and that we used to save a lot of hardware and a lot of testing. On the other hand, they went for hardware and testing. And it was the situation they were in, and they made the very best of it. And we've evolved a little bit past that. You know, sometimes that's good and sometimes it has its drawbacks. That is the position we're in today. But the people, I was impressed by. They were sound. They knew what they were doing. They still—you still always had a flavor of kind of compartments and sort of restraints on them, much more so than I felt existed in our system, although that might've been a personal bias. But they were good. They were good at what they did.

Now the hardware. I was often asked when I was—when I'd come back from a trip, especially by our media—and remember this is 1972, 1973, Vietnam is still struggling and so on—there was, I was generally asked questions, especially by our media, that had to do with comparing technology. And the questions were usually phrased in such a way as to invite me to criticize their technology and to praise ours. And I found, after a while, that that just—from the beginning actually—that just didn't seem appropriate. They operated in a different kind of an environment than we did. They had different priorities than we did. So, they would do things that were consistent with that. But their hardware was effective. It did the job that they had designed it to do. And it did it reasonably well.

I mean, they've had a tremendous record with their Soyuz launch vehicle, for example. They just launch those things, launch those things, launch those things, and they work pretty well. They do not have some of the sophistication that we have in terms of onboard computers, and that is a fact. They don't have that. But, recognizing that they didn't have that much of an—apparently an industrial capacity in that regard as we do, a lot of ours, by the way, is generated today by our commercial interests in the field where their society was all driven by their, you know,—their military or technical requirements for things. But aside from that, they would do things that might seem crude to some of our people. If they didn't have to worry about something, they didn't go away polishing it. I'm talking about metal finishes on things. They didn't waste time with what they considered to be frills, what we would consider to be, you know, completing a job or whatever.

But on the other hand, the stuff worked. I mean, it worked for the purposes it was designed, and it worked pretty well. I think they—their progress probably suffered from the lack of the computer capability that we have in this country. They just do not have the same kind of capacity that I ever saw. And—but other than that, they built hardware that did the job that it was supposed to do. I still have this sense that their system operated in kind of compartments and constraints, probably consistent with what you would consider to be an apparatus to put high degree of tension or high priority on national security and classifications of various kinds. Need to knows and so on. It was almost like they carried that to an extreme. It may have actually hurt them a little bit in terms of the full capability that—their capacity that they might otherwise have arrived at. But that's hard—that's speculation. It's hard to tell that.

So, the people I was impressed with. They were always good. The technology although—I think the most obvious example where our technology was far more advanced was the computer field. But other than that, their hardware did the job it was designed to do. They have flown this Mir space station for now probably 12 years, 13 years. They've flown a lot of flights up to it. The launch vehicles have had a terrific record. The spacecraft have had a good record. They've had some trouble with rendezvous and docking, but I think most of those problems have been manifested in the computer area—in the general area that you and I would call computers. They seem to have some trouble with their flight control systems and the logic systems onboard. All in the general electronics area, what you and I might call their computer industry. But I was impressed.

I was also impressed in their—in the kind of dogged perseverance and the way in which they applied these things. I mean, we worked with guys who were in the Tank Corps in World War II. And, you know, they used to just strap 50-gallon diesel barrels on their tanks, take them into combat, and then when they got close to the fight, they would just roll the tanks off, roll the 50-gallon drums off the tanks and proceed. So, they kind of adapted what they had and made the very most of it. And they did it in a very tough kind of persevering kind of a way. Physically tough. Mentally tough. They lived in a very tough system. So, they kind of had a way of dealing with it and, you know, developed these shells for shielding themselves from some of these realities. But that was a form of protection, and it manifested itself as kind of a toughness.

NEAL: Well, with that differential—we're out of tape again? [Recorder turned off.]

With these differences that you've talked about—philosophic as well as the hardware itself—it must have been a terrific job trying to marry the two technologies. Was it?

LUNNEY: Well, it was. And, again, probably because of my age at the time, I mean, I wasn't as aware of some of these things, these cultural differences, as I should've been. But I worked at it. And I was blessed with an interpreter, a fellow by the name of Alex Tetischev, who's since died. Alex's family was in royal circles; that is, in the Czar's circles for several decades—maybe centuries, for all I know. And his dad—his father was the ambassador to Germany from the—of the Czar at the time of the Revolution. So, his family was involved in these things, and Alex had a natural interest in Russian history. And he knew more about Russia than the people that we would be talking to usually.

And it was interesting to walk down the street with him in Moscow. The ladies that we came to call "the babushka ladies"—no disrespect but that was what they looked like, the little old ladies—when they walked by Alex, they always kind of sort of nodded at him in a deferential way as if they detected somebody from the old school and were paying some respect to it. But anyway, the point of that is Alex—he was about 70 at the time. He left his home country at the time of the Revolution because his class was being thrown out by the Bolsheviks. And he came, via a variety of paths, through Paris and sang over there for a while. Had a job with one of the government agencies until [Joseph R.] McCarthy got him. McCarthy not directly, but the effects of the McCarthy Era got him. So, he was—had a number of bitter experiences in his life. And, frankly, probably a lot of them. And then when he got involved in this, he seemed to take it as a mission to help his former country in this way. And I say that because, this was an older gentleman at the time, 70-ish, who knew a lot about the Russians, had been in the State Department, had been an interpreter, I think, for the State Department also.

LUNNEY: Alex—

NEAL: Alex.

LUNNEY: ——Alex kind of knew the Russian history, knew the people, knew the pressures, knew the current situation. And he knew a lot about their psychology and so on. And he helped me a great deal with negotiations. There were times when he would kind of pull me aside and say, "Glynn, you're pushing this subject too hard. He needs time, my counterpart needs time to go work it internally. So, give him some room." You know, and suggestions like that. And it turned out to be very helpful. But it also then turned out to just keep enhancing my understanding of what I was dealing with. Because by, you know—as this thing got rolling, we had several hundreds of people on our side and their side interacting regularly in meetings and technical exchanges and so on. But we started with a relatively small team, and we kind of added to it as we went. So, we kind of had a consistency of how we went about things.

For example, one of the things we used to try to do was, we always preplanned the outcome of any meeting to the extent of writing the minutes that would constitute the record of the meeting. So that when we went into a meeting with the Russians, we knew full well ahead of time what our going in intentions were in terms of an outcome. Sometimes surprises occurred. You know, new things could be introduced; so we could react to those. But we created this discipline of, "Don't go into any meetings unless you can write the minutes ahead of time and tell how you want it to come out." And we did that. And it worked pretty well for us.

And people—all the people in the team started to carry that around as a mode of operation in their head, which is a little bit different. Although you should do that in terms of domestic activities, too. You've got to have a good idea of outcomes before you get involved in some—or at least your desire to them—to the outcomes. But anyway, it worked pretty well. And we kept it on a really a technical basis and a professional basis. And the personal basis things were all positive. In other words, we went out of our way not to ever give the impression that we were idly curious about anything that they were doing. We avoided, you know, random fishing trip lines of discussion and questions and so on. We could always relate what we were doing to the success of the mission or the safety of the mission; and those were the things that worked for them, and so on. And over time, they became convinced that we were—even if they couldn't sometimes understand why we wanted to know something—they became convinced that we had a reason and it was acceptable—it would be an acceptable reason. That we weren't fishing. And we weren't, you know, trying to learn things about them that they—that weren't relevant or that they didn't want to tell us about, and so on and so.

But we also insisted that we know what we wanted to know, and we were adamant about it. I mean, to the point of saying, "Look, you guys don't get this for us, we're calling this meeting off and going home!" And sometimes that worked immediately; sometimes it took a little time. They had the accident where the three crewmen were killed because the vehicle depressurized coming down. I've forgotten what the Soyuz designation was. Well, that was a high-priority thing for us to understand because it reflected on the life support system in the Soyuz, which would have effects on us. Now, they did not want to talk about that. And it took, probably, two or three meetings to get an answer. But we were adamant that we get an answer to that question or we'd call this thing off! And it was interesting because, in the American system, I did not feel any political pressure from anybody. I mean, I didn't feel like anybody was pulling on my chain or constraining me or accelerating me in any way. We proceeded at a pace that was appropriate for the program, and we stayed within those bounds.

On their side, they felt a different sense of—they had this expression of "decisions that are made on high," you know, at whatever level. They had to respond to those as if they were, you know, down from the Mount, written on stone; and they didn't feel like they had any flexibility or any—and to do anything that would challenge that or threaten it or put it at risk was just not going to happen on their part. So, it took us about two or three meetings to realize that they were in that political situation and we were in a better one; that is, they were on the hook to the decision-makers on high to make this thing come out well. So were we, but we had more of a—my sense was, we had more of a system that would understand if we decided something wasn't acceptable and wanted to call a halt or make a big stink about something.

They didn't seem to have—I don't think they had—felt that they had that kind of flexibility. Their system operated on orders down. So, it took us about three meetings to figure out what exactly was their system; and I don't know how we actually got there, but we were always trying to piece together what was motivating them and what was driving them and what would work on them and what would not work. We gradually figured out that the political system in which they work was such that it really became the leverage by which we ended up conducting the rest of the mission. Because we felt like we were in the driver's seat, we could insist on knowing the things we needed to know. And they eventually, sometimes with pain, complied and came forward with those explanations.

Like the one the three cosmonauts who were killed because the vehicle depressurized. It reflected on potentially the life support system. But we finally got an explanation of that, and a very credible one that fit with all of the data and the information that they had provided us. And it was an achievement on their part—on our counterparts to get permission. We viewed it as an achievement in their system for them to get permission, because they would've told us if it were up to themselves. But they didn't have clearance, if that's the right word, to tell us about it. So, they had to go argue with whoever was wanting to keep that secret. They had to go argue with them. And they got it! And it took two or three meetings, but they got it. And we made it clear that we needed to know answers to those kind of questions.

But we kept it on a program basis. We kept it on a technical, professional, it had to relate to the program, was not fishing trips; but we recognized the leverage that we had on them because of the difference in our two political systems. I mean, I was no less responsible to our political leaders, but it didn't feel the same to me as I was interpreting it that they perceived it to be on their side. So, it gave us some leverage in this whole thing that worked to our advantage.

NEAL: You know, it would seem that the problems at the outset would've been almost insurmountable. The language barrier, how do you fly—for example, how do you compute a trajectory as compared to how they compute a trajectory? Were those problems as big as they at first appeared?

LUNNEY: Yes! Yes. And long before we got to trajectory subjects. There were things like language. I mean, we started to have to think about interpreters, making them part of our team, keeping a consistent stable or inventory of interpreters available. The language and jargon was such that you couldn't just move people in and out who were good at both languages. They had to—it was kind of a specialized language. And the interpreters could provide significant help, because, in my cases, the interpreters on our side had family or were first- or second-generation removed from having lived in the old Russia. As in the case of Alex Tetischev. So, he helped a great deal with that.

But, there were other things. Like, we have this tendency to document things. They have a tendency—I think it's part of this compartmentalization thing—they tend not to document and make available to a wider audience, you know, a set of schematics even or procedures or training manuals. They tend to keep it within a group, and it's some—it almost feels like sometimes that the group retains control by not documenting the "what they're doings" and "how it works." So, they just continue to have control. It's a priesthood of sorts around this sacred knowledge that only they then can dispense as they go forward. This is a little bit of sense that that's the way they operate. Internally, amongst themselves. And then, of course, that's the way they did it with us.

But we have this tendency to document, as you know, to a fault. And we also have this sense of creating a set of program documentation that describes all of the "how's this going to work" and "who's going to work with whom" and "how do we work together" and raar-raar-raar. They just didn't feel like they had that kind of a thought process. But to their credit, I mean I don't know how I would've felt if I were in their shoes. But they accepted a lot of the things that we insisted had to be done to be sure that we could document the program, document all the things we had to do, and so on. And have schedules for them, and keep them on track. They—sometimes reluctantly, but by and large—they went along with all of the things that we felt were necessary to do that. And it probably was a little bit of a little swallowing of—on their part to accept that. But they did it

And they again had this—they wanted to make the mission work, and they were willing to do what they had to do to do that. And part of that was keeping peace with us, which was part of this political motivation that we began to understand. And it was helpful for us to get a better feeling for the system that they lived in and what was motivating them, because it gave us a better strategy—a better idea about strategies for how to play into that and what would work.

NEAL: Do you think that we could be where we are today with the International Space Station had there been no Apollo-Soyuz to set up the technology in the first place?

LUNNEY: Well, there always has to be a first time. So had we not done that, I imagine that we could've done the Apollo—done the Space Station thing because it would've been the first time. And a lot of the people were new, certainly on our side. There were more on their side, by the way, that were carryovers from the old days, from the Apollo-Soyuz, than on our side. So, I think it could've worked. Now NASA, to its credit, went about this participation with the Russians in kind of a two-stage approach. They've done this Mir activity, where we've had people onboard Mir for considerable lengths of time. And I have said before that the Mir activity is a little bit like Gemini with the Space Station being the equivalent of Apollo.

So, the Mir turns out to be a way to learn all the current technical activities, systems, and so on and the interactions with the control centers and all that, with the current crop of players and the current crop of tools and techniques for doing that. And that's going to serve NASA and the country and the whole program, including the Russians, well in terms of getting ready to do the International Space Station. Because the Mir has been a big learning platform for our folks. And they are—the Russian motivation is now different than it used to be. I mean, I have explained that, at least briefly, what I felt was their motivation and how we took advantage of it. Today their motivations are very different. They don't have the same sense of the political mandate that they did before. On the other hand, they are driven by an economic and financial one more than they ever—more than were in our time. That didn't occur to them in our time. But now they're driven by more of that. So, you know, that's another potential understanding and, therefore, leverage point that our people could be—can be—I don't want to say "exploiting," but using to their advantage. But it's different. But I think they could've done that. I think Apollo-Soyuz certainly enhanced that. I have used this analogy to describe it a number of times, Roy.

Apollo-Soyuz was a process of making deposits in a bank account. Every time we were honest and straightforward and sincere, we kind of made a deposit. And over the course of the Apollo-Soyuz mission, by the time the flight was conducted, I think we had a substantial bank account of goodwill, where they would certainly give us the benefit of their doubt, and a quite a bit of goodwill. So, we built up this bank account. And I think that'll have to go on today. And it's been going on. I mean, we've done a lot of things to help them with the Mir situation, for example. And I think that builds a bank account that then becomes something that people can draw on in the future, you know, when times get a little tougher and so on. But we built up a good one in Apollo-Soyuz, and I think that served the country well when we got around to these discussions about the Space Station.

I think there was, you know, a residual or a—certainly a sense amongst a lot of the people who had been involved in it or had heard about it; and it was generally perceived in their country to be a very positive, very successful, very good thing for them. And therefore, it had a lot of positive vibes around it. And it probably made it easier for them to consider, and then easier for them to deal with, the Space Station; a new application of the same idea.

NEAL: You know, following Apollo-Soyuz, you had the Space Shuttle. As a matter of fact, you became Manager of the Shuttle Payload Integration and Development Program. What does that mean, really, Glynn? What is that title?

LUNNEY: Well, let's see. In 1975, we flew the Apollo-Soyuz in, say, July. And then we had a team of people that had just pulled this thing off; and it was not a large number of people, but it was a fairly tight-knit, technically strong group of people. And Chris, who was the Center Director at the time, of course had the Shuttle Development Program under way. Bob [Robert F.] Thompson was running it. Aaron Cohen was running the Orbiter Office. Bob was running the Space Shuttle Office. And the—a lot of the Center was very much occupied with that activity. Chris [Kraft] had the idea, though, that we, JSC [Johnson Space Center, Houston, Texas], would be developing quite a few of the payloads that would fly onboard the Shuttle; that is, that we would be in the—you read my title, it includes development. He thought that there would be a lot of payloads and, in effect, business for the Johnson Space Center to win that would amount to new work, new starts, and so on, building these payloads. And I think that was the thing that he had in mind when he went into it. And—but, frankly, so did we because we didn't know any better.

But once we got involved in it, especially once we started the deal with the commercial communications satellite industry and the Department of Defense, we began to see ourselves more as not so much a developer of payloads, but as a kind of a accommodater of payload interests and an organization that was trying to find ways to accommodate their requirements in as reasonable a way as possible. Let me just give you a technical example of what I mean by that.

When we walked into it, the Orbiter was designed with a lot of electrical capability, wires and so on, that would be made available to payloads. So, we walked into this and said, "Okay, well now, where are the electrical accommodations for the payloads?" Well, on the back of the bulkhead of the cockpit, where the payload bay starts, there was a big plate, about this big, and it must've had about 100 or more connectors in it. And they said, "Well, there it is there. You just plug in, you know, your wires into one of those." So, here we were, faced with a system that wanted to fly multiple satellites, multiple payloads—three, four, five at a time—on missions on turnaround times that were measured in short, relatively short period of times, you know. So, the accommodation was: here's this massive connector base, and we're going to thread everybody's wires that they want from their payload to here and then not use them up in such a way that when we manifest another payload with it, we've still got all the ones they need and so on.

So, you know, it was clear that we had not gotten to really think about how we would service four communications satellites in a cargo bay who all wanted a relatively minimal amount of service, but they wanted it to be easy and something they could repeat every time and that. So, it took us a while to bridge between where we had left the design of the Orbiter, for example, in its design stage to really being something that we could accommodate the payloads as they were being configured and likely to fly onboard the Shuttle. And the truth is, the guys who had designed the Orbiter didn't know. I mean, they hadn't interfaced with it and they didn't know. So, we were put in a position of realizing that that was a big gap and beginning to develop the techniques that took all those connectors, divided them up into four, made four standard connectors at four locations in the cargo bay so that four communications satellites could stack up and use the same arrangements every time without having to rewire a bunch of things from their payload up to the back end of this wall, and so on and so on.

So, our biggest learning was in trying to figure out how to handle the different kind of payloads that show up—that were starting to show up for Shuttle. And they were in three categories. There were a set of NASA payloads; and, in some respects, they were a little difficult to deal with. Difficult—there was some resistance to the Shuttle within NASA at the other Centers. And it spilled over into some of these discussions in an—unfortunately.

There was the Department of Defense, who also was being kind of—our decisions were made at high levels that the DoD was going to get on the Shuttle and Shuttle was going to be the only vehicle for economic reasons and so on. So, the blue suit folks who had been flying their payloads all along kind of resented that. And it was a difficult accommodation to make for them, and difficult for us to figure out what was motivating them and try to keep them happy and so on. But it was a learning experience for us.

And the one that was the easiest to deal with was the communication satellites. Because they had somewhat the same interest we did. "Look, we want this interface to be simple. We want us to be able to repeat it every time we do it. We don't want it to be complicated or expensive." And we've learned a great deal by dealing with those folks, learned a great deal in terms of what needs to be done, what should be done, and so on. And they represented kind of like the minimum standard that a commercial view would derive for services. So, they—usually requiring less than, or even far less than, the NASA payloads, who've got a lot of civil service guys who could sit and dream up a lot of stuff; likewise on the Department of Defense side. They were used to a certain amount of servicing, and they had a lot of people who expected to get the same thing here on the Shuttle side. So, it was a learning experience for us in finding these different categories or camps of potential customers for the Shuttle, and then figuring out how to price it, and how to prorate it amongst users who weren't using up a full Shuttle flight, etc. It was quite a learning experience for us.

We learned about the effects of—or the strategy of using insurance. The communication satellite people used insurance as a hedge, you know, if something went wrong with—the government doesn't do that. DoD doesn't do it and so on. But it was a new idea for us, to find out about insurance and how it worked and how people used it. It was interesting to find out that people who came to fly in the Shuttle came from other countries. And just as we found in the case of the Russians, and maybe because of our experience with that, we were sensitive to the fact that they would have pressures on them that we would not even think of. You know, and we wouldn't know exactly what they were; but we tried to operate in a way that respected the fact and the likelihood that they have pressures operating on them that are different from any we know, and different than any we could sit around here and think up. Therefore, we have to be careful how we deal with them, and we have to respect their degrees of freedom in trying to make decisions and make choices and so on.

As a matter of fact, I remember—do you remember when we had the flight when the nozzle—well, it turned out the nozzle fell off? And one of the PALAPA or the other one that went up that failed and—I guess it was a WESTAR failed in Earth orbit? It was a communication satellite that it turned out the nozzle fell off the motor that we had—fell off, broke off—and the satellite was stranded in Earth orbit. Well, the next guys up to do the exact same thing, on the same flight, were from Indonesia with the PALAPA. Well, all of our well-intended NASA hierarchy all wanted to put the arm on these guys not to deploy. And my reaction was, "Look! This is their decision to make. You have no idea what's going on in their country. You have no idea how much they may need this communication satellite. You have no idea what position these men, who are making this decision, are with respect to their powers-that-be back home. You have no understanding of their insurance. You have no understanding of anything here, except this technical stuff that you think you know all about. Butt out! Leave them alone! Let them make their own decision!"

And it was something that we learned, maybe starting with Apollo-Soyuz. I never thought about it that way. But we learned from dealing with them. And the NASA people who did not deal very much with payloads had this tendency to come in and just lard the NASA wisdom, whatever it was at the time, all over these people. And, you know, they had their own world to deal with and their own constraints. And we always tried to protect them. I mean, we tried internally with the NASA—the rest of the NASA system to protect them and give them what they wanted, and not get into their decision-making. It was their choice. A very difficult transition for NASA, who is a control and doing organization. Very difficult for them to get around to accepting that.

NEAL: It sounds to me like I begin to understand now why you got other titles, including Manager of the National Space Transportation Systems Program.

LUNNEY: Yes.

NEAL: Because that's exactly what you've just described to me.

LUNNEY: Yes. Well, that's a very fancy name for the Space Shuttle system. Now, Bob Thompson was the Space Shuttle Program Manager and took it through the whole—I think the whole development phase up through the first flight. Bob was the Program Manager up through the first flight. But by that time, I think Bob was ready for a career change and wanted to get out of that job; and, for a variety of reasons, whatever all, including the fact that I'd been working on this payload thing—customer thing, I should really call it—Chris asked me to be the Program Manager for the Space Shuttle. So, I was for 4 years, from '81 to '85, and we flew about 17 or 18 flights in that timeframe. And we went from, you know, the first couple of what we called OFT, orbital flight test, two men, ejection seats, and so on. And then we began to try to put the system in place that could handle all of the different customers who were going to fly in the Shuttle at an increasing flight rate and so on; and that was on the way. But—I guess I left in about June of '85—but it was really stopped and changed by the fallout from the *Challenger* [51-L] accident in January of '86.

NEAL: That's right. You left just before the *Challenger* didn't you?

LUNNEY: Yeah, 6 or 7 months. Yes. But 4 years in the Space Shuttle Program, we did an awful lot of things. We made a lot of progress with a lot of the customers. We made a lot of progress with the Department of Defense, with the Air Forces, their agent. We flew a couple of missions for them, and we had a lot of good things in progress. The communications satellite stuff was working very well. The NASA payload stuff was working well. Spacelab was working well—the thing that the Europeans developed that we eventually came to own and take over—we, the United States, came to own and take over—and bought another one from them. All those things were working pretty well.

I don't think it was—I don't think operating the Shuttle system was anywhere near as easy as people perceived and imagined it to be when they set about the decision process that said, "Shuttle's going to be the only launch vehicle, and we'll fly it 30 or 40 times a year," or whatever. That—you know, that would've been a giant strain if not impossible. I mean, you can do anything with enough money. But it would've been a very difficult thing to do. And it's an example of people getting trapped into financial arguments. In other words, the Space Shuttle was conceived as the next step, a way to shuttle up and down to a space station, and so on and so on. And then for funding, budgeting, Washington-oriented kind of reasons, the investment had to be justified on the basis of a payback, which then became cloaked in a picture that said, "The Shuttle can do anything for everybody, and it'll fly as many times as you want a year, and it'll be very cheap." It was kind of a—I don't want to say "a political answer," but it was almost a political position NASA took early on to justify the development of the Space Shuttle Program. And it became then an anchor around our neck for a long time, trying to live up to promises that people made to justify the system 10 years earlier. Which were difficult, if not impossible to meet in a lot of cases.

NEAL: Now as you look back across many more flights within the whole Space Shuttle hierarchy, you see a program that did, indeed, seek a level. That's really what it was doing, wasn't it?

LUNNEY: Yes.

NEAL: Seeking its own level. The number of flights a year. And I guess,—

LUNNEY: Yes, yes.

NEAL: —again, you come down to the same sort of philosophy that you might've had with the Apollo 1 fire. Was that an accident that had to happen? Or could it have been avoided?

LUNNEY: Well, the press of the business at the time of the accident was probably pretty high. And it was compounded by—we were working—the accident happened in January. The *Challenger* accident happened in January. In May of that year, May of '86, we were going to fly two Centaur-propelled interplanetary vehicles within a month or less of each other, so that the schedule had been just driven by flying these Centaur stages. And I say "Centaur." What I really mean is these were going to be stages that had hydrogen and oxygen inside them, inside the cargo bay. Represented a considerable risk that, you know, we tried to be very sensitive to and deal with. And then we had a set of safety requirements for them. We had to dump the propellants in case of an abort, and a complicated set of stuff. We'd have been better off not having to fly the Centaur and its payloads at all. But, the system was operated in a Washington-dictated environment that said, "The Shuttle's going to fly everything. And certainly it's going to fly these NASA payloads. And if these NASA payloads need this hydrogen-oxygen stage, unless you can prove that it can't be done, then we will decide to do it." So, we were in the position of never being able to prove you can't do it. But it got to be quite a load.

Now, had we been flying communication satellites, I think we could've flown lots of flights with communication satellites and not had a problem. The problem we got into was that certain NASA missions and certain DoD missions, because they're represented expensive projects, required expensive treatment. Which takes both money and time. And therefore, you know, if you're trying to run a railroad and somebody comes in and wants to change all the seats and all the cargo—size of the cargo vehicles you have all the time, it gets kind of difficult.

So, we had a little bit of a expectations problem in the sense that, we had this expectation of running a railroad with a lot of routine stuff, delivering coal, you know, or something, cars. And then there were people over here on this side, who were going to use the Shuttle, didn't have the same conception of it. They wanted quite elaborate treatment of their payloads. Quite expensive treatment in terms of time or whatever. And they had a right to say that, because they might be representing a very expensive, important, strategically important even, satellite; and therefore, they needed more servicing the communications satellite guys. Or at least felt that they did. So, it was kind of like a dichotomy or a conflict. It never really got resolved until it went away as a result of the accident. The requirement to handle all this other traffic was deleted.

The need to do that was deleted. NASA was sent back to the drawing board in effect and told, "Look run your own program internally. Don't fly any communications satellites." And the DoD made a DoD decision to get off it, based on the accident, and maintain a set of independent launch vehicles; which, by the way, I felt all along was a reasonable position for the country to take. The concept that all space traffic had to flow through the Shuttle cargo bay, to me, even as the Manager of the Customer Office and as the Manager of the Space Shuttle Program Office, that didn't make any sense to me. Now I—people did that because they felt that they wouldn't get any unless they forced it. You know, they wouldn't get any cooperation in terms of the government payloads. But, you know, it just to me never did make good sense that people should put all their eggs into the one single basket. And it tended to overload the basket.

Interestingly enough, the DoD has, by jumping off the Shuttle, done exactly the same thing on another launch vehicle. Just this time, they happen to control it so they're somewhat more comfortable with it. But they went back and put everything back on the Titan, and they don't have anything that's hardly—that's compatible with the Shuttle anymore.

NEAL: Well, they had an awkward position, too, in terms of the secrecy revolving around their missions and the way in which NASA operates in the public domain.

LUNNEY: Yes, yes. So, there are a lot of built-in conflicts to this image. Everybody wanted it to be cheap and efficient. But then all these other requirements and expectations and standards came to the program that other people had. And they were just incompatible. You couldn't make it all fit in a bag.

NEAL: I guess it comes down to one thing: Going into space, you can't be all things to all people all the time.

LUNNEY: I think that's right. I think that's right.

NEAL: You know, you were quoted as having said that "the Shuttle actually caused a change in mindset at the JSC from mission success as paramount to the payload's importance." Was that a true quote?

LUNNEY: Well, I don't know. I've said a lot of things, and that's probably one of them. But, I think the Center people gradually became more aware that what they were doing with the Shuttle, although to them it was an end, at a larger level of looking at it, it's a means—the Shuttle is a means to an end. And then the experiences that we had with the communication satellite industry, with the Department of Defense, and some of the NASA payloads, the people here at JSC who worked it from a Shuttle payloads point of view and a Shuttle point of view became much more sensitive to and supportive of the cargo activity that other people were. And by the way, not unlike the transformation that occurred when the operations team really began to engage the scientific community on the lunar science work.

You know, at first our priority was to land. But then having done that, and the point landing, then it became a logical sequence to start working with the people who represented the science and really get onboard that; and we did that. In this case, the Center, JSC, was consumed in the ’70s and early ’80s with developing the Space Shuttle, and they had no—the bulk of the people, the majority of the people, had had not much time to think about what it was going to be used for. They then began to engage all these different organizations that represent these different payloads. And I think most people who flew on the Shuttle—most organizations that had satellites or whatever that flew on the Shuttle—at the end of it, looking back, were pleased with the experience. I mean, I’m saying that. That may not be universally true. But I always had the sense of that with people, that after they went through it. But on the front end looking into it, all they could see was a hedgerow of difficulties. Bureaucratic, to them, difficulties that they didn’t understand what we were doing or why. Or, "why did we have to do this?" Or, "why did we have to do that?" But when they got all the way through and flew, especially those folks who might’ve had problems during the flight.

I think one of the outstanding organizations that we dealt with was Hughes, Hughes Communications Satellite Company [Hughes Electronics Corporation]—whatever their title was. They’re a crackerjack outfit. Technically, they were very good. But they were very can-do. We had several incidences—well, like, retrieving the two satellites that I talked about a minute ago, WESTAR and PALAPA. You know, we did that with the Hughes people, how to retrieve them, what to do with them, and so on. How to go about that. Hughes had the SYNCOM, a satellite where it failed to fire. It failed to fire. We went out and did this flyswatter thing and in effect it didn’t work, but it eliminated what would have been the conclusion as the cause. So, if we didn’t do that, we’d have been off working on the wrong solution.

We went back and fixed a bunch of stuff up, and flew a mission—Joe [H.] Engle flew in the summer of ’85—that actually recovered that satellite and got it on the way. And Hughes was a crackerjack outfit that way. And that interplay, because they were the predominant communications satellite player, plus they built a lot of DoD satellites, was really beginning to pay off for us. Because they were, in effect, similar to the NASA people in terms of response to a challenge. I mean, they just stepped right up to it and did it. And, you know, gangbusters. No tentativeness. No timidity. When they decided they were going to do something, they just went for it. And in that respect, similar to a lot of the people in the organization culture at NASA.

That was a good relationship. It was paying good dividends, and would've paid even bigger ones in the future. But then it all turned off with the *Challenger*.

NEAL: And right there, we just turned off because we ran out—

[End of Interview]