ORAL HISTORY TRANSCRIPT

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INTERVIEWED BY ROY NEAL
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NEAL: Let's go all the way back, when first you heard of some new organization called "Space Task Group." And I wondered, what prompted you to get into their scheme of things? How did you first migrate into the very beginnings of manned spaceflight?

LUNNEY: In the very early days, I remember when I got out of college—I got out of college in June of 1958—and across my desk came a drawing of the Mercury spacecraft, what became the Mercury spacecraft, with one person in it. It was drawn by Caldwell [C.] Johnson; he was at Langley. There was a group at Langley that was doing high-energy reentry studies. And they'd launched rockets from Wallops, and then they would drive them down into the atmosphere and then measure the heat transfer and the heat effects on different kinds of shapes of bodies—entry/reentry bodies. At Lewis, I joined a group when I got out of college—June of '58—that was doing the same work, except we used air-launch rockets. We'd drop them off the wing of a B-57 and they flew up and, again, drove the reentry test specimens down into the atmosphere at high speeds, and we would measure the heat transfer and so on and so on. So, when the folks at Langley began to start thinking about how this spacecraft—what became the Mercury spacecraft—would be designed, they called back to--at the time George [M.] Low was the Branch Chief, second level of supervision in NASA, and George was our Branch Chief, John [H.] Disher was my section head. John went to [NASA] Headquarters and Goddard [Space Flight Center, Greenbelt, Maryland] eventually but did not come here [to Texas]. But we started to communicate with the folks at Langley and began to start doing some studies for them up there to help them as we went along. It was sort of natural in those days in the NACA [National Advisory Committee for Aeronautics] world for different specialists who were working on different things to get together, compare notes, coordinate the research in effect, and so on.

NEAL: I noticed you said NACA.

LUNNEY: NACA.

NEAL: This was even before there was an NASA [National Aeronautics and Space Administration].

LUNNEY: NACA before there was a NASA. And we began to interact with them, and then we started to fly down there. We had a little DC-3 that Joe [Joseph S.] Algranti used to fly. And we would fly down on Monday morning, come back on Friday night. That didn't happen immediately, but probably by, oh, second half of '58, we were going down there fairly regularly, and then we'd understand what they were trying to do and bring the work back and work on it at Lewis [Research Center] in Cleveland, Ohio, sometimes. But after a while, it got to the point where we were spending just about full-time going down there.

Somewhere along the way, the idea that this was the Space Task Group came into vogue. I don't think I had that name connected with it when we first started. But they had a special place, kind of away from the main Langley Research Center, in another set of buildings. And we would go down and start working with them on how we might transpose these ideas, or take these ideas, that people had for the reentry shape and turn it into a

Mercury spacecraft and turn it into what became the Mercury Program, which was the beginnings of human spaceflight.

I remember, somewhere along the line, somebody said they counted heads at some point. And there were 35 of us; most of them probably, oh, 2 dozen from Langley, and then about 10 or 12 of us from the Cleveland Center, the Lewis Research Center. And, so I always felt I was part of the *Mayflower* team, in terms of human spaceflight, and I was fortunate enough to be right there at the time when this began. I remember when I went to college, I'd been a little model airplane builder and all the things that kids do when they're fascinated with airplanes. And when I went to college, I took aeronautics; there was no aerospace or anything like that in college. I took aeronautics because I wanted to be working in the field of flight, some kind of flight—aircraft flight at the time. And out of the blue my first month out of college, this thing came along to take a spacecraft—not an aircraft, but a spacecraft—to absolutely a new envelope in terms of altitude, speed, and place to go, and so on.

So, it was just—it was an exciting time for us, especially at the beginning. Although I expect at the beginning I, as a kind of a 21-year-old kid, probably I didn't have a very clear idea of what this was or where it might go. I just knew that it was going to be fun!

NEAL: Did anybody really have a good idea at that time of where it was going to go?

LUNNEY: Oh I think that was before, of course, the announcement for the Apollo Program, landing a man on the Moon and bringing him back in the decade. It was before that. And it was—I don't think it was clear. Now, it may have been clearer to some of our visionary leaders than it was to me; but, for me, this was just an exciting thing. I mean, the idea of putting people there! And, of course, the space age had opened. Sputnik flew in 1957, in October, and I remember I was at a wedding with a group of people [from] the Lewis Research Center. One of the fellows was getting married when the Sputnik thing occurred. And that began the *major* change in our country. That all occurred against the backdrop of the Cold War and the fear and concern that people had for where that was going to lead. It was sort of almost built into everybody at the time. I mean, when I was in high school and college, people were talking about building bomb shelters, and some actually did. There was that kind of a fear and concern for the competition with the—at that time the Soviet Union. So the background that we had for it was very real. And then Sputnik occurred, which was another indication that the Soviet Union was ahead; we were not. And the Mercury Project and the beginnings of it were—always were conducted and had the flavor of the American shot, the American beginnings, initiatives, to respond to what had been the Russian successes and victories early on.

NEAL: At that time, too, some of your thinking was already headed in military rocketry, too, wasn't it?

LUNNEY: Oh yes! I mean, what we had in the way of rocketry was basically a set of vehicles that came out of the ballistic missile programs. We eventually built some that were not ballistic missiles; but—for example, the first flight that we flew unmanned and then with the monkey and then with people, the Redstones, were initially conceived as small, tactical missiles—by today's standard small, but not at the time—tactical missiles for the Army. So, all of the rocketry that we had in the country was being driven by the ballistic missile idea, both short-range and long-range, eventually intercontinental range. And we were walking into a world where we had to convert these weapon systems into something that we could use for flying people. And at the time, I don't know how well people remember this, launching rockets was a very risky proposition. We had the Vanguard collapse on the pad. And we had so many other films, if not actual witnesses—at times I got to see them—of launches that just came apart right—either on the pad, practically, or right off the coast in Florida. So, our mental image was: we were in this race, we were dealing with these kind of machines, these launch vehicles that were really our means to getting to orbit. And boy, they were dangerous! Those things just blew up regularly. I don't know what our reliability numbers were, but if you told me it was 50% at the time, half of them failed, it would be easy for me to believe that that was true.

NEAL: A couple of weeks before Alan Shepard flew the first time, we had an Atlas failure in full view of our pooled cameras at the Cape.

LUNNEY: Oh yes. Oh yes.

NEAL: A couple of weeks before the fact.

LUNNEY: Yes, yes.

NEAL: So—no—there was some real—there was serious concern about whether the boosters would boost on the—

LUNNEY: Yes, yes.

NEAL: —spacecraft.

LUNNEY: But we felt confident that we could build a spacecraft that would work okay. But the launch vehicles, the boosters, were really scary! I mean, they just watched that stuff and it was frightening to watch it.

NEAL: You took your chances.

LUNNEY: Took your chances.

NEAL: And in so doing, one of the first chores I understand for you was getting a machine that would handle a man and getting a man that could handle the machine.

LUNNEY: Yes.

NEAL: I'm looking, of course, at simulation and how do you build this stuff that will work? And how did you set up control systems and simulators to work them?

LUNNEY: Yes. One of the things that we began to focus on, because of the riskiness of these boosters, was we called them "abort modes" but really they were escape routes. What would we do to get out, get away from the launch vehicle if something happened at various stages of it? We built an abort sensing system, and put it into both the Redstone and the Atlas vehicle, so that certain parameters could be measured on board the vehicle, and if things were going outside of limits and hitting red lines, then the vehicle could be shut down, assuming you could do that. But more importantly, the escape tower could be ignited and pull the astronauts—astronaut, singular—off the vehicle and then, of course, land him somewhere. A lot of that was kind of hard to determine where the landing would be, but when we got going fast enough we had a little bit of control, so we had a couple of specific areas that we would target.

But, we were in a search for a number of things. One, how do we make these rockets more reliable? And that was a problem that was addressed by people who were intimately involved with the launch vehicles at the time. And of course the Aerospace Corporation and the Air Force was providing the Atlas launch vehicle. So there was a fairly huge effort to so-called "man-rate" the Atlas vehicle. We put the abort sensing system on, which would add a degree of detection of impending failures and triggering an abort sequence. We had the design of the spacecraft to worry about. We had to put this thing in place so that all of this could be integrated in very short periods of time. I can't remember exactly, but the Atlas probably went from the pad to orbit within—I don't know—6 or 7 minutes or something like that. So, a lot of things happened very quickly. So we had to begin to plan on where to put our recovery forces, how to control any kind of accident, impending failure in the launch vehicle so that we had some degree of control over where we would land in the Atlantic. For a while we had ships spaced almost all the way across the Atlantic over to the coast of Africa.

And we began to also think in terms of, how would we train ourselves? And we had by that time begun the idea of a Control Center. And how would we train the astronauts to do this? So we began rudimentary simulators for understanding this kind of stuff and for figuring out what kind of displays to use, both in the Control Center and on board, so that we would know what was going on, so that we had some degree of visibility in it. And that we knew that—had the kind of information that we could make some choices about how to control the sequence of events in an operational way. So we built relatively crude simulators.

We eventually—I think we called it a procedures trainer for the Mercury spacecraft that we had at Langley.

And we—today, you can build a simulator where you can have something happen and then everything becomes so nice and digital and programmable that you can make a response, and then the vehicle responds that way, and the telemetry responds that way, and the people on the ground and the crew can see it. In those days, it wasn't anywhere near as clever and as capable as it is today. We would plan something, and often what happened was different than what we had planned. And then we would make tapes of everything, so that when we had an abort we would play a *tape* of the abort. Because the system just wasn't as close-loop or as flexible as the systems—the training systems—that we have today. So our simulations, especially then when we got to simulating both the Control Center in Florida and at Cape Canaveral at the Air Force station down there, and in for the stations around the world, we did all that with *tapes* that we would build ahead of time, ship around the world, and then try to keep what we had planned to happen in sync with what was really happening, that often did not work out that way, and we would have tapes that would go down Path A when the team was decided to go Path B and they would be—

NEAL: Even when it came to making tapes, you were in an era when videotape was just coming in.

LUNNEY: Oh, we hardly had it.

NEAL: It was a crude science, too.

LUNNEY: Yes, we hardly had them.

NEAL: The tape that we're using right now—

LUNNEY: Right.

NEAL: —is a far cry from the tapes you used.

LUNNEY: Think of video. We didn't even get around to videoing until, what? Gemini and Apollo Programs.

NEAL: Well, you had video. As a matter of fact, we even used videotape at the time of the original Shepard flight. But it was crude.

LUNNEY: Yes.

NEAL: It was a big, 2-inch—

LUNNEY: Yes.

NEAL: —quad.

LUNNEY: Simple stuff.

NEAL: But as you look back across, when you say tapes you really mean data tapes.

LUNNEY: Data tapes, yes.

NEAL: Telemetry type.

LUNNEY: Telemetry data tapes. And then telemetry would come down, and then someone would send the command and, of course, if we predicted what they were going to do, well, then, the tape would be right. But as often as not, what we predicted would happen and when it would happen was different than when it actually happened, so that the tape was—the tape system, in terms of trying to pre-plan and pre-can the simulations and the training exercises, was very difficult.

NEAL: Think back with me for a moment on the old Mission Control, Mercury Control, at the Cape.

LUNNEY: Ah yes.

NEAL: Remember just a little about that—

LUNNEY: Yes.

NEAL: —and what it meant to you. Because you moved—

LUNNEY: Ah yes.

NEAL: —on from there into a—

LUNNEY: Yes.

NEAL: —progression of what's here in Houston.

LUNNEY: Yes. Ah, the Mercury Control Center in Florida was a place that I loved. I mean, I have come to think of the Control Center in Florida, and now especially the Control Center here in Houston, as a kind of a church. It was a cathedral of sorts where we went and did what we thought was important work for our country and for humanity, and we did it in this place where we all came together and struggled, mightily at some times, with the problems that we faced and reaction response that we had to bring to the table. And when I go in the Control Center now, I still have this sense of coming back to the church or the cathedral of my youth where we did important—I don't want to put a religious word on it—but we felt that we were doing something very, very important—and very important for mankind. It was a big step for us, because until that time flight had been airplanes. And here we were taking this really major step to go somewhere else.

So the Control Center at the Cape, where I was a Flight Dynamics Officer, and we had a little corner over on the right-hand side where we had our plot boards that would track the vehicles and tell us where they were, and we had—our computers were actually up in Washington, DC—on Pennsylvania Avenue! The computers we used to run the system that we had in Florida, the Control Center in Florida, basically were on Pennsylvania Avenue in a big IBM building—a small IBM building—in Washington, DC. And we would, of course, send all the tracking data to the computers, and then they would compute the trajectory, send it back to the Cape, and display it on our plot boards. And when we got in orbit, we would also use the same system to calculate the deorbit times for the various landing points that we had scattered around the world in various oceans that we had recovery forces in.

So it was, again by today's standards, a relatively crude system. The telemetry was all analog, so it came down in Florida and then got processed and displayed on meters. We didn't have any cathode ray tubes, any video screens that people are commonly looking at data today. Everybody has their PC. But we had little meters for all the telemetry, and then we had some—we had these built-in displays into the console with little numbers, almost like a clock, where we could calculate and display the retrofire times for the various opportunities we had to bring the spacecraft back.

NEAL: The big plotting maps, were they manually controlled, or were they—?

LUNNEY: No, they weren't manual, but they were—what had grown up in Florida was: The Range Safety Officer used this kind of a plot board, where they tracked the vehicles. Range Safety Officers had an interesting job at that time because their job was to monitor all launches and be sure that the vehicle stayed within certain boundaries. And if it went outside of those boundaries, representing a threat to landing on something in Florida, then they would destruct the vehicle. And, that a couple of plot boards were used in the Control Center, where the follow-on to that technology that had been developed and used, probably for a decade, or maybe not quite that long, we hadn't been flying quite that long, but something of that order; probably 5 years in Florida. And then we used those in the Control Center. And, of course, in the front of the Control Center, just like today, we had this great, big world map that kind of moved a little symbol of the Mercury spacecraft across the map so that we could at a glance see where we were, what stations we were coming up on, what our comm was, what our communications would be with the crew on board the spacecraft, and how much time we were going to have. I mean, we have today, with the tracking and data relay satellite, almost full-time coverage, full-time communications, both telemetry, command, and voice, video, etc., from the Shuttle as it flies. In those days, the only telemetry we got was when it was over one of these little circles on the world map, which were about 5 minutes big in terms of spacecraft travel. And that was if you went from the maximum points on this circle. Sometimes it just skimmed the edge of the circle, where you'd have 1 or 2 minutes of communications.

So, our brains began to be driven by: What do we need to communicate? What's our next opportunity? What do we need to get done in this pass in the way of conversations with the crew? And then, what do we need to do in terms of problem-solving? What do we need to do in terms of recommendations or direction to what we were going to do with the flight? So we all got *tied* to this little 5-minute circles that were spotted around the world, where we had teams of people. We didn't even have high-speed communications that could take the telemetry and bring it back to the Control Center. The telemetry was all processed locally at each one of those stations, where we had a small flight control team that was like an extension of the Control Center. But while the crew was overhead for that station, that little team handled the whole thing.

So you had to prep the team ahead of time with what you wanted to know and what you wanted to do. Often, the crews would report something that was different than had been happening before, so you had to modify your plan in real time. And one of the things that caused to happen in all of as, certainly in me, was you had this tremendous sense of time-sequencing and time criticality, and I must get this done by, I've only got 2 minutes, and so on and so on. And either it's innate in me or I developed this. You could almost, in your head, keep track of the time in the sense of: When was the next pass? How much time were you going to have? What did you need to get done by? And that there was going to be an LOS, or a loss of signal, in a little while. And that clock was also ticking in here, and you knew you had to get things done in just a matter of a few minutes, in many cases, to keep the mission on track and keep it communicated, keep it well tagged up between the crew on board and the people both in the Control Center and that team of people that were scattered all around the world.

NEAL: You even had astronauts at some of those tracking stations—

LUNNEY: Yes.

NEAL: —just to keep them honest—

LUNNEY: Yes, yes.

NEAL: —didn't you?

LUNNEY: And we had what we now call the Capcom position, and we had that at each of the tracking stations, so that the communications with the crew, even in those days, both from the Control Center and at all the remote sites around the world, was conducted by a fellow astronaut who would be sympathetic and understanding of the physical and technical situations that the crews would face, and would help translate that to the folks on the ground who were looking kind of at like what a system was doing and how—a subsystem—and how it was behaving. And the Capcom provided the bridge between what the system/subsystem was doing, how it was behaving, what do we want to do with it, and the way that would be communicated with an astronaut on board in terms of what switches to use and so on and so on.

So it was quite a learning time. And I think all of us developed this sense of having internal clocks that are running all the time. I find even today that I am impatient with time-wasting talks that seem to, you know, branch off into what I consider to be irrelevancies and they don't quite get to the point. I mean, we dealt in a world where: What are the options? What is your recommendation? What do you want to do? Let's get on with it. And it was all measured in minutes, some cases even seconds. So, it was—time became very, very precious to us and drove many of the processes that we put in place for dealing with controlling the flights. And I think it has carried; it carried with me the rest of my life. Time is very precious, especially when you're trying to deal with something in a business sense or today in a technical sense or a program sense. And I get impatient when things get off track and wander around a little bit, and I go back to the mode that we had, which is: Look, what's the situation? What are your options? What's your recommendation? Let's be crisp and clear about it and get on with it. You know, go/no-go kind of became—the go/no-go, I guess, terminology entered the vocabulary as we built our methods for handling spaceflight. And go/no-go means: Is it yes, or is it no? You know, make up your mind!

NEAL: Don't give me anything in between.

LUNNEY: Yeah. I don't have a lot of time to listen to a lot of this stuff. Is it yes, or is it no? What do you have to do?

NEAL: Did it surprise you that those military boosters that were used in the beginning performed as well as they did? You never had a major failure.

LUNNEY: No, not after the first failure that we had that was—what?—MA-1, Big Joe, I guess, we launched and we had a problem with it at the regime of maximum dynamic pressure where the biggest loads were on the vehicle. And it got—and then we learned from that, and put a belly band around the place where the launch vehicle and the spacecraft came together and strengthened it so that the rest of the Mercury vehicles flew well; the Mercury-Atlas vehicles.

But, yes, I was surprised, because by the record that we had—and not being able to quote reliability numbers today—but the record we had was: We had a lot of problems and a lot of very violent, catastrophic losses of vehicles that surely gave us great cause for concern. But the work the people did on understanding those failures and fixing them, the design and engineering work, the abort system that we put in place, and then all of the thought processes that we put in place to deal with the Control Center, the interaction with the crew, and the selection of escape routes, mission rules, all that stuff began to come into place, so that we began to have at least a sense of, "Well, if something happens, we have a system that can detect it and get the spacecraft off. Or we can shut it down and get on and do something in terms of choosing one of our escape routes." I even had a "shut down the booster" switch on my console, so that if it were going badly I could shut the Atlas down and then we would move into one of our escape modes; abort modes.

NEAL: Not to say, too, that everything went all that smoothly. There were times when you physically had to make a save or make a decision—I'm thinking, for instance, John Glenn and the pack—

LUNNEY: Yes.

NEAL: —retropack—

LUNNEY: Yes.

NEAL: —that stuck.

LUNNEY: Yes, yes.

NEAL: Would you like to tell us about a little of that?

LUNNEY: Yes. Let me first say that in the job I was in, which was flight dynamics, was basically a trajectory monitoring job. I didn't have too much to do at that time with the subsystems, although I knew about, of course, the subsystems that affected our planning of the trajectory, such as the retrorockets and so on. But, in the course of that flight, which by the way 3 revolutions of the Earth is 4½ hours; it's not a very long period of time. And somewhere in the course of that flight, I can't even remember how early it occurred, there was an indication in the telemetry that the heatshield itself may have come loose. That is, the heatshield that we were counting on to protect the vehicle because it had a big bag in it. There was a natural separation of it at some point when it gets on the water.

But, the indication came through that we had—possibly the heatshield released, so the concern was, was it really valid? And, what can we do about it? Well, the truth is, when we instrumented the vehicle early on, we did not have in our minds the concept of having multiple ways to measure and detect things. So that as we fly now, well, you can get this measurement and then you can confirm it, usually, with several other measurements downstream of this event, so that if it says "The pressure's wrong," for example, *here*, you can look at what's happened down here in the system and you can correlate it and say, "Yes, it's really true." Or, "No, there's something kind of funny about this measurement."

In those days we hadn't really evolved to that level of sophistication, so we had this little measurement staring people in the face, saying the heatshield might've come loose, which would portend, probably, loss of the vehicle during entry, or at least that had to be the concern. So, despite all our efforts to try to understand whether that was a false or a correct reading, it was inconclusive. The only action available was: Well, the retrorockets were on the front of the heatshield and they were strapped to the back end around the corner of the heatshield. So the only action that anybody could think of was: Well, maybe we can leave the retrorocket package on and that will tend to keep the heatshield on for as long as this package was going to last on the front of the vehicle. Now, of course, that introduces a whole set of different aerodynamics than we had planned for and studied for. And, fortunately—as matter of fact, I could make a speech about how fortunate we have been in the space program in terms of events and in terms of people. But fortunately, of course, Max [Maxime A.] Faget was around, who was the father of the design, the blunt body shape for this vehicle, who had almost an intuitive, instinctive feeling for how things fly and how they work and what would happen. And I think Max was satisfied that we could leave the heatshield retropack secured and it would not change the aerodynamics enough to be of concern, that the vehicle would still fly okay, based on his judgment. Based on his judgment, his intuition, and however many years of experience—15 or so, probably, at that time—that he had had in thinking of and experiencing, studying these kinds of effects.

So the decision was made to leave the retropack on. It came as a surprise to John, I'm sure. And that's the way he reentered, and it did indeed work okay, work well. And John, of course, was recovered fine. And it turned out in retrospect that the indication was false, and that we really didn't have the heatshield coming loose. Which drove us to thinking about, "Gee, how do we really—?" It's like the human body. How do we instrument this human body so that we don't decide, just on the basis of one flimsy measurement, that we've got to go in and operate on you, but rather that we can measure a couple of different things and before we take any action, like operation on you, we will know what your problem is and that we are indeed attacking it appropriately and not chasing a false measurement and—you know, doing something to you that you don't need to have done in the first place.

So, the whole idea of how do you instrument the vehicles and how do you begin to use that instrumentation, then how do you build it into, a let me call it, a code of ethics. We began, early on, to conceive of the idea of mission rules; that is: "What would we do in these circumstances?" A whole bunch of our world was driven by "what if?" What if this? What if that? What if this? And this was this chess game we played with mother Nature, I guess, and hardware as to: What are we going to do if this happens? What are we going to do if that happens? And gradually we evolved both a way to instrument the spacecraft so that, when we were trying to detect something, that we had various ways of knowing that we indeed were really defining the problem; and then we had to develop this code of ethics about how far were we willing to go in continuing the mission in the face of various kinds of failures? And when we started on that, people had a fairly—it was sort of intuitive. Well, if this happens, I should do this. But we gradually began to build first off a kind of a philosophy of risk versus gain. The risk we're taking appropriate to the gain that we are getting out of any decision that we made? And then we began to build a framework below that for how much redundancy we wanted to have remaining in order to continue. So that if we lost, or if we believed that we had lost, certain kinds of systems or capabilities, we developed an attitude about how much redundancy we wanted to have to remain in order to continue the whole mission. And if we passed over the threshold of having enough redundancy that we wanted to have to continue, then we were into one of these no-go conditions where, okay, we're going to start looking for the closest place to come home. Fortunately, in the Mercury spacecraft and a lot of the others—although occasionally that's not true—we found ourselves in a position where we basically had enough capability to continue, usually to the end of the nominal or normal planned mission.

NEAL: There was another player of that era whose name comes to mind: Walter [C.] Williams.

LUNNEY: Yes, indeed. You know, there were so many names of people, and so much of it can get lost. I realize now at this stage of my life that the contributions and the work and the problem-solving that went on is understood by peers—the peers at the time; peers are those involved—but is lost really to the outside world. I mean, outside of this small collection of people, maybe measured in 100/200 people, when you get outside of that size of a group, there isn't a full understanding of what all the internal considerations were. But, you know, again, the space program, we were fortunate. It's almost reminiscent of the people who show up in American History when they're really needed, the kind of people who show up. At this time, we were embarking on this great challenge. Dr. [Robert R.] Gilruth was leading the team in the Space Task Group and eventually in the move here to Houston. Dr. Gilruth was a genius. He never got the publicity or the attention or the credit that he should have gotten for what he put together to put this human space program on track. We called it a "manned space program" at the time; now we call it "human space program." And he brought in—Dr. Gilruth was kind of a analytical designer, kind of a person with a lot of research experience from Langley. When we began to realize that we were going to be dealing with these vehicles in what you and I came to know as an operational way—which is, they're flying; what are we going to do with them? what decisions are we going to make? how do we put in this instrumentation? how do we feed this intelligence into a Control Center system with remote sites? how do we pull all these people together and build a set of rules for them? how do we do all that?

Somewhere, somehow, that I don't know, Walt Williams showed up. Walt had been at Edwards in the X Programs, airplanes, and was a major player out there at Edwards. Came to the Space Task Group and began to focus on the operational end of life, as differentiated from the design of the vehicle end of life, although he played in that sphere also. Walt was also a absolute powerhouse in the NASA management of the launch vehicles. He almost single-handedly—almost single-handedly, with maybe one or two helpers—interfaced with the Air Force and the Aerospace Corporation in their building of the Atlas vehicle, and of course they were the experts on it. But Walt managed that activity from a NASA point of view and from the manned flight point of view, and *built* into their system, and eventually into their factories, this whole idea of Snoopy awards and so on, began to take shape in those early days where NASA, at the time in the Space Task Group, and the astronauts realized we need to really get out and touch people who are making these things in factories so that they really know what they're being used for and the criticality of them. And out of that came some of those early awareness recognition activities. They—for example, in factories where they were building launch vehicles for both manned use and other use, they had a way of tagging parts that were going to be used for the manned vehicle. I don't remember how exactly they tagged them. But it was a sense of trying to build an awareness and a sensitivity into everybody that handled the flight hardware.

Then Walt came and Dr. Gilruth was overseeing the whole event, including Max that represented the design—Max Faget that represented the design half. Walt came in and started to think about integrating a set of flight crews with the Control Center and with the ground crews and with the new launch vehicle *use* that we were going to make of the Atlas. And he began to work on that problem. And again, America's inventory of talent, out of that also came Chris [Christopher C.] Kraft [Jr.], who became Walt's right-hand man, I suppose you could say. And Chris saw to the operation, the building of, the operation of the Control Center, the operation of all the remote teams. He built the mission rule idea with help, of course, from his staff. But he was—for us, Chris and Walt and Bob Gilruth, I mean, they were just *leaders*. I—so much attention is paid in modern times to management and leadership and what that is and how it works best. We were in it. Absolutely, completely in it, because we had the *best* of leaders. And we always felt that way. We had the absolute best of leaders! And, they were—all of us were aligned with accomplishing the purposes of the program. And they were on the front lines with everybody else. They made tough decisions. They were *tough*-minded in what had to be done. And they made sure that it happened.

The simulations we used to run, oh, woe be to him who screwed up! Because, we debriefed each simulation, and it was confession time. It was absolute confession time. Whatever happened, you had to recount what happened, what you saw, what you did, and why. And, occasionally people would do something that was a little bit not correct or incorrect, as seen in retrospect, and they would suffer the humiliation of exposing themselves and maybe even getting some chewing on for whatever they did that wasn't quite right. But it built a sense of real teamwork, and our leaders were in front of us. I mean, they were not behind saying, "Go do this." They were in front of us. They were making all those kind of tough decisions at their level in their spheres of activity also, just as we were, for example, at the planning level and at the console level in the Control Center in Florida—the Mercury Control Center—and then eventually back here in this Control Center.

I watch this Control Center operate today. I still see, I *really* see, Chris Kraft is still there. I mean, the attitudes, the techniques, the balancing of risk versus gain, the sense of how much you can do, how far you can take things, when to back off, all those things got instilled in us really by Chris, and with help from Walt, who was one level up, doing a variety of other things, including this launch vehicle management that I talked about. But today, the Control Center is operating the way Chris Kraft designed it to operate. I'm talking in terms not of the technology, but in terms of the *stuff* that people deal with and the decisions that they're trying to make. The balances that they're trying to make on decisions, as to how much risk to take versus how much gain. All of that is still very, very operative. The attitudes of performing well. The simulations and the debriefings and the confessions. And the compulsion or obsession, almost, that people have with doing it well and not screwing anything up, but doing it very well. Knowing what they're doing, being prepared. All those things are still alive over here in this Center, and they started with Chris. He was the hands-on manager/leader of that activity, and he instilled a sense of what was right, what was wrong, what you had to do, how good you had to be, and those standards that he kind of inbred into everybody, by his own example, and by what he did with us, continue today. The Control Center today, the operation today, is a reflection of Chris Kraft.

NEAL: Did it help that early on you had a goal? You knew where this program had to go. Shortly after, in other words, Mercury started—

LUNNEY: Yes.

NEAL: —flying, suddenly here was the target thrown right in your face—

LUNNEY: Yes.

NEAL: —and with all these icons at work that you've described, you now had a sense of direction. All you had to do was figure out how to get there.

LUNNEY: Yes, yes. Although, I have to say that, when I first heard President Kennedy's speech at Rice University, I was overwhelmed at the magnitude of it. I mean, we were launching things and struggling with spacecraft that weighed 2500 lbs, 2000 lbs, you know they were about a ton; the Mercury spacecraft was about a ton. We were talking about doing something with launch vehicles and with spacecraft that were 10, 20 times that big, or more! I mean, a spacecraft that would be 10 or 20 times bigger. And for me it was over—I mean, it was just an overwhelming thought that we could actually go and land on the Moon and bring somebody back. It really was. And yet, you know, capturing history is good because it's only somewhat recently, in the last 10 years or so, where I've begun to reflect on what we did and how it was and so on. At the time, we were consumed with getting on with the next step of whatever it is we were doing that month. In other words, we had so many of the—for example, the early Redstone launches, where the first one I was down for, the bloody thing lifted off, shut down, landed back on the pad, the escape tower blew off, and all the parachutes came out. I mean, I was over with the Range Safety Officer for that flight, and I was nervous as a cat going into it. I was probably 22 or [2]3 at the time, and since I had worked on all this trajectory stuff they said, "Well, go watch to see what the Range Safety Officer does." Well, I was nervous as the devil being in there, and this Captain—I can't remember his name—was just calmly doing his job like he'd done all other flights, he's going out for breakfast. I mean, the idea of having something to eat was beyond anything that I could believe at the time. I just couldn't eat anything. I was so—my stomach was rolling and nervous. And then this vehicle shuts down on the pad! The motor goes, the chutes pop out.

And then we went on with that series and flew 1, and we flew the monkey on one of the Mercury-Redstone flights. We flew another extra flight in there because something didn't quite look right to the folks in Alabama, to the Wernher von Braun team. They wanted to fly an extra flight before Al's [Alan B. Shepard]. And then while we're getting ready for all that, in the middle of all that, Yuri Gagarin flew a month or so before. And then we—I guess we flew Al, didn't we? before the—or was the announcement before Al flew? President Kennedy's announcement?

NEAL: Kennedy after—

LUNNEY: After.

NEAL: After Alan—Alan was his vehicle. We flew Alan to decide to make it big enough.

LUNNEY: We flew this one thing 200 or 300 miles downrange, and this little bitty thing that only weighed a ton, and, by comparison, this little rocket, this Redstone. And here we were. I mean, the *boldness* of the decision-making and the *challenge* that it presented to the country, and to the technological, technical community, was just *staggering* to me. But, we were so busy that it was, "Well, okay, I guess we're going to do that. So let's get on," and we'd get on with the next flight, the next flight, the next flight. And, by that time, we had, of course, another Mercury-Redstone with Gus. And then we had a number of unmanned Atlases that we flew. And then we finally flew John Glenn in February of '62. And then we ticked off the others reasonably well: 6, 7, 8, and 9—Mercury 6, 7, 8, and 9. They went pretty well. And, I can't remember how close they were to schedule, but as well as we held schedules in those days, they went reasonably well.

But, the enormity of what we were asked to do—I mean, I think we were all aware that it sunk in, I think, it had sunk in to us what we were being asked to do. The *scale* was just, it was just immense. And at the time we were dealing—people, people have a hard time remembering they were relatively simple, almost crude spacecraft. The only thing we could do with the Mercury spacecraft to change its direction was to fire the retrorockets and come home. I mean, we could control the attitude. But the only thing we could do to change where it was and where it was going to be and change its direction would be the retropack that brought it home.

NEAL: So along came Gemini, and, of course, the need for a whole new Control Center.

LUNNEY: Oh yes.

NEAL: You had to mature.

LUNNEY: Yes.

NEAL: The program had to mature—

LUNNEY: Yes, it did.

NEAL: —to that level before it could go ahead.

LUNNEY: Yes. I had another perspective on the events there, too. Let me say it this way. In Mercury, we had a relatively simple, one-man spacecraft. No EVA; no maneuvering; no guidance; no rendezvous; no kind of experience like that at all. You couldn't even get outside the spacecraft, right, until it—after it landed. We flew 6, 7, 8, and 9, a couple of 3-orbit flights, a little longer than that, and then about a day on Gordo [L. Gordon] Cooper's [Jr.] flight. So we had a relatively small amount of experience.

Now let me jump you to Apollo. We had a couple of unmanned flights that I worked on, different Saturn rockets. But in the manned sequence, we had Apollo 7 that flew 10 days on orbit, manned—3 people. We had the incredibly courageous decision to do Apollo 8, an absolute breakthrough, gutsy call. We did Apollo 8 on the *second* Apollo flight; and then we did 9, the LM in low-Earth orbit; 10, the whole thing out around the Moon; and 11, we landed, which for us, by the way, felt like downhill from Apollo 8. Apollo 8 got us to the Moon; we were in orbit around the Moon; and all the getting there's and the getting back from there's had been figured out and worked out. So, Apollo 8 was a real gate-opener to the landing mission.

But, think about that. We had *four* orbital flights with Mercury, that were relatively crude and simple. And on Apollo we went to a 10-day flight. We went around the Moon. We had a lunar [module] flight, both in Earth orbit, and around the Moon, and we landed in five flights. We would *not possibly* have been able to jump from Mercury to Apollo without this training, vetting ground that we had called Gemini. We flew—what?—10 manned missions, 2 seats, different control of the launch vehicle. We put a lot of these things in that we had learned in Atlas, and we had a redundant guidance system, and, I think, even hydraulic system on the vehicle. The Gemini—it was then a Titan launch vehicle we were using under the Gemini spacecraft. But we had two people. We had digital computers. We had maneuvering capability. We did EVAs. We rendezvoused. We docked. We actually tethered, as you remember, and swung one of the Agenas around. We did guided reentries to real landing targets, not just the see-what-happens thing that we were doing in…Mercury. And, we made that jump from four Mercurys. And then we—you think about the sequence of manned flights for Apollo. The reason we were able to do that is, we had this team of people—planners, the flight crews, and the Control Center and its team of both planners and actual monitors, flight controllers during the flight—and that team of people came out of Gemini with a tremendous amount of experience. We had fuel cells that flooded. We had thrusters that clogged up all the time. We brought a mission down early—Gemini 8—out in the Pacific. We rendezvoused and docked with a—both rendezvoused with two Gemini spacecraft, when the Agena went in the drink, and we rendezvoused and docked with Agenas. We docked them and burnt the engine on the—ignited the engine on the Agena, went to high altitude. We did EVAs.

Looking back on our EVA history, we again were kind of simple-minded about it. We didn't realize how difficult it was going to be for people to hold themselves in position. We were probably deluded by the Gemini 4 experience, where Ed [Edward H.] White [II] went out and just kind of floated around. But when you have to go out and stay somewhere and work, we found the crews were expending so much energy to work that they were overloading their air-condition systems, their helmets were fogging up. And the spacecraft were limping; fuel cells, thrusters, God knows what else would go wrong.

But by the time we got through that program, we had experimented with all kind of rendezvouses; we'd built that into our code of ethics—all the learning that we had experienced. We had a very, very *strong* team of people who had the sense of how to conduct missions—the flight crews, the planners, the ground guys. And the Control Center here in Houston just became more and more capable as we went along. And we were able to do the five flights in Apollo because of what we did on Gemini, and what we learned together. The operations team; all those people—several hundred, maybe, is the total number of people I'm talking about—came out of the Gemini Program gangbusters to take on Apollo. We were ready to take on Apollo. We *stumbled* with the fire. It took a while to recover from that. But the sense of this elite team of high-performance people that came out of Gemini, coupled with the people who had been planning for the lunar missions, came together and, by the time we got the hardware for the Apollo missions, we were more than ready, more than anxious to grab a hold of it and get on with it.

The Gemini story is a terrific story of a bridge that allowed the Apollo sequence to go so well. Had we not done Gemini, Apollo probably would have taken us 10 or 12 flights to land on the Moon. And something probably would have happened in one of those flights—witness Apollo 13—that might have changed the whole history of events. I think even amongst us, we don't stop to reflect on it in a way that says, "How quickly would we have been able to do Apollo if we had not done Gemini?" The answer is: "We would *never* have had the courage to fly, for example, the first flight 10 days. We would *never* have had the courage to fly Apollo 8 around the Moon on the second manned flight. Etc., etc." It would have taken us a dozen flights or more to do that.

NEAL: During that era, you helped write the mission rules.

LUNNEY: Oh, yes.

NEAL: You broke-in Mission Control.

LUNNEY: Right.

NEAL: Let's go over some of the things that were done during that time; the mission rules, for example.

LUNNEY: Right.

NEAL: What did you build into there? How *casual* were those mission rules? How bendable were they?

LUNNEY: Yes. I think I would first, again, put a little context on it. Chris [Kraft] was our natural leader, and he had a number of key players who were in the same age group as Chris—mid-30s or thereabouts. Then he had a bunch of guys like us, who were all in their 20s. So, we came to all this as energetic, perhaps a little brash, but probably quick learners for the most part. I'm always amazed at the talent that—again, the country needed something, and this talent got called out. We were not, you know, selected by any process that says we were the best and the brightest. We just managed to be here and to grow with the job. And even—and, of course, within that, some were quicker than others. But even the ones who were not as quick as the others ones knew what they had to do and worked at it and did it very well. Even if it was a big stretch for them to do what they had to do.

So, we began to build what—our technical term is mission rules. I think of it as a code of ethics. We began to build something so that, when we flew, we and the flight crews would know what we were going to do under certain sets of preset circumstances, which allowed us to develop this ethics base for, "Okay, well, if we got into something we hadn't planned, how far would we be willing to take it?" We found that most of us in responding to circumstances, we'd end up with about the same solution, given the right amount of time to work on it, so that we did have this sort of common base. And we developed it by just starting to sit down and write: What am I going to do if this happens? What if this system fails? What if the trajectory deviates over to this line? What if we lose communications with the crew during ascent, during the powered flight phase of the vehicle, etc.? And then we would write these down and then we would bring them in and we would argue about them—*emotionally*, argue about them. And it wasn't like we had the code all figured out before we started writing. We started writing sort of and met in the middle. We started writing and we gradually tested everything and argued about it and decided whether that was really right or not for that what-if condition. And as we did that from the bottom up, we began to realize that we had a more—that we could capture our more umbrella approach, or a higher-order approach, to this in terms of: How much redundancy do I want to have left to continue? And that became aware of risk versus gain. We had a way then of packaging up at that level and then we began to reflect all these individual rules against this higher order of thought, so that the more that—and we would do that hour after hour, day after day, where we would bring in and argue amongst ourselves and then argue with the next level of people, the Flight Director or the full team, then we would argue and discuss with the crews, and then we would do it all over again when we ran some simulations and tested it.

But we gradually built this very strong, common understanding of: how far were we willing to go; and when would we pull back? You know, stop doing something. We developed this so that—and it served us well, Roy, because we encountered a lot of different things, especially in Gemini and then in Apollo, where the communications amongst people and the decision processes that were going on in people's head was almost like—it was almost like a—*Star Trek* calls it a "mind meld" or something like that. But we knew what we were thinking without even having, perhaps, to express the full thought. And everybody, *everybody*—the crews, the folks in the Control Center—got comfortable that we kind of knew how far we were willing to go, both for the cases we had defined, the what-if's, the mission rules, and that provided then a basis for us to respond to whatever else might happen in flight. And we generally would arrive at about the same answer, given the same def—

NEAL: You wrote them—

LUNNEY: —definition of problem.

NEAL: —so well that they're still in effect today, are they not?

LUNNEY: Still in effect. And they continue to be tweaked and tuned, but fundamentally, they haven't changed very much. And the other thing that happens is, as a result of this documenting, testing, melding, arguing, and then fitting it into some higher-order way of thinking about them, became a system of thought for us.

As a matter of fact, I suspect in almost any business that you could mention, the people go through something of the same thing. They may not have been as explicit about it, in terms of risk versus gain and being sure that you know what you had to do before you do something and not just taking action for the sake of action. I mean, it's a lesson that all professions apply in their various ways. They may not say it the same way we did, but we kind of tried to get to the generic or the general underlying principle that we were dealing with, and I suspect that everybody does it the same, more or less. They may articulate it differently; but decisions are risk versus gain in personal life too, and professional life. Do I want to do this? What's it going to cost me? What's the downside? What's the upside? Is it a good choice for me or my family? Or whatever. And, it works. It works. And we had enough time to pound on those things and then to test them in simulations and then to test them in flight, where by the time we got to Apollo we had a couple of hundred people in this operations team that had a very, very common understanding of how far we would be willing to go and what we would do under certain circumstances and when we would pull back and sort of retreat to a less risky mission or back away from an activity and so on. It served us very, very well. It made Apollo easy.

NEAL: And then suddenly, on the eve of Apollo, tragedy struck. Right squarely in your midst and from—

LUNNEY: Yes.

NEAL: —a corner that was least expected.

LUNNEY: Yes.

NEAL: Let's take the Apollo 1 situation, and what it did to put the program essentially back on track in time.

LUNNEY: Yes. January '67, Bill [William A.] and Val [Valerie] Anders were at our house for dinner. They were running a test at the Cape. We get a phone call at the house. Bill left immediately. I had to clean up and went over to the Control Center.

The fire was absolutely unexpected to us. In retrospect, it was a risk we should have defensed in a design sense. We should have defensed it, but we didn't. We had been also, perhaps—we had dealt with 14 psi oxygen in the Gemini spacecraft. Perhaps we'd gotten used to it and didn't recognize it for the risk that it really was. And then when we got to Apollo, it was probably compounded with—we had—didn't have a—we did not have a tremendously rigorous materials program; that is, the materials that were allowed to be in the spacecraft were not really screened for flammability or anything of that type. The materials were more dealt with from a convenience basis: I need a blanket for this, or I need a something for that, or whatever, and so on. Or I need to put this stuff in on the displays. But we didn't have a flammability criteria in our mind as people began to design and to add things to the spacecraft—loose equipment in the spacecraft. And lo and behold! here we were with a 14/15 psi, pure-oxygen cabin. We had a short somewhere that started a fire, and bingo! the whole thing went. The oxygen environment, this loose material that was flammable, and the spark—the ignition source—caught us; and it was like, you know, a tremendous *punch* in the stomach to all of us. Three people—some, certainly—we had *worked* with all three of those. Roger [Chaffee] was the first flight out, but I'd worked with Gus [Virgil I. Grissom] and Ed [Edward H. White II] and all of us had, and Gus was beloved, I think, of the people who worked on the program—as they all are. But Gus had been in it from the beginning. Ed and Roger came along in some of the later selections.

And I mean, it—it just was—just a real *blow* to the, psyche, I guess, of those of us who were working on the program. We'd gotten to the sense of feeling that we had our—we knew what we were doing and were on top of it and, you know, thing—we kind of could figure out how to defense these threats. But we missed that one, and, for whatever all the reasons; and it certainly rose up and bit us very badly, the loss of those three guys on the pad.

And I think it also, afterwards, caused some major changes in the program that, in the end, were very healthy for the Apollo Program. Because, prior to that time—and I don't say this critically and I don't have anything specific in mind—but there was a sense of trying to meet the schedule, to land by the end of the decade. And maybe we were not being as thoughtful as we could be about some of the designs, some of the risks we were taking, and so on, in a design sense. And maybe we had gotten a little overconfident or something. It's hard for me to say that's really true, because I think people were really doing their very best and so on. But this is a tough business, and we missed something, and caught it, and bit us very badly.

In the response to that, a couple of things would come to my mind: One, I know it's been chronicled in a number of places and in a number of ways, but the role that George [M.] Low played in bringing the program back together was just a *remarkable* accomplishment. He, after the fire, was named the Program Manager. And, he had his hands full. But he brought together—George, smart, very—bordering on genius, I guess, kind of a man, that I had known and worked with in a lot of ways—usually a couple of levels away from me in terms of my job—but everybody had the greatest of admiration for George. He brought people together. He brought all the designers and the ops people and the astronaut corps. He brought them all together and made them part of this team. And he had these rotations around the country, where he would go to California and check on the command module. Then he would go to Bethpage and check on the lunar module. Then he would check on the other parts—the suits, and the various other things that were being made. Then he'd go to Washington; he'd do his coordination with the launch vehicles that were being managed out of the Marshall [Space Flight] Center [Huntsville, Alabama]. He would do his work with the

[NASA] Headquarters; Sam [Samuel C.] Phillips became the Apollo Program Director somewhere in that time frame. That was, I think, before George.

But George came in and he had this pulling together: "Okay, you know, we have a problem. We didn't account for it. Now we have to recover from it. So we've got to get together as a team and get this program back on track." And I think, by dint of his intellect and his energy and his way with people, George was able to effect a great deal of that recombining that needed to occur after the fire, bringing people back together where they had perhaps been fractured a little bit by arguing about how did it happen, why did it happen, and how could, you know. So, yes, you can go through that guilt trip for a while, but sooner or later you had to get back with, "Okay, now let's go do it." Also, so—and, in that process, he clearly brought the people at this Center that I work for, in the person of Chris and of course the Astronaut Corps, Max Faget, he brought all those people in and welded them—if that's the right word—into a real force.

Prior to that time, a lot of the Operations people, Chris's organization, had been involved in the Gemini flights. When they came to Apollo there was an existing structure where everything was kind of—had its way of being done, so there was a little problem with the people, the Operations people, who were coming out of Gemini to fit into that. And so on and so on. But after the fire, and under George's leadership, that became a kind of a single integrated team, I would call it. And George was very adept intellectually, of course, but he was also very adept at bringing people together and threading through masses of confusing stuff and arriving at the right decision. I'd also comment on one of the other things that happened in there is, somewhere along the line—and I don't know who made this assignment, it might've been George, or it might've been George and Deke together, or Deke by himself—they sent Frank out to California, to the Downey plant—

NEAL: Borman?

LUNNEY: Frank Borman. And Frank's job there, although it had probably had a lot of technical things to it, was to rally a team of people who saw themselves as having been defeated, perhaps, by the fire. Or certainly beaten—

NEAL: They considered themselves the heavies, really.

LUNNEY: They were the heavies in this thing. And so, they had a big, emotional *wound* of sorts to heal and to get themselves back on track. And I think Frank, God bless him, brought a lot of that to the Downey group. I don't know how the Downey group received it, but—and they would have their own opinion there—but I think Frank helped with this healing process and, you know, the search for the guilty and the why did this happen and how could you let this be, moved from that stage onto, "Now let's get on with it. We've got to move it forward." So in that respect, he was a very good representative of George Low, who was in effect trying to cause the same transformation to occur. "Okay, we've had the problem. Okay, we've had all our recriminations. Now we got to get the hell on with it. And we've got a big job to do. So let's get together. We're all going to pull on this thing together in the same way and we're going to make it."

NEAL: Facts of life. In a remarkably short time, you had a workable spacecraft. You were getting ready for Apollo—

LUNNEY: Yes.

NEAL: —7.

LUNNEY: Yes.

NEAL: Remarkably short time.

LUNNEY: Yes, yes, yes.

NEAL: I wonder if, perhaps, that could be done today.

LUNNEY: Well, you know, with respect to being able to repeat that today, we—it was a unique time. I mean, there [were] a lot of things that the program had going for it that have *fractured* since that time today. For example, you just go to Washington [DC] and, in those days, when you went to Washington, I mean, of course you talked to the White House, and there might've been 4, 5, 6, at most, committee chairmen—probably not even that many—that needed to be involved, discussing the problem, resolving whatever with those folks, that was the end of it. Then it got done that way. Today, it's much more. There's much more opinion in Washington. As you know, the Congress has got a lot of members who are asserting themselves. And so the strong committee chairmen, simple, clear, easier decision-making, it's not as obvious today. There's just—and I'm not criticizing. I think there are a lot more points of view that are prevalent today that we didn't have in those days, and so on. There's less single-mindedness about what we're doing today than there was in those days. Maybe that's a better way to say it.

So that the—but that's just one example of the stuff we had going for us in those days, and it allowed people who had the talent to cause it to be successful in coming and healing the wounds, getting over the problem, getting over the recriminations, and moving on to life. Whether we could repeat that today, I don't know. It's *tougher* today because there's just sort of—you get a sense of things being somewhat more fractured than they were in those days. And maybe that's a little also nostalgic and looking back a long time. It may seem that way looking back. Maybe at the time it was *not* that way, or at least people might feel it was not that way. But I always had the sense it was somewhat more single-minded in those days than it is today. There's just more opinion; there're more things to balance; there's not the threat.

This was conducted against the threat that existed, represented by the Cold War and so on. There was probably a serious sense in the American people that maybe we were falling behind. Maybe our opponents in the Soviet Union were really going to win, not only the space race but just win in general. The threat of the weapons that started to come into play in those times. All the other things that were going on made it easier perhaps for people to be single-minded about it. Today, Americans are not threatened about activities in space. They're not threatened about anything that the Russians or the Japanese or anybody else is doing. They don't feel threatened by any of that. And, frankly, that's good! I mean, their security is not threatened by any of that. It's an absolutely positive thing. On the other hand, that then there doesn't induce them to go do a lot of stuff, as was the environment we had in the '60s and the support that we had during the Apollo Program.

By the way, I also would like to say a few things about that while it popped into my head. This is true of anything. You know, if—different people have different takes on this stuff. I had a sense that, especially in response from just people in America, perhaps as personified by my parents. My parents—and I think they were typical of a lot of people in America—were very, very proud of America's program. They were extremely proud that one of their children had an opportunity to be such a player in it. And it engendered in me a sense of—a realization that I was in this position and doing this thing, but I was doing it for other people. I was doing it for the folks in our country. And, so I developed this sense of *stewardship* about the program. Like, yes, I was in this position of doing wonderful things and having great fun at it. But I was doing it *for* large numbers of other people. And therefore, I felt like I was always answering to them. Like, "This is why we're doing this." I mean, both in my head and sometimes in public. But inside me, I had this sense of, we were stewards through this program. It was important to the country. We had to do it well because of what it meant to the country at the time. And therefore, I began to think of it that way, even at a fairly early age. I mean I was in my 20s and growing into my 30s when I was doing a lot of this. But I had this sense of stewardship about the program, in the sense that I just happened to be involved in it and, therefore, had the obligation to do it really well for the sake of a lot of other people for whom it was also very, very important.

And I would say in connection with that, that I was raised also dealing with the media. And, for me, that was quite an eye-opening thing. I mean, the Press conferences and so on. I remember Chris Kraft and Walt Williams, at the Mercury Control Center, they would say, "Glynn, all those reporters out there. They're all hassling us about this. Go out and explain this stuff to them, will you, please?" I mean, people didn't know about orbits or anything. I remember it was all so brand new at that time, so—"You get out there and explain this thing." Then they'd laugh, and it was like sort of a sense of throwing this young kid to the wolves, you know? And, the Press—I don't want to say just the Press, but the way the *country* operated, including the role that the media played at the time, made us and made the country run a completely open space program. And, in the end, I think although it was difficult to see at the front end, that became one of our major strengths. I mean, people knew what we were doing. They knew why we were doing it. We were not BS'ing them about it. We had—when I was on duty as a Flight Director, every shift, almost, I mean—it didn't always stay that way but almost every shift—we would come over and visit with people either in Florida, back here in Houston, and explain what we were doing and why, and then a lot of other interviews around the flight. And a lot of times the Press would be very tough on us, you know, insisting on—demanding answers to certain kind of questions. And that was fair. I mean, I gradually began to understand that that was fair, and that it was another check or balance or whatever you want to call it in our system where it forced us to be conscious.

I could go back to my stewardship idea, which is what I relate it to. We were answering to a lot of people about what we were doing and how we were doing it. And I could personalize it through my parents to the American people. But one way to do that was through the media; the media was the intermediary by which that happened. And although I think there was a strong testing all the time by the media, I always had the sense, much as I did in terms of a sense of emotional support from the American people, my parents personified, that we had the same sort of support from the media. The media, indeed, seemed to love the program—the people who covered it—seemed to love the program as much as we did. A differing point of view, and they had different responsibilities than we did, but, nevertheless, they seemed to love it and care about it the same way we do. And I could detect that in various ways. But especially, for example, when we would have a difficult problem in flight. I mean, the Apollo 13 thing clearly comes to mind. My sense when I talked to the media the next morning after that night's work was that, you know, they were there to help us. They were there to help us. And, they were as concerned as we were. And, they had as much of themselves invested in the program and its success, in a way, as we did. And I felt—you know, media relations can be sometimes difficult and adversarial. But I always felt somewhat nurtured by it. I felt that they tested us, which was fair. And I felt that when the chips were really down and we faced great danger, they were *with* us; that they certainly would not tolerate bad mistakes and would publicize whatever needed to be publicized in terms of things that might have caused things to happen. But when the chips were down and the stuff was flying, they were on our side and they were trying to be helpful. And I always had the feeling that we were getting this emotional support from them. And it was good.

And while I'm on that, I might say one other thing. I talked earlier about the leadership that people like Gilruth and Walt Williams and Chris Kraft provided to us, and how, you know, as a young man I thought, "Gee, everybody must be this way" if I thought about it at all. I mean, I lived in a world where people were just almost perfectly matched for the jobs that they had to do, and America somehow pulled them out of its inventory and these people showed up who were just *perfect* for what needed to be done. And, you know, I guess if I thought about it at all, I would've thought that everybody lived in that kind of environment. You know, it's taken me some degree of experience later on to realize that's really not the way it is all the time. But we were extremely fortunate.

And the point I want to make is, Apollo 13. I came on duty shortly after the tank blew, worked all night to stabilize it, and we'd gotten things kind of, somewhat settled down, more or less, to the point where we were entertaining the various options we had for coming back. You know, swing around the Moon, which engine to use, how much to burn, what ocean to shoot for, how quickly we'd try to get back, etc. It's all risk/gain balancing. And sort of towards the end of my shift, after we'd gotten 10 hours of stabilization to occur, we began to entertain a strategy for getting it back. And I worked that for a while. Then I think I came over here and did the Press conference after my shift—which, again, another experience of sensing this emotional support from the people who were covering the flight—who had, by the way, thinned out by that time in history after the Apollo flights.

But then I went back to the Control Center and continued to work a little bit with Gerry [Gerald D.] Griffin, I believe, and then we went downstairs and briefed the NASA management: Tom [Thomas O.] Paine, who was the administrator, George Low was his Deputy at that time, and all the people here at the Center. Gerry and I went in there and I laid out the options for the return. Here're the options; here's our recommendation; here's what we think we ought to do and why. A little discussion about it, about whether we could get back faster or not, was basically the question, and we discussed whether that was a good idea and what we'd have to do to do that, and traded it off, etc., and got where we got. And after a brief discussion of that, the only question that was asked of us that I can remember of any significance was by Tom Paine, whose question was: "What can we do to help you guys?" "What can we do to help you guys?"

So, you know, here we are, 30 years old, you know, dealing with this problem of national significance, and the only question that management really had for us is, what can they do to help us? And again, at the time that didn't profoundly register on me. But the more I thought about it later, I said, "My goodness. Doesn't that say something about, you know, a chain of command, the roles that people play in it, the delegations that they make, and the confidence that they have, and the courage to live with those delegations?" I mean, we were 30-year-old kids. I won't say kids. We were 30-year-old young people doing this stuff, and all they gave us was their complete support.

NEAL: I noticed that you singled out Apollo 13. Would you say that was the culmination, perhaps, the highlight of the various flights?

LUNNEY: Well, let's see. I spent 10 or 12 years working on how to conduct flights safely, and how much risk to take, and how far you could go, and how to invent ways to get out of problems, and so on. I spent a decade or better doing that, from 1959 almost when I started on it. In that we had a lot of experience with it.

Apollo 13 was perhaps—if you were designing a test case, it was perhaps the *maximum* test case you could provide in terms of damage to the status quo or the condition that we had on the way out and the amount of margin that existed to solve your way through it and get back alive. It was, I think, the maximum case that we ever faced, and it was close to the maximum case that you could have designed to test the system of people to respond to it. You could have designed cases that we could not have gotten back from, right? I mean, if we were in lunar orbit, the LM was gone, and then we also lost the engine, well then we were stuck. But in terms of a case that would allow a threading of the needle to get home, with no margins anywhere along the line, and yet pose a very serious long-term couple of days' problem to deal with, I think that's what Apollo 13 was. It was probably, in retrospect—it was probably what we—I don't want to say, "we trained for it"—but we trained and thought and prepared ourselves to be able to handle eventualities as bad as that, with the confidence that, if there was a way to thread through it, that we would find it and be able to make it.

I say that for myself, and I say that for the people who were involved at the time. I think for all of them, they would tell you that it was a maximum—if a simulation team went off to design a case, this would be one of the maximum tests that they could have generated that had a way to get home, but with very little margin in the threading of the needle all the way back to get there, in all kind of dimensions and parameters. So it's sort of a maximum challenge, maximum test, posed to this team that had spent—off and on various people coming in and out of it—but the core team spent, you know, a decade putting itself together and preparing itself to deal with it. It's another one of these American inventory things. The country needed a solution and some people to do it and, lo and behold!, by dint of what we had been doing for the country, we were able to do that. And that's true in probably a lot of other professions, too. Certainly the country calls out the best in people when it really needs it, and somehow people show up.

NEAL: An outsider's point of view. I'd like your comment on it. It seemed to me that it was absolutely amazing, the way in which the various Flight Directors concerned with that flight, each having their own team, were able to peel off—

LUNNEY: Right.

NEAL: —do separate sections, and put it all together—

LUNNEY: Right.

NEAL: —under a common guidance.

LUNNEY: Yes. Yes, for example: Gene was on the team before me—Gene [Eugene P.] Kranz—and he had had a long day—a long day in terms of hours. It was kind of easy floating out to the Moon; there wasn't much going on; TV shows, etc. But, you know, shortly before his shift was scheduled to end is when the "Houston, we've got a problem" report came in. And at first, it was not terribly clear how bad this problem was. And one of the lessons that we had learned was, "Don't go solving something that you don't know exists." You've got to be sure that what you're really having—because of the scale of the problem, an explosion and all that it induced, there was a lot of measurements and there was a general presumption that, "Gee, we couldn't have had one thing so bad that all these measurements are doing this." So, it was generally a go slow, let's not jump to a conclusion, and get, you know—get going down the wrong path. And Gene struggled with that for probably, I don't know, 45 minutes or an hour or so. At the end of which time it was becoming clear that we had to get people over into the lunar module, that it was indeed that bad. And when it got to that stage, it was clear that Gene's team had been at the end of a long day. It was time for my team to pick up, which we did, and we stayed on for the next 8 or 10 hours doing all things that it entailed to stabilize this thing. And then at the end of that shift, began to entertain how we would get back to the Earth.

And Gene went off and looked at the—Gene's team went off and looked at—tried to reconstruct what happened, although it was something of a—that was a lost cause at that point, worrying about that. And Gene's team eventually got redeployed to work on the entry, off line completely to us. And then Gerry Griffin came on behind me in the morning and picked up the continuing of the return strategy. And, actually at that point, we kind of had a game plan. It was: Don't let anything else screw up, and don't get anything else—get anything else worse than it is. We kind of got a little thread here we can move through these needles, the eyes of these needles, if we're lucky. So let's keep it that way.

And Milt [Milton L.] Windler, of course, was on the flight and then he picked up after Gerry. I can't remember if Gene actually ran another shift until entry or not. My memory is that he didn't, but he may've come in another shift or so before that. But we all sort of had to do this, and we had this sense of hand over. Difficult to let something go, when it's your time to leave, especially if you're just real deep into it. On the other hand, after 8 or 10 hours, there's a need for a fresh set of players on the console. And, it's actually relaxing in that kind of an operation if when the new guy comes on and you get him all briefed then he starts in to just sit there and watch for a little while; because one of the features of working on a console in that kind of environment is that, it's very helpful to have someone else who's completely attuned to the job sitting alongside of you—we called it riding shotgun—because sometimes they can see and think about things that—because this person, the on-duty guy's actively dealing with this, he may not have had time to think about something else and the shotgun rider can say, "Hey, you know, this looks like it's going a little awry," or "Maybe you need to pay some attention to this," or "Why don't you get some people off line working on that?"

The other thing I would say about it is, and we talked about Flight Directors and teams, equally important was the fact that, during those flights, we had this Operations team that you have seen in the Control Center in the back rooms around it and we sort of had our own way of doing things in our own team, and we were fully prepared to decide whatever had to be decided. But in addition to that, we had the engineering design teams that would follow the flight along and look at various problems that occurred and put their own disposition on them. Sometimes that would affect the flight and our decisions, but mostly it would get them ready for what they had to do to fix this thing when they were getting ready for the subsequent flights. But they do follow it along, and so there's the ops team doing its thing, and the engineering design team's kind of following along in parallel, in somewhat of a shadow mode, and they're not responsible for real-time decision-making in any way. But they're there for support. And on a number of problems, by the time the flight team got around to saying, "Oh boy, we need to get a solution for the carbon dioxide, because the thing we got ain't going to last," you know, their response is, "Hey, Glynn, we're already working on that. We've been working on that for the last, you know, since it happened. So, when do you need a solution by?" "We need a solution by, you know, 24 hours." "Okay, we'll have one for you." And, the support of the engineering team in all of—not only here in Houston but connected with all the factories and plants around the country—they had MIT [Massachusetts Institute of Technology] involved and, of course, the Downey plant involved and everybody else I suppose in the world—figuring out how to respond to all these things.

But again, that was part of this network of support. People had their certain jobs to do. They knew what it was. They knew how they fit in. And they were anticipating and off doing it. It's similar to the role that the media played in the coverage of the flights, and their keeping it honest but being supportive of it kind of a role. It's support we got from the American people. The support we got from our own management. It's very heart-warming.

NEAL: [Olin E.] Tiger Teague put it directly to the point, he for whom this auditorium is named. Tiger said, "You know, Apollo 13 was the time when, for the first time, the media was actually a working part of the Mission Control team." They were here and they were telling the world what you people were doing.

LUNNEY: Yes, that's a good way to put it. You were part of the team.

NEAL: Yes.

LUNNEY: You as part of the team. Tiger Teague was a soul. God, we loved that man.

NEAL: All right, well let's continue then, because right at that point in Apollo when we deviated to talk about 13 and what it really meant—

LUNNEY: Yes.

NEAL: —we had just derived Apollo 1—

LUNNEY: Yes.

NEAL: —and the spacecraft was now ready to fly again, and you were the lead Flight Director—

LUNNEY: Yes.

NEAL: —for Apollo 7.

LUNNEY: Yes.

NEAL: And, although the flight went very well, it wasn't all a piece of cake.

LUNNEY: There was some testiness involved in—you know, you can attribute whatever you want to that. But, it was the first time we actually had a serious falling out between the ground crews and the flight crews, and it was a *fracture* in what had otherwise been a relatively seamless, cooperative kind of an effort. And I guess, since I was a participant in it, I've shied away from making judgments about it. But I would say that the events of Apollo 7 were responded to publicly, and they were responded to by the crews of Apollo 8, 9, 10, 11, and so on. So, what had been a fracture in a very strong team was healed immediately, and by the people who would be in the best position to cause that healing, and that would be the subsequent flight crews. And, Apollo 7 was difficult for me because I was kind of upset with what went on. I felt it was uncalled for. But, we got through it, and the flight worked okay. It worked fine, and we were ready to get on with Apollo 8. I mean, and I knew before we went into the flight that we were going to be doing Apollo 8. So, we were ready to get on with it.

NEAL: That's really the essence of Apollo 7, isn't it? It was a successful flight.

LUNNEY: Yes.

NEAL: It set the ground—

LUNNEY: Yes.

NEAL: —set the ground rules and set the scenes for Apollo 8.

LUNNEY: The spacecraft worked, yes, and, set the stage for Apollo 8. It certainly would have been difficult to do Apollo 8 if we'd had a lot of spacecraft problems. I would say also that, compared to Gemini—and this is not to criticize any of the people involved in either program—but I think the maturity of things that we knew how to do in the country was just less there in Gemini than it was in Apollo. We had a difficult problem with fuel cells, thrusters, and a variety of other things. By the time we got to Apollo, a lot of the lessons learned from Gemini had been applied to the design, the hardware, and so on, and the spacecraft really behaved pretty well. There were some notable exceptions, but, by and large, the spacecraft worked pretty well when we got them in flight and didn't give us a lot of the same subsystem failure/subsystem impending failure problems that we had on Gemini. And I attribute that to just the learning process that was going on in the country. And all the Gemini lessons also got applied on the design side, where people were figuring out, "Well, look what they learned here. We'll do this a little different, hopefully avoid some of those difficulties in the future." We were quite surprised when we got to it, how well the spacecraft—the command service module in Apollo—how well it worked compared to what we were used to dealing with in terms of spaceflight problems.

NEAL: I'm surprised that you were surprised.

LUNNEY: Well, I mean, I guess I was because I didn't have much time to think about it. Yeah, I was off doing all this Gemini stuff, and we flew a couple of unmanned Apollo's. I was involved in those. But when we got around to the manned vehicle, it worked pretty well. Then the lunar module came along, and it worked pretty well, too, for the frail, aluminum foil thing that it was; it seemed to work pretty well. People had given a lot of thought to it, and it seemed to be designed to do its job.

NEAL: And just about that time, the people here put on their thinking cap and said, "Let's go to the Moon with Apollo 8." Did you share in that decision?

LUNNEY: Ah, no, not really. That was a fairly—I mean, the decision itself was a fairly closely held activity while it was in the process of being made. And I don't know all the details of it because I wasn't involved in it. But my sense of it is that, the idea either originally came from George Low or Chris Kraft or both together, or something. I'm not quite sure how. Because in no time at all, those two guys had bonded that they were on the right path and had begun to test the idea with a number of other people. And, you know, it was—at first, when you—when I first heard it, my reaction was, "Holy mackerel! I mean," you just go, "we're just getting started with it." And then the more you think about it, it said, "Well, that's really the right thing to do." What I mean by that is, the lunar module was not ready; it was a couple of months down the road. The Saturn-V had had two unmanned flights, one went very well and then the next one had a variety of propulsion problems to it. So we had to fly the Saturn-V again.

Now, once you decide you're going to put people or even a spacecraft on board a Saturn-V and run the engines and burn all the fuel in the tanks, you might as well have it take you to wherever you really want to go rather than just in some halfway—half direction, or half distance. So the idea of, "Gee, we're going to use it anyway, so why don't we point it in the right direction and go to the Moon? And then we'll jump over all of these lunar issues: How do we get there? What's the trajectory? What are all the abort modes? What's the navigation like? How accurately can we do it? How is the crew? What's the barbecue mode to keep the spacecraft nice and warm and toasty like it should be? Etc., etc." All those things got resolved, you know, forced to be resolved in a planning sense before we flew and in an experience sense by flying. So that after we had done that, what remained—We had the Saturn-V under our belt, we had the lunar experience under our belt—lunar orbit experience anyway—with all that that entailed. What we had to do was get the lunar module to enable the final landing. And then we did that in three steps: Earth orbit, lunar orbit, and then down. It was a great, courageous decision. Wonderful leadership!

NEAL: As you were watching Apollo 8 take place, were you working the mission?

LUNNEY: Oh yeah, I worked it. Yeah, I worked Apollo 8.

NEAL: What were the sensations? What were your thoughts as you saw those guys really making the long haul, achieving escape velocity alone?

LUNNEY: Oh yes. Well, you know, it was something that we had thought about and planned for. We were going to go to the Moon at some point. I think what was energizing about it is that we were going to get to go there that early in the sequence. A lot of the Apollo planning up until that time had these elaborate sort of prerequisites that we had to do this and that and the other thing to get there. So it would have entailed a lot of flights. But this was kind of like a—just an absolutely bold, genius stroke to leapfrog a whole bunch of problems and get them solved at one time, without an unreasonable risk in terms of the gain that we were trying to achieve as measured by, "Are we going to get this Apollo thing to the Moon and land before the decade is out?" So in those terms, after the first *shock* of the thought—and I would say this occurred within seconds to minutes after the first shock of the thought, not days—you can start thinking, "Oh yes, that sounds like the right thing to do. Can we do that? Yeah, we can do that; yeah. What do we have to do, to do that?" You know, it quickly turned into: *How* do we make this happen? Not: *Should* we make it happen?

NEAL: How'd you feel when suddenly those words started coming back: "And in the beginning God created—"

LUNNEY: Yes, I loved that. I loved that. I mean, I had no idea what the guys were going to say. You know, in general, the crews off and on had various reactions or responses or whatever in flight. And my sense of it always was that this is generally pretty appropriate. But here we were, and, you know, I guess, this captures forever, I guess, seared in my memory that night of being out in the Control Center and then having them come over the hill around the Moon and into comm, and then go through that sequence. It was very moving, and I sometimes describe my feeling about what we had done in the space program in terms that border a little bit on kind of a religious flavor to it. I mean, everybody has their own version of that, and that's fine with me. But for me, it was a sense of, I mean—We had people go to another planet, you know, live on another planet. We had taken this very bold step. We were *lucky* in a lot of respects. Looking back, we say, "Boy, if this had happened this way instead of that way, we'd have been in trouble." So we were lucky. So there's a sense of, maybe we were being a little looked after. And I talked about my Control Center as a church. I mean, so, it was where we did what we considered to be pretty profound things; and, not to compare it to religion, but profound things. I felt very—I *feel* very emotional and personal about it all. And the choice of that passage, and even the passage in itself, but that particular passage, just seemed to me to be—It could not have been more perfect. I mean, however long it's been, some 30 years later, I'm not sure I would have suggested anything any better than that in retrospect, than what the crew did that night. And again, I think it's a tribute to, you know, America has this inventory of people and here comes the people when you need them; out they come. And then, to cap it off with that kind of appropriateness and dignity, maybe—that's not quite the right word—as again, America asked for them and they got them and they were the right people and then they did the right thing. They conducted themselves in exactly the right way. Where again, this sense of stewardship, I'm sure everybody in America just loved it. You know, it was what they wanted to hear, even if they didn't know it at the time.

NEAL: We were talking earlier about the fact that one of the tenets of NASA's license is to be in the public domain.

LUNNEY: Yes.

NEAL: And here was—well, if you will, Borman was a deacon in the church?

LUNNEY: Yeah, I think he was. In the Episcopal church.

NEAL: —and here he was, relying on his religion—

LUNNEY: Yes.

NEAL: —to give America a Christmas—

LUNNEY: A message. A Christmas message.

NEAL: —message at Christmas, from the space program.

LUNNEY: Yes.

NEAL: From the space program.

LUNNEY: Yes, yes.

[End of Interview]