NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY TRANSCRIPT

JAY H. GREENE
INTERVIEWED BY SANDRA JOHNSON
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JOHNSON: Today is November 10th, 2004. This interview with Jay Greene is being conducted for the Johnson Space Center Oral History Project in Houston, Texas. The interviewer is Sandra Johnson, assisted by Rebecca Wright and Jennifer Ross-Nazzal.

I want to thank you again for joining us today. I'd like to start by asking you to share with us a brief summary of your background and how you first came to work for NASA.

GREENE: I grew up in New York. Went to school at Brooklyn Polytechnic [Institute (later renamed Polytechnic University), Brooklyn, New York], and when I graduated—that was in [19]'64—I went as far away from Brooklyn as I could. I wound up working for North American Aviation at the time, in Downey [California]. Spent about nine months there in a job that wasn't particularly satisfying. One day I got a telegram from JSC [Johnson Space Center, Houston, Texas]—I guess it was MSC [Manned Spacecraft Center] back then—and they said, "We've got a job." And without asking any questions, I said yes, packed all my belongings in a suitcase, and I headed for Texas.

JOHNSON: Did you have a connection already at MSC, and how did that telegram come about?

GREENE: No. I interviewed while I was in school, and they were slow to respond, and so I guess they were working down a list, and I made it. Came down, and I didn't know where I was going or who I was going to work for or what the job was.

JOHNSON: So you didn't have any idea what type of job you'd be moving into?

GREENE: No.

JOHNSON: So maybe you can tell us, when you got here, what were your first assignments, and just walk us through some of those first days when you first arrived.

GREENE: Well, when I first arrived, Personnel was at Ellington [Air Force Base, Houston, Texas] in a little shed. That was pretty impressive. I was checking in, and while I was checking in at one end of the counter, John [H.] Glenn [Jr.] was checking out at the other end. That was impressive.

Drove onsite. We were officed in the Mission Control Center in the little potato chip windows behind the main entrance. I interviewed, I guess, two or three different people. The one who interviewed me for Flight Dynamics was [Philip C.] Phil Shaffer, and Phil worked for [Grayden F.] Grady Meyer was the guy's name who ran the section. It was the FIDO [Flight Dynamics Officer] section, and we worked in Glynn [S.] Lunney's branch. Glynn was the Flight Director. Gemini [Program] was just getting started. I'm trying to remember. It was divided into two branches; two sections. One was the Apollo [Program] section, and the other was the

guys flying Gemini. I still didn't know what the job was, but they sounded like a good bunch of people.

So I became a Flight Dynamics Officer and was assigned to Apollo. Initially we started training by watching the Gemini guys, who were just getting started out of the Mission Control Center here. Our section was responsible for designing the trajectory displays for the Apollo launches. Initially, as I say, we watched what the Gemini guys were doing. We started designing displays based on what they did and adding some little touches of our own. At the same time we were doing that, we were learning about the spacecraft and trying to figure out how you monitor a manned spacecraft during a launch phase.

We began interactions with the [NASA] Marshall [Space Flight Center, Huntsville, Alabama] guys and the Saturn rockets, and not too long after that I was given my first assignment, which was to design the Flight Dynamics Officer, a FIDO position, on one of the Apollo tracking ships. The thought was that a Saturn rocket was so big, it would burn so long that it would go beyond Bermuda. So we put a ship out past Bermuda, and we had a full control center on the ship. We had about seven, eight people. For about two years that's what I did, until Saturn 501, the first Saturn V, launched. We were there; we spent about a month out at sea for a five-minute pass, and that was it. We came back in, and when we got back to Houston, I was told that my next assignment, I would be the lead Flight Dynamics Officer for 502, which was another unmanned test of the Command and Service Module [CSM], preparing an entry test in preparation for the lunar landings.

JOHNSON: You mentioned that you watched the Gemini group. Did you start running simulations at that time for the early Apollo flights?

GREENE: We were running simulations when the Gemini guys weren't using the Control Center. Actually, we had the second floor and the third floor, and I think they ran on the second; we would run on the third. But they weren't total backups. Red Bluff Road used to be a two-lane road, and at one, two, three, four o'clock in the morning, it was an incredibly beautiful drive. But we practiced mainly during the night hours, and it was towards the end of the Gemini program that we got prime time in the Control Center.

JOHNSON: You mentioned that you were on the tracking ship for that first Saturn launch. Can you just walk us through what that was like? You said you were out there quite a bit of time. Where exactly were you?

GREENE: Well, you know where Bermuda is. You know where Africa is. We were in neither of those; we were about right smack dab in the middle. The ship was owned by the Navy. It was operated by the Air Force. It was outfitted by Goddard, the Goddard Space Flight Center [Greenbelt, Maryland]. It was manned by Johnson, and all the sailors were Panamanian and like that. So it was an incredible experience. We left from Miami [Florida].

Well, we were headed straight to our tracking station, and if I remember, the antenna broke. One of the antennas broke. So we put into Bermuda. We had to spend three days in Bermuda, which was terrible duty, and then we left Bermuda, we went on station, and we waited until it was ready to launch. Between getting there and staying on station, before you got to the station they had to lay out some beacons on the bottom of the Atlantic so we could tell where the ship was and therefore get our tracking data back to the Control Center. So we spent a couple of

days doing that. As I said, it was about a five-minute pass, and we were done. Then we had to wait a few days to pick up the beacons, which we never did recover. Gave up and came on home.

JOHNSON: You mentioned that you spent a couple of years writing those procedures. Maybe if you'd take just a second and just share the details of what a FIDO is responsible for during a flight.

GREENE: The FIDO stands for Flight Dynamics Officer. During launch he's responsible for monitoring the trajectory of the vehicle, maintaining the vehicle within a set of limit lines, and if the vehicle were to violate the limit lines, initiate an abort and then the eventual recovery of the capsule. During entry, it's preparing the targeting and monitoring the trajectory down [through the atmosphere] and advising the crew if they had to take some different actions. On orbit, it's again monitoring the trajectory and then computing any maneuvers to change from one orbit to another orbit, based on what the mission requirements were, including rendezvous, for example. So it was a fun job.

JOHNSON: In that position, you were in the control room, or would be in the control room in what they called the trench.

GREENE: Yes.

JOHNSON: We've heard various stories about the trench.

GREENE: None of them are true.

JOHNSON: [Laughs] Did the reputation exist before you started working there?

GREENE: Sort of. Sort of. It was an ever-building-type thing, and I guess there were events that maybe made it more prominent. It was always us against the systems guys. It was more of a Lunney's guys against [Eugene F.] Kranz's guys. We did everything we could to build on the mystique of being a trajectory guy.

JOHNSON: What was it between the systems guys and trajectory?

GREENE: It was just a rivalry as to who had the more difficult job, and everyone knew we did, but they wouldn't give up.

JOHNSON: You mentioned the mystique of being a trajectory guy. What was that mystique?

GREENE: We were the mathematicians and the scientists, and they were the mechanics and the hardware guys. In truth, they were as much scientists as we were, but nobody would admit it.

JOHNSON: You mentioned that your next assignment was for the unmanned Saturn V launch. That was Apollo 6?

GREENE: Well, there was 502, and I guess that probably was 6. That was very similar to 501, and everyone expected it to be a nominal mission. It was about a twelve-hour flight intended to insert into Earth orbit much the way that we went on a lunar mission, and then it was going to do a full-up translunar injection; first time that had ever been done. Then it was going to abort off that trajectory into a 9,000-mile—if I remember; something like that—ellipse, and then burn for entry conditions that would simulate maximum heat load for a lunar reentry.

First stage, everything was nominal. We got to the second stage, and we had a visiting booster engineer who was watching the flight, and then over the airwaves I heard him say, "That looks like two engines out." It turns out, per the flight rules, two engines out was supposed to be a loss-of-control case, and by the time the booster guys realized that we had lost two engines, it turned out the vehicle was stable, and so we just let it fly.

The vehicle lofted, and then got on third stage and it started to dive straight at the Earth, and based on that, I had a limit line that we were approaching and had my sweaty little fingers on the abort switch, and the thing finally straightened out and it made it to orbit. Probably the first time we ever inserted into orbit going backwards, based on the way the guidance missed its target box, and it just kept on trying until it got there. So we inserted into an orbit, and everything looked copasetic, and we came up on TLI [translunar injection] and counted down, and S-4B [engine] was supposed to light, and it never lit.

So I got to throw my little switch that separated the spacecraft from the booster, and we went on and completed a semi-nominal mission. Completed all the mission objectives. So we had three engines out and we had this aborted profile. We did an approximation of the nominal entry, and everything went so well that we man-rated the Saturn V based on that, and the next time we used a rocket, we went to the Moon; Apollo 8. Pretty exciting day.

JOHNSON: Sounds like it was.

GREENE: That was the day that Martin Luther King [Jr.] was assassinated, during the flight.

JOHNSON: That whole time period was pretty turbulent. The Tet Offensive was just a few months before that. Martin Luther King, of course, the same day. Robert [F.] Kennedy, a couple of months later. We've heard different people talk about how isolated or how on target they were as far as—

GREENE: Isolated is a good word.

JOHNSON: Yes, isolated. As far as getting to the Moon, and that these other events sometimes didn't enter into that. Would you like to comment on that, or is that a true statement?

GREENE: We lived getting to the Moon. Our whole lives were focused on it. When we weren't working, we were partying together. We pretty much lived space and let everything else go by in the background.

JOHNSON: I'd like to go back just for a second and ask, were you on duty or did you have any assignments during the Apollo 1?

GREENE: The fire?

JOHNSON: Yes.

GREENE: Well, I did. I wasn't on console at the time, and it was the kind of test that was supposed to be so routine that I was downtown at the LeCue Pool Hall when it came over the radio, and it was sort of devastating.

JOHNSON: The aftermath of that, how do you feel it affected the Apollo Program as far as what happened next?

GREENE: Well, we were the flight control guys. We were probably the least affected of all the players. We were in a stand-by-and-wait mode. We probably used the time effectively to build better procedures, to train more than we would have had we not done that, to build teams, get close to the flight crews. The end result is we probably wound up with a better spaceship, a better spaceship than had we not done that. And we did it quickly, especially in comparison to what's going on today with [Space Shuttle] *Columbia* [accident].

JOHNSON: You mentioned that Apollo 6, of course, was the Saturn V, and then the next one was the Apollo 8 flight, the next time that that was used. The announcement actually came on November 12th of [19]'68 that Apollo 8 was going to go to the Moon. At what point did you hear about it?

GREENE: Not significantly before then. After 502, the next flight was Apollo 7, and we were working the Apollo 7 flight. I was on one of Gene Kranz's shifts; I think it was a sleep shift. We were called into the office before that flight and told what we were going to do, and assignments were given out. We went in and did the Apollo 7 mission, and if I remember, we were taken off console towards the end of the flight, and we went from the second floor to the third floor, and we started simulating manned Saturn V flights, translunar injections, lunar orbit injections, the whole nine yards. We were learning while we were simming [simulating], and the flight was a matter of months away. It was intense.

JOHNSON: Was there anything significant about Apollo 7 that you'd like to share or anything during that mission?

GREENE: It was our first exposure to manned space flight. It was our first exposure to flying the Apollo in a manned configuration. It was our first exposure to shift work and handovers, teamwork between the FIDOs and the GUIDOs [Guidance Officers] and the RETROs[Retrofire Officers]. So we had a rapid learning experience as a result of being thrown into this whole situation, unparalleled in what goes on now at the Johnson Space Center.

The interaction between the ground and that particular flight crew was rather unique. The crew was testy, and we got into everything shy of verbal battles between the ground and the flight crew. Probably the most significant was prior to entry. If you remember, that was the flight that [Walter M.] Wally Schirra [Jr.] got his cold; and made his millions doing Actifed commercials after that. There was a big debate between the ground and the flight crew over whether to come in suited or unsuited, and then once it was decided you had to come in suited,

because the foot restraints for the entry were built into the suit, and so if you didn't have the suit on, your feet would sort of flop around.

It came down to a shouting contest between Wally and the CapCom [Capsule Communicator]. The original CapCom was replaced by [Donald K.] Deke Slayton. The head of the Astronaut Office came in and decided to tell Wally which way was up. It was pretty intense, and after it was over, I remember Glynn Lunney called us, all us Apollo guys who hadn't gone through Gemini, and apologized for the way the flight went and said that "Manned space flight is usually better than this."

JOHNSON: You mentioned the relationship between the people that you worked with on the consoles. Maybe you can explain some of that as far as your positions, especially the ones that were sitting next to you.

GREENE: The FIDO was the leader of this trajectory team, and the two other players were the Retrofire Officer, RETRO, and the Guidance Officer. We formed a team, and the FIDO was the leader.

We had some colorful characters, one of whom was John [A.] Llewellyn, who was the Retro Officer. Let's see. That was [19]'67-ish, something like that. So I was twenty-five, and John was—I don't know how much older than I John is, but he was the RETRO, and we wandered in and here he was, he was a big veteran of the Korean thing, and been with Glenn and Chris [Christopher C. Kraft, Jr.] since the agency was started. I sat down at the console, and he started giving me grief, and I said, "Hey, John, either cool it or unplug." And he unplugged and

left, and I said, "Wow." I said, "This is pretty good stuff." So we made up, and we've been good buddies, but that was the threesome, and as I say, we worked together as a tight team.

JOHNSON: Maybe if you could talk for a minute about the relationship between the ones working on console and then the back room, the SSR, the Staff Support Room, and how that relationship worked and what they were doing back there during a flight.

GREENE: They were helping, and they probably helped more in the Gemini time frame than they did in Apollo. That was a trend, that as capability built in the front room, we sort of did away with the back room. Part of that was display capability. Early on we used XY plot boards that wouldn't fit in a modern Control Center, so they made us keep them in the back room, and we had guys who virtually paralleled us watching the plot boards. The Guidance Officer, for example, though, used in-line support, virtually augmenting what he did with eyes-on capability in the back. Probably the biggest example of that was [Stephen G.] Steve Bales on Apollo 11 and his [lunar descent] calls; and the guy who probably made the call really was [John R.] Jack Garman in the back room. So it varied.

JOHNSON: As you mentioned, Apollo 7 was everyone's first experience with manned Apollo flight. As far as the Flight Directors were concerned, and then the shifts, how were you assigned to the Flight Directors? Did they pick who they wanted?

GREENE: No. By the time we got there, Glynn originally was the branch chief, and he moved up, and they had a Flight Director Office, so Jerry [C.] Bostick, I guess—well, let me think. See,

you're taxing me. No, Glynn kept the Flight Dynamics Office through Apollo. Bostick had the FIDO group. That's right; we broke into FIDO, RETRO, and GUIDO groups, and the section heads made the assignments, approved by the Flight Directors.

JOHNSON: Were they based on expertise, as far as you know?

GREENE: Expertise and gut feel.

JOHNSON: Which team were you on for the Apollo 8 flight?

GREENE: Apollo 8, I was on [Clifford E.] Cliff Charlesworth's team. Cliff was one of my favorites. He was a great, great guy. We did virtually every exciting phase of that flight. We did the launch, the translunar injection, all the outbound midcourses, trans-Earth injection, all the homecoming midcourses, and entry. The only thing we didn't do was the lunar orbit insertion, and that was Glynn's team, Glynn Lunney.

JOHNSON: Typically, how long were the shifts?

GREENE: We tried for eight. An hour before, you'd come on and hand over, stay an hour [after the shift ended]. So it was a ten-hour shift, nominally.

JOHNSON: You mentioned that you started those simulations as soon as you found out that you were going with Apollo 8. Did the simulations prepare you for everything that was experienced on that flight in particular?

GREENE: Yes, Apollo 8 was wonderful. It was probably the neatest thing we've ever done, more so than Apollo 11.

JOHNSON: If you don't mind, if you would just walk us through that flight, since you were on console for so many important parts of it. If we can just start with the launch.

GREENE: The launch was nominal. The new thing was we did the translunar injection, and we had the new plot boards that showed the trajectory between the Earth and the Moon, the vehicle moving out on this trajectory. For a systems guy, a system is a system, and the air supply was the air supply, but for a trajectory guy to see these new numbers that had never been seen before, as we started screaming out of Earth orbit and headed towards the Moon, was pretty exciting stuff. I've often told this story; I went home after that, and I got me a bottle of good Scotch and went out to the pool and just stared at the Moon. It was a pretty incredible feeling.

Lunar orbit insertion, we were all in the Control Center, regardless of when our shift was. It was a crowded room. Locked the doors and had a clock counting down to when we would lose the signal because we went behind the Moon. The clock went three, two, one, zero, and the static broke, and we lost lock, just as we were expecting. Glynn let everyone go, and we all broke for the men's room, and I say the men's room because there were no women's rooms in

the Control Center at that time. Fact of life. It wasn't till much later that the first women's room—the men's room was replaced by a women's room, as I found out by mistake.

But we all came back. We had two clocks counting down, and the first clock was if they didn't get the burnoff; the burn was behind the Moon. The second clock was the nominal time. So we passed the first clock, and no signal, so everything was going well. Got closer and closer to the second countdown, which was the nominal time of emergence from behind the Moon, and bingo, it went to zero, and we had radio contact and everything was cool.

So we did all that. The Bible reading I'm sure you know of, and that brought everybody to their knees. A lot of food during the holidays. Pretty exciting times. We got on for the trans-Earth shift. That was exciting. Burn went nominal. The whole flight was virtually perfectly nominal. Then we landed, and it was over, and we started simulating for Apollo 11.

JOHNSON: I read that people in the control room, when the display went from the normal display that they were used to, to a display with the Moon, that that was quite a moment for several people. Do you remember that moment?

GREENE: Well, yes. I was the one who put the display up. As I say, it was a trajectory display. I don't know if you've seen the big figure-eight. It's a big figure-eight display, and initially you move out real fast, and as you get farther away from the Earth and Earth's gravity, your acceleration slows down, and so most of the trip is made in the early parts of the flight. As I say, it was dramatic being the trajectory guy, counting the tens of thousands of miles that we were moving. Intense.

During entry, we'd have team meetings, and they wanted to meet after the shift so we can plan what we would do in the way of celebration. There was a big American flag the guys got their hands on that filled the whole front of the Control Center. Turns out it was the flag that was from the Prudential Building down around the Medical Center [Houston, Texas]. Then we had this other flag, and we designed a red, white, and blue flag with a "number one," signifying we were the first on the Moon. It was a "in your face, Russians" type thing. I forget whose wives they were, but they sewed these dynamite flags, one for each member of the team, and Public Affairs and the State Department and everyone else said no. So we wound up waving regular American flags, and somewhere around the house I have a "number one" flag. If it ever makes it to eBay, I'll sell.

JOHNSON: When that mission was over, you said you began training for [Apollo] 11. Were you involved in 9 and 10?

GREENE: Nine, no. We let 9 go to do 11. Ten, yes. In order to monitor the lunar landing, we required a new radar capability, and actually what we were using was something called a Kalman Filter that was designed out at the Jet Propulsion Lab [Laboratory, Pasadena, California]. It was actually called the Lear Filter. William Lear was the guy who I guess we hired from JPL, and we used Apollo 10 to see what this thing would do at lunar distances. So we watched 10 a little bit. The 10 guys also verified some of the rendezvous tools that we would use on Apollo 11. So, minimal participation in 10; major stuff with 11.

JOHNSON: On any of these other flights, you mentioned the tracking ship early on. Were you ever on a tracking ship again, or was that the only flight?

GREENE: No, you only get a guy from New York to do that once. Actually, we never used the tracking ships after the first time. We had enough signal coming from Bermuda that we put them in positions as we needed them around the world, but we never manned a control center again. Or at least that's the way I—I know we didn't put a FIDO out there again. I don't think we put a control team out there.

JOHNSON: How were the assignments made for Apollo 11?

GREENE: I'm not sure. Jerry Bostick tells me that he's the one who selected me, and Lunney approved, and Kraft had to approve. There was some hurt feelings, because I got the descent assignment, which was *the* thing for a Flight Dynamics guy. I did descent, and I think it was Shaffer who did the ascent, but I don't remember. For that flight, the lunar descent was important enough that we didn't do any of the other shifts. That was *the* shift. We used to train, and anytime there was an accident, anytime the simulation crashed, they would convene an investigation board, because we were crashing; we crashed several of them. So that was pretty intense stuff.

JOHNSON: Can you share some of the details about those simulations as far as what you were working through?

GREENE: First of all, we had to develop the flight rules for how do you monitor a lunar descent, and it was hard building an envelope that would be sufficient criteria and sufficient rationale to abort a lunar landing. By the time it was over, what we decided was that we would use abortability as the criteria to terminate a landing. In other words, as you're going down, we monitored—well, the first thing we monitored for was to keep the crew from crashing into the Moon. That would have ruined everything. But the other thing we monitored for was maintaining the ability to leave the trajectory we were on and make it back to rendezvous with the Command and Service Module, and if we ever lost that capability, or prior to losing that capability, we would abort the descent.

So the FIDO's job evolved into one of monitoring this trajectory and always keeping a rendezvous capability so that anytime I aborted, I had a plan for how to get back to the Command and Service Module quickly. That turned out to be a full-time job. Later on the job also picked up some targeting capability. We did Apollo 11, then we did Apollo 12, and Apollo 12, we went back to the Surveyor [III Spacecraft] and picked up a piece of that, and so we needed a pinpoint landing capability. In order to do that, we had to figure out how you remove some known targeting errors, or known trajectory errors, navigation errors. On Apollo 11, as we were monitoring the trajectory coming in, we picked up some velocity errors. They were radial errors, and we got all excited and then rationalized during the flight that radial error was a unique thing with the Lear Filter and the fact we had a down-track error.

So, after the flight, when it got to Apollo 12 times, we figured out we could use this measurable velocity error to figure out how much down-track displacement. We would do it backwards. Here's the velocity error; now let's figure out how far down-track we had to be to cause that error. So we figured out down-track error, and that was part of it. Then we had to

figure out how do you tell the onboard computer about this error. It was rather risky trying to change the spacecraft's knowledge of its position. What we wound up doing, though, was we lied about where the landing site was; faked it out. So we developed this thing called Noun 69, which was a position change to the landing site that allowed us to land virtually within walking distance of whatever the target was, which is what we did on Apollo 12.

JOHNSON: Let's go back to the simulations for Apollo 11 for a moment. The simulations right before the mission, were they more intense than the simulations for any other mission at that point? And how so?

GREENE: *(A)*, we had a deadline; *(b)*, we were doing something that had never been done before; *(c)*, we anticipated aborting. Nobody, nobody on the team believed that we'd make it down the first time; I don't think anybody did. That became particularly bothersome for a Flight Dynamics guy, because the first part of the job was monitoring the descent; the other part of the job was if we abort, computing all the rendezvous maneuvers to get the LM [Lunar Module] back with the Command Module. So, it was intense. Then you had this accident investigation if you had a crash, and, yes, we had crashes. The spotlight was on us; the papers were counting down. So there was a lot of pressure.

JOHNSON: How much interaction did you have with the crew at that point?

GREENE: A lot. A lot. Not as much as many of us have had on later flights. A lot compared to Mercury and the Gemini things, and it was a topic of conversation; how close do you get to the

crew? But we had quite a bit of exposure. A lot of it came through the strategy meetings we had, the data priority meetings, and [Howard W.] Bill Tindall's [Jr.] session. The crew would always be there, and we'd hash out our arguments. We had flight rules reviews; the crews were there. It wasn't till later in the Apollo Program that we got to drinking beers together and partying together on a routine basis.

JOHNSON: Was that a concern at the beginning, of getting close to the crews?

GREENE: No, it was more or less the way people grew up, and a lot of it probably had to do with the politics of who was running the respective organizations, and things changed as it went on.

JOHNSON: As you were doing the simulations, the mission rules were being written, and then, from what I've read, eleven days before the launch it was discovered that there were no mission rules for the computer alarms, because of the simulations that you were running through. Do you want to talk about that, that situation and how your team dealt with it?

GREENE: No, because I wasn't heavily involved in that. There's probably a lot more folklore than fact. You couldn't hire better press agents than the GUIDOs and the computer guys. They were playing their whole computer alarm thing, and they had ideas about what was wrong. I was panicking, because if they said, "Abort," they could go to the restroom, and it was my problem. No, I vaguely remember the meetings on alarms and reactions, but not enough to help.

JOHNSON: What about the communications delay? Do you remember any issues with that as far as having to get the information and the communications with the Lunar Module?

GREENE: It wasn't really a big deal. It wasn't really a big deal. I mean, I have a bigger problem talking on Instant Messenger now than we did back then. We had a time delay, and because of the time delay we had to bias some of the limits we had, because by the time you reached the limit and you recognized it on the ground, you had already passed it in flight. So that was a problem. Mars is going to be twenty-, forty-minute time delays; that's a problem. But the Moon was not a significant issue.

JOHNSON: If you will, just walk us through that mission and what you remember about Apollo 11. Were you in the Mission Control anytime up until the point that you were on console?

GREENE: I was in the room for launch and TLI. We had sleeping quarters in the Control Center, and Steve Bales and I, we took advantage of that. We slept in the building. I remember we went out to dinner at—if I do this, I'm good—Perusina's [Restaurant, Dickinson, Texas]. Did I do good?

JOHNSON: Yes.

GREENE: On the Gulf Freeway, which it may be Heartbreakers.

WRIGHT: Think so. Think that's right.

JOHNSON: I think so.

GREENE: So I'm not that old. It wasn't topless. It was a good steak joint.

We came back and slept in the building and went on for our shift. It was tight. The day before launch, we wandered into the Control Center and Kranz was there, and he was with the guy who wrote *Twelve O'Clock High* [Beirne Lay, Jr.]. That was pretty neat. There were celebrities all around the place, and a lot of press interest. Lot of press interest.

JOHNSON: You mentioned your age, and so many of the controllers and the people working Apollo and these missions were so young. What was it like to be that age and then be surrounded by these events and celebrities?

GREENE: Maybe being that age made it easier. We were doing our thing, and we knew our thing was neat. We had total public acceptance. You can walk anyplace in the city of Houston and saying you work for NASA was almost a free pass. It was a total different environment. We were isolated to a certain extent, and we did our own thing and didn't really care what people were saying about—at our level, at Flight Control. I'm sure there were levels above us that sweated that outward appearance stuff, but we were immune to all that. Had a certain amount of swagger, because we knew what we were doing. We were the first ones to do it, and since we were the only ones to do it, we were probably the best. It was pretty slick. It was pretty slick.

JOHNSON: Why don't we stop and just take a quick break. We'll change tapes before we get to that.

[pause]

JOHNSON: When we stopped, we were still talking about Apollo 11, so if you'd like to, let's go ahead and talk about your role in that mission.

GREENE: I was the lunar descent FIDO, and as I think I said, we were responsible for the monitoring going down and the ability to abort coming up. We got into the Control Center probably about four hours before landing, and we targeted DOI, descent orbit insertion burn, which took us down from a sixty-mile circular, I believe, to a sixty-by-eight, and then from eight we did the descent. So we targeted the two maneuvers and stood back to monitor. I remember the room was crowded. The other shifts decided they couldn't stay away. Security guys at the doors; doors were locked. We effectively went to battle short on the Control Center; in other words, let the hardware burn before you let a fuse blow and lose capability. We all puckered, and it was off, and it was just like a sim [simulation].

Everything was nominal till the computer alarms. While they were battling with the computer alarms, I was geared for the abort if they decided they didn't want to go on. So we fought through that, and we got down low, and Neil [A. Armstrong] started looking a prime piece of real estate. Again, the slower you went, the faster the Command Module was going in comparison, and so the whole rendezvous situation was changing faster towards the end than it

was at the beginning. So we were computing abort modes based on what we were going to do and how time was elapsing.

He landed, and then we had two—if I remember, there were two go/no-go points, T-1 and T-2, and one of the big debates preflight was how do you report to the Flight Director that you are okay to keep on the Moon, and everyone was used to when a Flight Director polled, you're saying go. Do you want to go? We wanted to stay. So everyone gave a "stay" call the first time, and we didn't sink and fall, and the cheese—the Mars guys didn't get us, and the Moon guys didn't get us. So we went from T-1, T-2, we will stay; and then you're committed for at least one orbit, and the relaxation after the biggest adrenalin rush in the world was incredible.

We went back to the barracks and we thought the crew was going to go nighty-night and do the EVA [extravehicular activities] the next day. Of course, the crew decided that this was not the time to rest. So we came down and we watched part of that, and then figured we hadn't slept in a couple of days, really well, so we called it a night. But fantastic. Fantastic.

JOHNSON: You mentioned the computations that you were making as the mission was moving on, and these were all with the information that you were getting. You were having to continuously recompute what had to be done?

GREENE: Yes.

JOHNSON: Tell us how that was accomplished. If someone was reading this today, they would think with computers, with whatever, how somebody would do that today.

GREENE: You mean the whole building had less computational capability than this here IT [*Blackberry* wireless handheld device]. Yes. We did a little bit better than using abacuses. We used Frieden calculators, if you remember what a Frieden was, with thousands and thousands of gears grinding. We had adding machines that would add hours and minutes and seconds, because that's what we had to add, so they were modular sixty adding machines that you probably couldn't find even on eBay today.

So we had these processors. We didn't have computers on the console, because there weren't computers that would fit on the console. The computers were in the ground floor of Building 30, and in order for us to make inputs to the computer, we'd have to call down to a guy who would do the actual typing for us. He didn't type everything because it took so long, so we had this artifact. We had paper tapes, and the paper tape was the predecessor of a mag [magnetic] tape, and he'd type his commands and punch a tape with a hole code in it. For every series of inputs we figured out we'd need, he'd type up the inputs and put it on this tape and have little coils of tape all around. We'd tell him what we wanted, and he'd take this tape and feed it into the reader, and we'd see the display screens and make any changes we wanted by calling down and telling him what we wanted to change.

JOHNSON: What kind of a time frame would it take to get that accomplished?

GREENE: Ten, twenty seconds. It was quick. It was quick. We were using the best machine, you know what I mean. We were using IBM's [International Business Machines Corporation] best.

JOHNSON: Were you on console any more during that flight, or after that did you just rest?

GREENE: No. Eleven, we had one thing we were going to do. We came in and watched ascent, and then we came in to be there during entry.

JOHNSON: What was it like watching that ascent phase?

GREENE: Everyone puckered. There are certain places usually we have backups for everything we do. Apollo 8 was an exception, but even on subsequent Apollos you needed that SPS [Service Propulsion System] engine to get out of lunar orbit—single-point failure—and a single engine to get you off the surface of the Moon. I'm not sure we would accept those designs today, which doesn't bode well for the guys working on lunar exploration.

JOHNSON: After that mission, you mentioned before, having time for parties and that sort of thing, and everyone has heard about the splashdown parties.

GREENE: Not me.

JOHNSON: [Laughs] Do you want to share any of your memories of any of those, for that mission or maybe some of the other missions?

GREENE: They vary. They had a character all their own. Apollo 11 was the big blowout with the fabled piano in the swimming pool. I wouldn't know. I think I passed out before we got that far.

Some of the places we used to go to, most of the places, aren't around anymore. The Singing Wheel on Highway 3; the [Flintlock Inn], which is where the putt-putt is on NASA-1; the Hofbrau Garden out in Dickinson. They all closed. Not that we had anything to do with them closing—the Nassau Bay Hotel, which ain't no more, that's where the piano went in. The Holiday Inn was always a big, big hangout.

But the Flintlock was one of the best. I don't remember what flight it was, but we landed early in the morning, and it didn't matter; we didn't know what time of day it was. The flight was over, so we went to drink, and there were a thousand people in the Flintlock, and at seven o'clock in the morning, Bloody Marys seemed like the right thing to do. There was this bartender who was making them one at a time, and everyone wanted Bloody Marys, and it was an adventure going back and forth and having one of his Bloody Marys. So we went to bed early that day.

We had good times. We really did. We worked hard. We earned the right to celebrate, and we celebrated hard and went back to working hard. Totally different environment than today.

JOHNSON: When you first came to this area from New York and then from your first position, how did you find a place to live and where did you decide to live in this area?

GREENE: First thing I did was find a quick place. I wound up living on Red Bluff Road next to the hospital where the guy took his horse. What was that doctor's name who ran the Red Bluff—

JOHNSON: Red Duke?

GREENE: No, this was not nearly as nice a guy as that. Anyways, I lived out in Red Bluff, and within a year I moved from Red Bluff to one of the really great apartment experiences in anybody's life, which was the Tally Ho Apartments. Tally Ho Apartments were on Airport Boulevard right off the Gulf Freeway. Tara Hall is the big one. There was an A&P [Supermarket] across the street. All the guys worked for NASA. All the women worked for Delta [Airlines], because [William P.] Hobby [Airport] was the only airport. It was one of the greatest living experiences I've ever had. Still keep in touch with people just from the apartment complex, and a whole bunch of guys from the center used to live there. Then I matured and got married, and I moved out here, and I've been here forever.

JOHNSON: When you first moved out here, did you move into an area with a significant amount of NASA employees in the area, too?

GREENE: Yes, but a five-minute commute makes it really worthwhile.

JOHNSON: Let's move on to Apollo 12. You already mentioned about being able to pinpoint the landing. What Flight Director were you working under for that mission?

GREENE: I didn't. I took 12 off, I think. Yes, I took 12 off. I was supposed to be the descent Flight Director for 13, and then other things happened that they said, "We don't need you this flight." Then I did 14, 15, 16, and 17. I did all those descents.

JOHNSON: So during 13, were you in the Mission Control at all, helping?

GREENE: Yes. Well, yes. I was at home, because I had a shift and I was going to do descent. I was lying on the couch, and my wife, who wasn't my wife, she called and she said, "You see what happened?" And I hadn't. So I drove onsite. We all sort of responded to what we heard on the radio and drove onsite. It was pretty grim. I don't think there was anybody who expected that crew to live. A lot of them, in retrospect, will tell you how macho and cool, but it was pretty grim.

JOHNSON: What did you do during that time, do you recall?

GREENE: We divided up into teams, and I was sort of assisting one of the guys for various reasons and participated in a couple of meetings here and there and had some spiffy suggestions, if I remember, but I was not a major Apollo 13 guy.

JOHNSON: Let's move on, then, to Apollo 14. You said you were working that mission.

GREENE: I think I was. You got me. I know I worked 15, 16, and 17. Thirteen and 14 are sort of a—

JOHNSON: Let's move on to 15, then. Do you have any specific memories about that?

GREENE: Yes, I do. We did descent, and we also did—I remember I was on for—it must have been TEI [trans-Earth injection]. I don't think I did the ascent. There were a whole bunch of things going on on the surface of the Moon that were pretty messy, and the crew got together and they were moving the rocks back from the LM to the Command Module, and they had a sick guy that they had to deal with.

We targeted the separation burn, and we thought we had everything under control, and the crew was late getting separated, and we had the targets on board, and it was probably half a rev [revolution] late, an hour, halfway around the Moon, that they finally got separated. They were going to execute the targets. We thought it was neat from the little telemetry that we had, and the crew reported that if they executed the target, they would burn directly into the LM, at which point we decided that we didn't know where we were. We'd stopped, and then the crew gave conflicting reports on their attitude. At one point they said the sun was in their eyes, and that didn't make any sense, because they were supposed to be pointed the other way. So we asked them, "Where's the LM?"

He said, "It's right in front of us." That didn't make any sense because it was supposed to be behind them. But it had to be in front of us if he could see it, because he didn't have any side view mirrors. Well, that took us about an hour to get that sorted away and get it retargeted and understand what happened. It was so confusing. It was one of the first press conferences

that Lunney invited me to attend, because he couldn't explain how we screwed this one up. There are certain guys around the site who still remember that scenario. It was ugly. But aside from that, we got separated; we did TEI, and it was semi-noneventful.

JOHNSON: What had happened that caused the problem?

GREENE: This is like describing a spiral staircase without using your hands. The targets are fixed relative to the local horizontal, local vertical, and then frozen inertially. If you're going around this way [gestures], and you're inertially pointed posigrade, and you keep that same attitude, 180 degrees later you're no longer pointed forward, you're pointed "backerds." That's what Texans say; backerds. That's effectively what happened. We hadn't compensated for the one-hour delay, and there was a simple way to do that. We learned a lesson. Fortunately, the crew knew that they shouldn't be burning into another spacecraft, and everything was cool.

JOHNSON: Was that the first time you had an experience with press conferences?

GREENE: Yes. I had others later that were messier than that, but yes.

JOHNSON: If there's nothing else on that mission, do you want to move on to Apollo 16?

GREENE: Apollo 16 was T. K. Mattingly [II] in the Command Module, and it was John [W. Young] and Charlie [Charles M. Duke, Jr.]. John and Charlie separated from the CSM, and T. K. did a gimbal check and failed secondary gimbals on the SPS, if I remember correctly, and

decided that he was no-go for descent orbit initiation, and there we were. So we had to work that one out, and while we were doing it, we decided we'd get to land back near the Command Module, because he was drifting; they were drifting away.

So we told John what to do, and John decided in his own little mind that we had just ordered him to deorbit into the Moon. He was wrong. Finally we got the two spacecraft together, and we computed probably three different rendezvous profiles and seven descent targets, and eventually we landed and everything was copasetic. So that was the highlight of Apollo 16.

JOHNSON: It didn't affect the landing as far as the targeted area?

GREENE: No, that was fine. That was fine. You got me thinking. Apollo 12, I did ascent. I was the Ascent Flight Dynamics Officer, launch. Lo and behold, that was an exciting launch. That was the lightning strike. That was sort of slick.

JOHNSON: Do you want to talk about that one for a moment?

GREENE: Well, not much. Probably a lot of people had more to say than I did. Except, that, you know, again, the Flight Dynamics guy was the abort guy, and it looked like we were going to have to do something rather significant. We didn't. We made it to orbit, and we were coming up on Carnarvon [Space Tracking Station], the Australian tracking station, half a rev [revolution] later, and we kept an acquisition table, when we're going to get acquisition and lose it; how long

the communication pass was. With all that was going on, we got acquisition, if I remember, it was almost five minutes early, and all the systems guys are happy. "We got data. We got data."

I looked at it. [Charles F.] Chuck Deiterich was the RETRO. I got a funny look on my face, and he looks at me, and I said, "Chuck, there's only one way we can get here five minutes early, and that's if we're reentering and we don't know where we are." Turned out that wasn't the case. It was what they call multipath, bouncing the signal off the Earth a couple of times. Scared the hell out of me. But we never told anybody.

JOHNSON: Do you want to move on to Apollo 17?

GREENE: The only thing I remember about Apollo 17 was the party. We had a big party.

JOHNSON: Because it was the last flight?

GREENE: Because it was the last flight, and Gene had some rather influential friends who decided to throw a party. So we threw a party at the Astroworld Hotel. It was at the P. T. Barnum Suite. I remember one of the guys came up to me, Gerry [Gerald D.] Griffin came up, and he said, "Do you ever get the feeling if there's one place to be on an evening, this is the place?"

JOHNSON: You worked for a lot of different Flight Directors during Apollo. Do you have any thoughts about any of them specifically that you'd like to share? Also, since you later on moved

on and became a Flight Director yourself, what you could have learned from them during those years.

GREENE: I enjoyed probably working with Cliff the best; Cliff Charlesworth. My best friend among the group is Glynn. Glynn would drive you crazy, because his mind would race so fast that he could churn out action items quicker than you could absorb, much less answer. Kranz was an impressive leader on Apollo 11. I like to think I became somewheres between Lunney and Charlesworth. I don't know whether I did or not.

JOHNSON: During Apollo, what would you consider your most challenging experience, during the Apollo Program itself?

GREENE: Experience.

JOHNSON: Or a moment or challenging moment or something that you had to do.

GREENE: The 502 launch, because we were headed for a rather significant limit line, probably as close as we've ever come to a trajectory trend towards a limit line, ever come during space flight. I was moments away from throwing the switch. We would talk. I was talking to the Flight Director, Charlesworth, at the time, and he was trying to calm down the Range Safety guys. Probably for hairy moments during Apollo, that was probably it. Apollo 11 was just an out-of-body experience. It was a different kind; it was a sustained adrenalin rush. I would say that was the moment.

JOHNSON: Do you have any favorite memory or proudest moment as far as the Apollo time?

GREENE: The 11 descent. The 8 mission. Eight and 11 are the two favorite things, or two of the favorite things. We did some pretty neat stuff later on.

JOHNSON: After 17 and Apollo ended, how did that affect MSC and the people there, and how did it affect your position?

GREENE: Well, we had Skylab to look forward to and ASTP [Apollo-Soyuz Test Project], eventually. Some of the guys got real impressed with that. We had the concept for the Shuttle, and we had some beginning design stuff, and the Ops [Operations] guys, we got involved in the Shuttle design as much as we could. I became a Section Head and a Branch Chief in that time frame.

There weren't enough significant events in that time frame that I really remember one from the other, except I got rid of the RETROs. I decided I didn't need RETROs. Didn't matter whether you were going forward or backwards, one trajectory guy was all we needed. That's in my autobiography. I got rid of the RETROs. John Llewellyn hasn't spoken to me since, which isn't all bad. Actually, he has, but not lovingly.

So we did Skylab, and Skylab had three launches and three landings and a lot of time when, for a trajectory guy, there wasn't much of interest. ASTP, more of the same. Limit, going around and around; the flight, and everything's cool. Then sometime in the mid-seventies, we started transitioning away from that and getting serious about aerodynamic flight tests and the

Shuttle Program and Shuttle ascents and what do you do about that. But the Skylab stuff sort of passed me by, and I have very little recollection of—I had guys in the Control Center, and I'd fill out their time and attendance reports, but there wasn't much going on.

JOHNSON: Do you want to continue on and talk about some of your other positions, or you want to go ahead and break now? We can come back and talk about Shuttle.

GREENE: Do you want to do that?

JOHNSON: That's fine.

GREENE: Otherwise I'll get "confusled."

JOHNSON: Okay. That's fine. We can do that. Before we stop, I'm going to see if Jennifer or Rebecca have any questions that they want to ask you, if that's okay.

WRIGHT: Can you tell us how the sims differed from when you were first planning to go with Apollo 11, and how they changed through the later missions?

GREENE: You mean through now?

WRIGHT: Through Apollo 17. During the Apollo.

GREENE: I don't think they changed very much, except the Accident Investigation Board thing sort of stopped, because—you see, at first they didn't think we were going to be able to pull it off. They had real concerns about the Ops team that sort of went away.

WRIGHT: Could you share a little bit more about the investigation team?

GREENE: I don't know much more about it. Maybe they never happened, but they sure threatened us with the fact that they were going on. Part of the problem was they had the lunar simulator, the descent simulator, and there were two of those. There was one here and one in Florida, which was sort of interesting, because if the crew was in Florida, then the communications would go from Building 30 to Building 5 to Florida. If the crew was in Building 5, the communications to talk to the crew, the com would go from Building 30, Building 5, to Florida to Building 5. That's the way it was hooked up.

So the point is, we had lunar surface and it was a very detailed model of the surface, and it had a camera that, as we descended on the Moon, obviously would get closer to this lunar surface, and then it would go blurry and kick up dust. They found out the hard way that if you crashed the LM, the camera would go smashing into the lunar surface and break the lens, which by itself was an expensive piece of hardware. So eventually they figured out they could put a probe under the lens and stop the visual before we crashed.

I don't know what that has to do with your question.

WRIGHT: We're talking about sims, how they changed, because the missions changed, the objectives changed as—

GREENE: Yes, but the pilots wanted to do ascents and descents and launches. That was the fun part. That pretty much stayed the way it was. The thing that was neat about the old days that we've lost, I think, over the years was debriefings. Back in the old days, guys, I mean, they'd screw up, and they'd throw themselves on the sword; and somebody would screw up and not throw themselves on their sword, and people would attack them, and there would be everything but fistfights over the debriefings. The honesty and the learning experience, we've lost a lot of that.

WRIGHT: That leads me to another question. You mentioned Bill Tindall. Can you share with us how some of his meetings went and how so much was accomplished?

GREENE: Oh, he didn't do anything. [Laughter] Bill was my neighbor. I hope I learned more from him than I did from the other Flight Directors. Bill had the ability to get a bunch of engineers in a room and work out problems in real time. Now, part of that capability comes from the fact that we used blackboards and chalk more than we used viewgraphs, and so you can have a discussion in real time, and somebody could lay out a hypothesis and you can build on it and you could erase and you can redraw a line and you can change a word, stuff you can't do with [Microsoft] PowerPoint and computers, and people don't do.

That led to problem solving with groups of hundreds, and Bill was a master at taking charge and leading the groups and coming out with a product, and then being able to take that product and put it into a very concise two-, three-page letter that became known as the Tindallgrams. I happen to be one of the owners of a full set, a full set of Tindallgrams. When

the price is right, I'll put that on eBay. But they were masterful pieces of work. He was a hell of a guy.

WRIGHT: The last question is about another gentleman you mentioned that we don't get to hear much about, and that was Cliff Charlesworth. You said you learned quite a bit from him. What were some of the attributes as a Flight Director that you really admired?

GREENE: He didn't try and do your job. He knew how to trust his people. If he didn't build that trust, they wouldn't be on his team real long. A lot of people disliked him. Cliff was Glynn's deputy for a long time. Just a real gentleman and a nice guy.

WRIGHT: Did you have a lot of turnover in your area?

GREENE: Turnover? You mean people leaving? Where would they go? No. Well, one. We had one. [H. David] Dave Reed left, and probably because I got the descent lead job on [Apollo] 11. He went up and he joined the Department of Transportation. We had an amazingly few number of casualties. We partied hard and partied into all hours, blowing off steam, and I don't remember losing anybody. We used to think that the curbs on the feeder of the Gulf Freeway were to keep you going in the right direction, and they did. They did. I have one guy who got on the Broadway traffic circle. You know what a traffic circle is? At Broadway. He was too drunk to figure out how to get off, so he just left his car and walked away. So we did all that stuff and we never lost anybody. Amazing.

JOHNSON: That just brought something to mind. The hours that you spent at work compared to the hours that you spent away from work, how did that affect your life at that point?

GREENE: It was different. It was different. We worked primarily during the week, and working nights ain't that bad. Sometimes we work days and nights in the same—you know, and that got a little hard. Maybe that was the advantage of being young. We were all resilient and didn't know any better. We lived around the Manned Spacecraft Center. We partied around the Manned Spacecraft Center. We went to marriages around it. You talk about the family; really close. Really close. Close to this day. I don't know about the younger kids, but the old Apollo guys, we're still close.

ROSS-NAZZAL: I'm just curious, did you see the History Channel documentary of Gene Kranz's book?

GREENE: Why would I not see it?

ROSS-NAZZAL: I don't know. What did you think of it?

GREENE: I thought I was spectacular. Did you think I was spectacular?

ROSS-NAZZAL: I thought you were fantastic.

GREENE: Thank you. I thought they did a dynamite job, and they're in town this week and next week, and they're doing a sequel. There was a mistake in that movie, a significant mistake.

ROSS-NAZZAL: Can you share that with us?

GREENE: Yes. At the end of the movie they made a comment that all of Kranz's guys are retired.

WRIGHT: And we know that not to be true.

GREENE: Now so does [Rushmore] Rush DeNooyer, the producer. He promised to bring me a reward, and I promise in the very near future to make his movie correct.

JOHNSON: So you're going to be in the sequel?

GREENE: No, I'm going to retire. I'm going to talk to them, I guess, Monday. Monday, I think. So this was a good—

JOHNSON: Yes, a good experience getting ready for it.

GREENE: I thought they did a fantastic job and really believed in what they were doing, and they got the right people together. There's another guy; Charles Murray. You know Charles Murray? Have you spoken to Charles Murray? Charles Murray is the author.

WRIGHT: No, we haven't, but we use his book [*Apollo: Race to the Moon*] extensively.

GREENE: He's a real fan. He's the one who got Harlan [R.] Crow. Harlan Crow is a financial supporter of some think tank that Charles Murray is in, and so a couple of months ago, Kranz, myself, Jerry Bostick, John [W.] Aaron, Chris Kraft, Glynn Lunney got together down at Perry's [Restaurant] with Charles Murray and Harlan Crow, who is Trammell Crow's son. We just had a good time talking about the old days and drinking Harlan Crow's liquor. Trammell Crow developed like three-quarters of Dallas [Texas] and half the rest of the country.

ROSS-NAZZAL: I just had one more question for you.

GREENE: Did you like me in it? I thought I was good.

ROSS-NAZZAL: I did. But I do have one more question for you. You talked about the splashdown parties. Can you talk to us about the annual picnics, if you went, or the Christmas parties onsite during the Apollo Program?

GREENE: No, we didn't do much of that. I mean, we were partying five, six—I mean significant; make that more than that. We didn't really do the Christmas party thing. I'm not sure we knew there were Christmas parties.

ROSS-NAZZAL: That's it.

JOHNSON: Okay. We thank you for sharing with us today.

GREENE: A pleasure.

[End of interview]