ORAL HISTORY 2 TRANSCRIPT

EUGENE F. KRANZ
INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is January 8, 1999. We are visiting with Eugene F. Kranz in the offices of SIGNAL Corporation, Houston, Texas, for the Johnson Space Center Oral History Project. The interview team is Rebecca Wright, Carol Butler, and Sasha Tarrant.

Good morning, and thanks again for taking your time. We appreciate you doing a second oral history with this project, and today we'd like to focus on your involvement with the Apollo Program, which we feel is somewhat apropos, because in just a few months we're going to be noting the thirtieth anniversary of the first manned lunar landing.

You've already shared your experiences, some of your experiences, with us on the early missions of the Apollo Program. So we'd like for you to begin today by telling us some of the preparations and the training that were needed to set that stage for the historic mission.

KRANZ: Are you speaking specifically of the Apollo 11 mission or are you talking about the transition from Gemini to the Apollo Program? Because that's about where the other interview ended.

WRIGHT: That's where we'd like for you to pick up.

KRANZ: I was working as a flight director on the Gemini IX mission, and it seemed almost overnight I was picking up the responsibilities for the Apollo Program. [Christopher C.] Chris

Kraft, myself, and John Hodge were to be the first flight directors to fly the first manned Apollo mission. The remaining flight directors, Glynn [S.] Lunney and [Clifford] Cliff Charlesworth, continued to finish the Gemini Program, and as they continued these missions, I'd go back in and fill in the night shifts for them to give them a bit of a break so they didn't have seven, eight, and ten days of two-shift operations continuous.

In the meantime, I was a division chief, had the responsibilities for the Flight Control Division, and we were in the process of learning the Apollo spacecrafts. We had a new contractor. We were very comfortable working with the McDonnell contractor in Mercury and Gemini. We had developed a very close association with them. They knew us, we knew them, and we believed they understood the nature of the space flight business, where [North American] Rockwell had been producing aircraft, fighter aircraft in particular, and were actually getting into the space business, and it ended up in some very heavy, some very strong conflicts of opinions on how the work was to be done.

In particular, with my control team, I demanded the responsibilities to do all of the mission preparation, mission design, the writing of the procedures, the development of the handbooks. This was alien to Rockwell, because they were used to producing all of these products for the people who flew their airplanes. So this was a time period where it just seemed that it was a very tempestuous, very tumultuous time frame, but we managed to get working through this, and it really amazed me how quick the turnaround was between the end of Gemini and the first of the Apollo Program. At times I felt like I had a foot in each program and couldn't quite figure out which way to go.

It was also surprising to us that we were going to fly the first of the Apollo Series in a manned fashion. Always before, we had been very conservative in the development of our test

programs so that we'd do what we call "incremental flight testing." We'd basically take a step at a time and very conservatively make sure that we understood what we had learned from the previous flight. We'd have relatively long gaps between missions-when I say long gaps, I'm talking the order of a few months-and then develop the next mission, which was a small, baby step forward.

But for the Apollo Program, the race to the Moon was very real to us that time. We had the lunar challenge laid out in front of us. We were three years from the end of the decade, so this did not allow too much procrastination in the directions that we were taking. So we elected to fly our first spacecraft, I mean first the Block One spacecraft, in a manned fashion with [Virgil I.] Gus Grissom, [Edward H.] Ed White [II], and Roger Chaffee. We had spent a time working and training and conducting various tests with back-up crew, and the initial back-up crew was [James A.] Jim McDivitt, and then late in the year 1966, he was swapped out, and Wally [Walter M.] Schirra became the back-up crew for the mission.

So we spent a lot of time with the crew really getting to know the spacecraft. The first flight in a program is very intense, and it's the first big milestone that kicks off the program. So there's a lot of personal contact between astronauts, flight directors, flight controllers, and we're all pooling our knowledge, trying to get to the point where we all feel that we're ready. And this feeling just never quite seemed to get there. It always seemed that every time we'd turn a corner there were things that were left undone or answers that we didn't have or we were moving down a wrong path, but we had the confidence that we'd been through this before. We'd been through it in Mercury, we'd been through it in Gemini, so we had the confidence that by the time we got to launch date all the pieces would fit together.

So we continued the testing program, and January 27th, I believe it was, when we were conducting the plugs-out test with Gus Grissom, Ed White, and Roger Chaffee, we had had a test two days before, the plugs-in test, where we had a variety of problems. We had problems with communications and life support, numerous deviations to our procedures right on down the line, but again we staggered through this test. An 8-hour test would routinely, in those days, take 24 hours, and then you'd take sort of a break because you only had one test team, and you just had to get away from it all. You had to regroup, basically rewrite the procedures, give everybody a little bit of a time off, and then come back to the console and then hit it again.

The test with Grissom, White, and Chaffee started off early in the morning. I had the responsibility for the Mission Control team, the Mission Control Center, communications, the remote site teams, etc. So basically I was generally the first one in to support the countdown, and we were following-myself, Hodge, and Kraft were following the same sequence that we did for the Gemini missions. I would work all of the systems-type issues, John Hodge would do the planning, and Kraft would conduct what we called the execute shift, the dynamic shift with the crew awake.

I had checked out all of the communications. I'd talked with the launch team down at the Cape [Cape Canaveral, Florida]. We'd picked up all the deviations to the procedures and had worked through into the early afternoon time frame when John Hodge came over. I had handed over the console responsibilities to John, and he was going to continue the countdown until the time frame when we got very close to the simulated launch, and Kraft would come in and pick up the count.

I had handed over to John shortly after noon at this time. The crew had entered the spacecraft, and everything looked like it was going reasonably well for a change. We had had

problems in communications, but nowhere as severe as we'd had the previous day's testing. I went over to the office, and we had small intercom boxes where we could listen to what was going on in Mission Control in our offices, and this was pretty much the norm, and you would listen to what was going on until it was time for you to come over and do your thing or pick up your shift.

By the time that it got to about 3:00, 3:30 in the afternoon, it seemed to be going okay. We had had some problems for holds with the crew, but we were again slowly staggering through the countdown to the point where I was sure we'd finish the test that day.

Marta had had our third child, so I'd promised her an evening out for a change, and one of the places that you would go would be the Houston Ship Channel. This is where all of the flight controllers would go. It had a Greek restaurant there, and at that time it was a great thing, apparently, to eat food wrapped up in grape leaves. I'd never done this, but we decided we were going to do this. We were in the process of dressing to go out, and my next-door neighbor, Jim Hannigan [phonetic], came over. Actually, we were waiting for the babysitter, and we heard some loud pounding on the door.

I went downstairs, half dressed, and I was expecting the babysitter, and instead it was a neighbor. Jim Hannigan came in and identified that he had heard over the radio that they had had a serious accident in the launch complex and that they suspected the crew was dead. So this was the first indication that I had that we had had the Apollo 1 disaster.

So I came out, hopped in the car, and it's about a 15-minute drive out to Mission Control from the small community that we live in. I arrived out there, and they had secured all of the doors, and there was no way to get in on the phone from the security people up to the Mission Control floor. I kept circling around the building, and there was a freight elevator back there,

and I sort of buffaloed the security guard to get access to the freight elevator and up to the floor where we were conducting the test, and got up there and got into Mission Control.

I've never seen a facility or a group of people, a group of men, so shaken in their entire lives. Kraft was there. He was on the phone down by the flight surgeon talking to the people down at the Cape, I believe [Donald K.] "Deke" Slayton, down there. John Hodge and myself had grown up in aircraft flights tests, so we were familiar with the fact that people die in the business that we were conducting, so we had maintained maybe a little bit more poise relative to the others, but the majority of the controllers were kids fresh out of college in their early twenties, and everyone had gone through this agony of listening to this crew over the 16 seconds while they—at first we thought they had burned to death, but actually they suffocated, but it was very fresh, very real, and there were many of the controllers who just couldn't seem to cope with this disaster that had occurred.

You keep playing—and I think this is the characteristic in Mission Control—you'll play the data back. You're looking for something so you can try to find a cause or an answer, and you're actually doing what it amounts to as meaningless work. You're basically trying to kill the time. And we couldn't find any answers.

We used to congregate, as flight controllers, over in the Singing Wheel, which was our watering hole. We also called it the Red Barn. One by one, as the controllers secured their consoles, we secured all the records, there wasn't anything more we could do. We went over to the Red Barn, and the proprietor, Lyle, over there also had heard that we had had a bad time out in Mission Control, so he sent out all of his normal customers, and for the remainder of the evening we just sat and commiserated with each other and tried to work through the fact that we had lost our first crew. One by one, we all dribbled home.

The next morning, we came back out to work again, trying to see if there was any answers, because in that kind of an environment you're trying to find answers, you're trying to find out why, what happened, etc., and there were no answers. We worked through the Sunday time frame, again just sitting in offices almost just paralyzed, we were so stung.

Come Monday, I had the responsibility for the flight controllers. I was the deputy for the Flight Control Division. I was the chief of the Flight Control Operations Branch, and I wanted to get my people together and just talk to them, because I had also flown fighters over in Korea, and when you lose a crewman or one of your squadron mates, you sit down and talk it over. You've got to get through this. You can't avoid it. The fact is that someone has died. I wanted to call my flight controllers together, and John Hodge decided it would be good to call the entire division together.

So we had a meeting in the auditorium, in Building 30 [Houston] what we used to call the office wing there. John Hodge sort of opened this session. He really reiterated what we had learned about the team, what we had learned about the accident so far, but, in particular, the team that was forming to take charge and determine the cause, determine what we were going to do about it. He talked about the responsibilities of Sam Phillips. He talked about the responsibilities given to [Dr.] George [M.] Low; he was picking up the program. Frank [F.] Borman, [II] was going to be part of a committee, and a guy by the name of Floyd [L. "Tommy"] Thompson was actually assuming the responsibility to lead this group. He came out of, I believe, Langley [Research Facility] or--I believe it was Langley at that time.

So this was sort of the news of the day, and it then came time for me to speak. I tend to be maybe one of the more emotional of the controllers. I believed that that's part of a leader's responsibility, to get his people pumped up, and I gave what my controllers came to know as the

"tough and competent" speech, and concluded the talk identifying that the problem throughout all of our preparation for Apollo 1 was the fact that we were not tough enough; we were avoiding our responsibilities, we had not assumed the accountability we should have for what was going on during that day's test. We had the opportunity to call it all off, to say, "This isn't right. Let's shut it down," and none of us did. So basically the toughness was from that day forward we would stand for doing everything right, literally being perfect and competent.

We had become very complacent about working in a pure oxygen environment. We all knew this was dangerous. Many of us who flew aircraft knew it was extremely dangerous, but we had sort of stopped learning. We had just really taken it for granted that this was the environment, and since we had flown the Mercury and Gemini Program at this 100 percent oxygen environment, everything was okay. And it wasn't. And we had let the crew literally paper the inside of the spacecraft with Velcro. We had kept shoving throughout this phase-testing, we would shove pieces of paper in there for every time that we had a test deviation, and the fact was that we had not done our job.

I had each member of the control team on the blackboards in their offices write "tough and competent" at the top of that blackboard, and that could never be erased until we had gotten a man on the Moon. I believe that set the framework for our work in the weeks and months that followed.

It's amazing how NASA took charge of itself in those days. We had pure, raw leadership, incredibly talented and capable people, and by November, ten months later, we were launching our first all-up Saturn V, very gutsy move by George [E.] Mueller to conduct what was called "the all-up testing," and this was every time you fly you're going to test everything. You're going to test all three stages of the booster. You're going to test the spacecraft. You're

going to test inside the spacecraft, the guides, navigation control. There is no test that will not be a complete entity.

The obvious advantage of this was, if you're successful, you're buying yourself time on the schedule. If you see a bunch of problems, you've got time to fix them, but if you're unsuccessful, you've got a whole bunch of space hardware that's reduced to junk. So it's a go-for-broke kind of approach that he kicked off that really paid off and, I think, was the real key in getting to the Moon.

Well, his first all-up test was the first launch of the Saturn V in November of the same year that we had the Apollo 1 fire. NASA in those days seemed to have an ability, an incredible ability, to pick itself up and set itself on the right path and then go do things.

The Saturn I flight, that was Apollo 4, was followed by a mission I flew in March. The lunar program, the lunar module, was starting to get behind in manufacturing and tests. The program looked like it was starting to stretch out and the lunar module was going to be the pacing entity. We conducted an unmanned test of lunar module, which, to me, was probably the most interesting of the unmanned flight tests that we ever flew. Most of the histories don't talk about the unmanned missions, and from a flight control standpoint they're the greatest thing that we've ever done, because if you really think about it, in the test program we are the first people to fly the spacecraft. It isn't the astronauts.

This test again showed the ability of the control team to take charge. We had to launch it. The basic objective was to test all of the propulsion systems in the lunar module, the descent engine that we would use going to the Moon, and this was a throttlable rocket engine. It was one of the first throttlable rockets, liquid rockets, ever developed.

Then we had what we had fire-in-the-hole staging in case we'd have to conduct a lunar abort while that descent engine was still running. We would have to blow some pyrotechnic bolts, separate the two stages, and ignite the ascent engine, change guidance systems, electrical power systems, and actually launch back off that platform, while we're still going down, launch back up for an abort. This is exactly the same technique that we use when we're on the surface of the Moon. So we had to test that out. And then we had a series of ascent engine burns. This is the engine that we used to get off the Moon.

So this was our baby, and it was a go-for-broke test, again in Mueller's all-up test concept. If we didn't get this done, we weren't going to be able to fly the lunar module. So we launched, and the mission was designed to be only about eight hours long, so we only had one flight control tape. Well, in the middle of the third orbit, when we were getting ready to kick off this testing, we found a computer bug. Somebody had left a fault in the design of the computer software because we had ignited the engine, and as soon as the engine started, it shut down.

This was really key, getting that engine started back up again, and we tried to get it started under automatic control, but in those days you didn't have global communications. You didn't have satellites. You had basically isolated stations, and for an eight- or ten-minute period every orbit one station might be able to track or two stations or three stations. So you had to try to plan your activities all to occur over the stations, and by the time we got to the third orbit we were starting to get into the area of sparse network coverage.

So we took over ground control, just like an astronaut would do in flight. We were punching in the commands for the engine just as the astronaut would do, and we finally managed to get the descent engine testing, all those engine tests accomplished. We then went into the ascent fire-in-the-hole stage, and this is a very complex maneuver. We got that

accomplished, but as we finished up, the lunar module had lost almost half of its weight. So we ended up in an autopilot mode that was incompatible. So we started hosing out the fuel, and we were blowing thrusters off the spacecraft, etc., and we had to find some way to again control it, so we shut down one of the propulsion systems to reserve that, came up with a new game plan.

In the meantime, the media was very interesting in this, because the East Coast newspapers already had their deadlines, and they had declared this mission a total failure, and they had talked about the great setback to the Apollo Program. But in the meantime, we kept charging on. We finally got the ascent engines started and completed those tests so that about eight hours after we had this initial problem, at about midnight we finished up with the mission. The West Coast newspapers were able to talk about Apollo Program on track, the test of the lunar module a total success.

Every team had those kinds of experiences. The next mission was one that was really a solid test of the Saturn launch vehicle where we lost two engines on one side during powered flight during launch, and the Saturn's not supposed to fly. It's supposed to basically start spinning, lose control, but this Saturn didn't. And when you lose two engines one side, we go through it, we use a term "chi freeze" which means we actually hold the attitude we're in. Well, this kept the booster going essentially straight up.

At the time that we now finish first-stage burn-out, the booster recognized it was too high and too slow, so now it takes all of the five engines in the next stage and starts driving back down towards the ground. Okay. Then the guidance realizes it's got the right velocity but the wrong altitude, so this thing keeps turning around on it.

This rocket that we're getting ready to launch people to the Moon on goes into orbit thrusting backwards. In the meantime, it's throwing all these wifferdils all over the plot boards,

and the team, by all rights, they should have called an abort, but since the engines were running, they were just watching this thing keep going.

Well, this is a good demonstration that the Saturn and the people down at Huntsville [Marshall Space Flight Center] had done a spectacular job of designing and implementing, with huge margins, this rocket. Each of these lessons that we learned in the unmanned missions were very important for us to get confidence in the hardware that we're now ready to put the men on.

We then went through the Apollo 6 and eventually into the Apollo 7 mission, and this was our first manned flight test. Again, myself, Glynn Lunney, and Gerry [Gerald S.] Griffin were the flight directors for this mission. Kraft, by this time he was targeted to be a flight director for the early space program, but with the accident and the delay and basically the replanning of the entire program, he actually moved out of Mission Control and actually he just ran the organization that was trying to put all of these pieces together.

I should back up, really, to before the Apollo 7 mission in April of 1968. Kraft, at one of his staff meetings, started talking about the problems that came out of this booster that went into orbit backwards and all the things that had to be fixed, and he started getting concerned about the schedule and our ability to go to the Moon. What he started was a series of mission-planning exercises to determine if we can't fly this sequence that we had planned, what alternatives do we have for maintaining on schedule?

One of the missions that we had in this very long plan sequence was what we called the "E Mission." We gave letter designations to each of the missions. The C Mission was the first command and service module. The D Mission was the first mission involving a lunar module in a manned fashion and the command module, and the E would take this lunar module and the command module into very high elliptical orbit, about 4,000-mile-high orbit.

Kraft and many of us felt that this was sort of a nonsensical mission. It was just too darned conservative for the tight program that we were flying, and it was really going to delay us getting to the Moon. So he proposed that we take this E mission, which would go the 4,000 miles, only instead of taking it 4,000 miles, take it 250,000 miles up to the Moon. So what we would do [is] we would fly one mission that would go up around the Moon and come back to Earth.

Well, this was very important because it would allow us to check out the ability to use the Saturn to inject towards the moon, which we had never done. It would allow us to check out the navigation system onboard the command and service module. It would allow us to check out our ability to track from the ground a spacecraft 250,000 miles away.

So he'd kicked off this activity, and Johnny Mayer, who was chief of Mission Planning, was an incredibly gifted individual. Well, he looked at this now as his opportunity to really kick into high gear in planning the lunar mission. All through the months of April, May, June, and into July, we had people within flight control and Johnny Mayer's division seriously looking at a lunar mission at the earliest possible date at the time-frame that we were scheduled to do this E Mission.

Meantime—and this was one of the great things about NASA—you would do many things. You'd be doing one thing with your right hand, another thing with your left hand, and at the same time you'd be dancing a jig. We were in the process of getting ready to fly Wally Schirra's mission, and Schirra would be scheduled for October, I believe.

Come August, I get a call to go over to Kraft's office, and Kraft says, "Sit down. I want to talk to you. We've had a meeting between George Low and myself and Dr. Robert R. Gilruth. I'm taking a team over to Huntsville today, and what we're going to do is we're going to

propose going to the Moon this December." Well, this is in August, so we're talking in four months we're going to go to the Moon. And this sort of catches everybody by surprise here.

He had had a series of these one-on-one-type meetings, and he said, "I want you to go back and tell me tomorrow morning," which would be a Saturday, "tell me tomorrow morning who should work in building up this plan, and I want you to see if there's any reason that we shouldn't fly a mission to the Moon this December." Well, obviously you can pull together a list of reasons you can't do things as long as your arm, but that wasn't the way you did things in those days. What you really did is say, "Why can't we?" So you kept looking for the opportunities that were there.

Next morning I had pulled together a small group of people, myself, Jerry Bostick, and a few others, and [Arnold] Arnie Aldrich, and we went over to see Kraft. He had had a very successful meeting at Huntsville that Friday afternoon, came back, and we now had the meeting, which kicked off, at least within JSC [Johnson Space Center], Frank Borman's Apollo 8 mission. We were really told to keep this thing sort of in secret. In fact, we did a lot of these things in those days. You'd try to keep something going, but it was like trying to hide an elephant in your garage. The fact was that all kinds of things had to happen if we were going to go to the Moon.

One of the guys that was really instrumental here was a guy by the name of Bob Ernal [phonetic]. Ernal was one of the young Air Force officers that came to us in the Mercury Program, went back into the Air Force, got his master's program, then came back to Johnson. He still works here today. Bob was one of these first of the computer gurus, because in those days computers were slow, they were unreliable, big, bulky, etc. He went over to this meeting that we had Saturday with Kraft, and Ernal was given the job to come up with all of the initial

mission planning. It's really the question of what day should we launch, what day are we going to return, what ocean are we going to come back to, right down the line.

And Ernal's response was simply, "Chris, if you'll give me every computer in Building 12 and in Building 30 for the entire weekend, I will give you the answer on Monday." It was that kind of a problem. Computers were that bulky. And that's exactly what Kraft did. He turned to Jim Stokes, who was running our facilities at that time, said, "Jim, give him whatever he needs," and Bob went away and literally cranked away at his machines for an entire weekend. I think there were seven computers, these great big mainframe-type computers that were involved at that time, and came out with actually a set of four what we call launch windows. Three were for the Atlantic, two in December and one in January, and one was for the Pacific in December.

The following Monday, we had a meeting to make this determination, because the Navy, with its aircraft carrier task force, could only cover an Atlantic landing or a Pacific landing, and once it got all set up in that ocean, we were stuck with that for the remainder of the Apollo Program. So the decision was made that we'd use the Pacific launch window, and this basically led to the time frame that defined the Christmas Eve mission, and it had nothing to do—we weren't trying to plot it for Christmas Eve. It's just the way the launch window fell out that we would be circling the Moon with Frank Borman on Christmas Eve. But I'm getting ahead of the story at that time.

Anyway, so this mission was now going in the background. We were all trying to get this going, and Kraft wanted to know who should be the flight director, chief of the Flight Control Division. I pretty much nailed down who the flight directors would be, and I gave him

Cliff Charlesworth, who was going to be the lead. So that tied Cliff, and again Cliff, Glynn Lunney, and Gerry Griffin for that mission. So this pretty much set the stage.

Each flight director—even though we'd be working—we were flying missions roughly at two-month intervals during this period of time. So you would finish one mission, you would have maybe an evening off, and then the next day you'd be right back training for the next mission. So we were literally working every day for almost a year and a half throughout this time frame from the Apollo 5 until we got through the Apollo 10 mission.

Have you interviewed Lunney? I assume.

WRIGHT: Well, we have one interview with him. We're planning to do another one with—

KRANZ: Okay. Because he's probably the best guy to talk about the Apollo 7 mission, because this was with the grumpy commander, Wally Schirra, and this was, again, the kind of mission where Glynn demonstrated every aspect of this tough and competent discipline and morale. We had all kinds of buzzwords we used as flight controllers in those days, but the discipline was really key, because I don't think there wasn't anybody that wanted to sort of pull the plug on Wally Schirra and leave him to circle the Earth on his own there without any communications for a while, because he was sure ornery. To this day, I don't think anyone has ever figured out what it was that was really the burr under his saddle.

We took a lot of heat from the media as a result of that, but as a result of that mission, we accomplished the checkout of the command and service module, which is what we really set out to do. We really put that spacecraft through the paces. On the ground, we had a single flight test to do it, and I think this is one of the things that made Wally sort of grumpy. We kept

piling a lot of stuff on him, because with only one test to get the job done, every time we saw an opportunity, if a system was working well, we'd go for it, we'd press it, we'd try to get some more testing in there.

First flight test of any spacecraft, you're going to find surprises. Remember, this is the first time we've put the manned command service module up in orbit, and you find all kinds of things. Batteries work different in space than they do on Earth. We couldn't quite figure out why we could never complete the battery charging, which is one of the things that made Wally just want to know why the heck we didn't know, and we said, "Wally, we don't know. We're going to have to come back to Earth and test this system and see if we can figure out why it isn't fully charging." So we had a lot of those kinds of issues. We'd make engine burns longer than he had seen before in the pre-mission planning. But the bottom line was that we got the job done and we got Wally home.

We then went into the Apollo 8, the first mission to the Moon. This is one where I was almost glad I was sitting on the sidelines, because I think everybody—Mission Control and the flight directing business is really amazing. It always seems that the people who are watching the mission get more emotionally involved in the mission than the people who are doing it, because the people who are doing it have got to be steely-eyed missile men, literally. I don't care whether they're 26 years old or 35. The fact is that you've got to stay intensely focused on the job. It is the people who are sitting in the viewing room, I think, who have it the toughest, flight directors who are trying to find a way to plug into somebody's console so they can listen in to what's going on.

But I think that was probably the most magical Christmas Eve I've ever experienced in my life, to actually have participated in a mission, provided the controllers, worked in the initial

design and the concept of this really gutsy move, and now to really see that we were the first to the Moon with men. We were at the point where we were setting records, literally, in every mission that we flew in those days, because the Russians had long since ceased to compete, it was obvious that we had the best opportunity for the lunar goal. And this was just a magical Christmas. I mean, you can listen to Borman, [James A.] Lovell, [Jr.] and [William A.] Anders reading from the Book of Genesis today, but it's nothing like it was that Christmas. It was literally magic. It made you prickly. You could feel the hairs on your arms rising, and the emotion was just unbelievable.

WRIGHT: And was that a total surprise for you to hear that?

KRANZ: Yes. I think it was for everybody. Certain of the crews at certain times just seemed to have a magic ability to select the right thing and do the right thing at the right time, and Apollo 8 was one of those days. I was just happy as all get-out that I was one of the few. Glynn Lunney used a term, that as flight controllers working in Mission Control, to be flight directors or as member of the team we were always drinking wine before its time, because we were doing things for the first time. We were working missions that people a century from now are going to read about, but we never had time to really savor it, because as soon as we finished one, we'd be on to the next.

As a flight director sitting off-line, not working the mission, this time I did have an opportunity to really savor, to really get emotionally involved with what was going on, where the people working the console never had that chance. I mean, they've got to stay focused, and if they get out of line for even a second, that flight director's going to come down and say,

"Okay, everybody get your eye. Get squared away. Get back to business. Let's cut all this crap out." It's interesting to live in that environment. I'll talk about it when we talk about the lunar landing, my feelings about the lunar landing.

Anyway, we went through the Apollo 8 mission, and the next mission was mine. It was with Jim McDivitt, [David R.] Dave Scott, and [Russell L.] Rusty Schweickart, and this was the final mission in lunar orbit.

The Apollo 9 mission was the final mission in Earth orbit, and several things came out of Apollo 9 that were very important. It was my second opportunity to fly a lunar module. I'd flown the unmanned lunar module on Apollo 5, so this put me in a good position for competing with the rest of the flight directors for the lunar landing. We really hadn't established who was going to be doing the landing, and every flight director wanted to be part of the first lunar mission, first landing mission, and every flight director wanted to do the landing. So we were all trying to figure out ways to position ourselves so that we'd be the obvious one chosen.

So this gave me an opportunity to really come up to speed now with a manned lunar module, and with two lunar modules under our belt, I not only know the spacecraft but also know the mission control teams that work with them to understand the strategy and the use of the system, to be intimately familiar with not only the systems, but the procedures, the mission roles. So you're really flying missions, but you're also preparing yourselves for the big one.

This was also a good opportunity to really continue this testing of this lunar module, in five days. It was a nine-day mission, and the five days that we were working with the lunar module, we did ten engine burns, ten maneuvers, so we did essentially two major maneuvers a day. At the same time, we'd do rendezvous with the spacecraft, actually put the crew in this lunar module, and if we couldn't get the two back together, this crew wasn't coming home,

because there's no heat shield on it. So this led to a series of practices with the command service module where we'd rescue a lunar module. We'd do very various rendezvous to demonstrate rescue, etc.

Also, as part of the training—and this turned out to be very important for Apollo 13—part of the training, one day my team didn't do the job right, and when we were debriefing the training, our Sim Sup [simulation supervisor], which is our training boss, training lead, comes to us in the debriefing and says, "Why did you leave the lunar module powered up? Why are we using all that electrical power? Don't you think you should have developed some checklist to power this thing down? Whenever you've got trouble, you ought to find some way to conserve every bit of energy, every bit of resources you've got, because some day you might need it."

In debriefing—the guy's name was Jerry Griffith—and we had to say, "Jerry, that's a good idea. We weren't doing our job. We weren't thinking. We were thinking too many other things." So we started developing a series of emergency power-down checklists that really was our first line of defense when Apollo 13 came along.

But I'm getting ahead of the story there, now, because Apollo 9, again, was an incredibly successful mission, the last one in Earth orbit, and it really gave us the confidence that this command and service module and all of the procedures that we had developed so far were going to get the job done.

Now, think about the lunar mission and think about the sequence. We had gone through the sequence of an Apollo 7, checking out the command module. Apollo 8, we'd demonstrated our ability to use the Saturn upper-stage S-4B to inject us out to the Moon. We had proven our ability to navigate in the vicinity of the moon, to conduct precision maneuvers, to go into orbit around the Moon, and then come back home. Apollo 9, now, we checked out the lunar module,

what we call the transposition and docking, because once you get injected to the Moon, you have to separate the command module, turn it around, come back in, and redock with the lunar module, which is still attached to the booster, blow some explosive bolts, and extract that thing. We then demonstrated our ability to perform dock maneuvers which we'd have to do on the Moon.

So we were adding in all of these fundamental building blocks for the lunar mission. The final thing that we had to do was conduct a full-blown dress rehearsal, and that's exactly what we did on Apollo 10. It's to now put all of these pieces together and do a rehearsal for the lunar landing, including making a low pass across the surface of the Moon. This came off incredibly well.

So now we're coming up on Apollo 11. We're getting ready for the lunar landing. As division chief, in the early days shortly after the Apollo 1 fire, I had to run the division. I had all of the controllers and all of the flight directors, and all of the mission planning procedures, the whole nine yards. I also was trying to be a flight director and fly mission. I made what I guess I'd consider a lucky decision—might consider it fateful—that I could not fly every mission, and what I would do is I would fly alternating missions, and I elected to fly odd-numbered missions. This was very interesting, because it now set up the sequence that put me in interesting positions for the remainder of the Apollo Program.

The first of the key odd-numbered missions was Apollo 5, where I learned about the lunar module; Apollo 7, where I learned about the command module; Apollo 9, where I then got more lunar module and command module experience. So by the time it was time to select the flight directors who would work for the first lunar landing, Glynn Lunney had more experience in working in the vicinity of the Moon than I had. I had more experience in the lunar modules.

It was very interesting, the balance between the flight directors, because we were all positioning ourselves for what we considered the big one.

But Cliff Charlesworth, who was the designated lead flight director—and we would always establish one flight director for each mission who would more or less act as the orchestrator for all of the other flight directors. He'd establish what jobs they would do, and we always tried to distribute the workload. The flight director's job requires an incredible amount of knowledge, and when I say knowledge, knowledgeable of. He has to know the launch vehicle, a three-stage rocket, and all of its systems and the two computers on board that rocket, two spacecrafts with four computers and all of the software in those computers. He has to understand every aspect of the trajectory design of the mission: the launch, the launch aborts, the Earth orbit insertions, various aborts from Earth orbit, translunar injection, aborts from the translunar phase, going into lunar orbit, aborts from that phase, then finally getting into the descent orbit where you get down close to the Moon, the powered descent, the EVA on the surface, the launch from the surface, rendezvous and docking, then back, the trans-Earth injection, and then all the reentry phase. In addition to that, he has to know the science, he has to know the crew physiology.

So we always take and try to break up a mission into digestible chunks, and for the lunar phase of the mission we started adding in a fourth flight director because the job became so immense. Well, the flight directors that were tagged for the Apollo 11 landing, Cliff Charlesworth was the lead, and the lead assigns the mission phase responsibility. So he picked up the launch and the injection to the Moon, and he also picked up the responsibility for the extravehicular operation on the surface. Glynn Lunney had come off the Apollo 7 and the Apollo 10 missions, and he picked up the lunar ascent, getting off the Moon, getting

rendezvoused up in lunar orbit. I picked up the responsibility for the landing and the injection from the Moon back to Earth, and then we had Gerry Griffin in there, who picked up the reentry phases.

So, basically we were able to distribute this very large base of knowledge and get it packaged in four flight directors. So we all had a pretty well-balanced workload. I was happy as a clam. The day that Cliff Charlesworth came into the office and said, "You're going to do the lunar landing," I just ricocheted around the office virtually all day, and I don't think my secretaries ever saw me as happy. I had a spectacular secretary, Lois Ransdale [phonetic], who got me through all of the lunar program. In fact, she's the first woman, and the only woman, who ever became an honorary flight director. She was that well respected by all of the people on the flight control teams.

Now, there's one other honorary flight director, which was [Howard W.] “Bill” Tindall, [Jr.] and Bill Tindall was pretty much the architect for all of the techniques that we used to go down to the surface of the Moon. I think Tindall was probably the single individual who had—if there should have been a lunar plaque left on the Moon from somebody in Mission Control or Flight Control, it should have been for Bill Tindall. Tindall was the guy who put all the pieces together, and all we did is execute them.

I respected Bill so much that when the time came for the lunar landing, the day of the lunar landing, I saw him up in the viewing room, and I told him to come on down and sit in the console with me for the landing. He didn't want to come down, but basically I cleared everybody away and we had Bill Tindall there for landing, and I think that was probably the happiest day of his life. A spectacular guy.

So anyway, those were the two honoraries. Lois Ransdale was Pink Flight and Bill Tindall was Gray Flight, because we always assigned colors to the flight directors. I had the white team. Cliff Charlesworth had green. Lunney had black, Gerry Griffin had gold. So those were the team colors associated with the lunar mission.

Training for the lunar mission was probably the most difficult time of my entire life. The training process, you have a training team led by an individual we called Sim Sup, simulation supervisor, and the Sim Sup's job is to come up with mission scenarios that are utterly realistic and will train every aspect of the crew and controllers and flight directors' knowledge. It'll test every aspect of the procedures and planning that we have put together. It'll test our facility operators. It'll test our ability to innovate strategies when things start to go bad. Sim Sup has a team of five controllers, and throughout all of the time when we're pulling together the planning for the lunar mission, Sim Sup will sit in our meetings.

If I were having a meeting with Neil [A.] Armstrong, [Edwin] "Buzz" Aldrin [Jr.], and we couldn't come to an agreement, Sim Sup would write that down. Or at some point we just, in pure frustration, late day, we just decided to cut it off and say, "Well, this is the way we're going to go." So, Sim Sup would log all of those things. He would recognize when we just ran out of time in doing something. He'd realize when we had personality problems in people and in teams. So he would develop training scenarios. He'd look at the mission rules we would write, and he'd say, "Well, I don't think that's the right way to go. My team thinks—but again, they made a decision, so we're going to test them and see if they'll really live with this decision."

Well, Sim Sup is the guy, now, who writes—before the mission, months before the mission, he will take these scenarios, and the training sessions may be only seconds long, some

may be minutes long, some hours long, but he's going to write these out, and he's now going to test. Is this really the way we're going to work?

The training process for Apollo 11 began very late, because the lunar landing software in the simulators wasn't ready. So Cliff Charlesworth kicked off the training, and we'd launched Saturns before, so he basically led off for the first month, in April, and he accomplished the training for the launch phase. So that gave myself and Lunney pretty much access to the simulators when we needed to in the months of May and June, because we were going to be launching in July, and we generally cut our training off about two weeks prior to launch because the crew had other things to do, we had other things to do.

So, the first month of training with my team went like a champ. I mean, the training in May, it's almost—we came off missions, we were familiar with the lunar module, we had a hot hand, too cocky. We really thought we were on top of the world. We'd generally run one training session associated with the lunar landing each week. It's hard for me to believe nowadays, watching the mission controller's training, but at the time that we landed on the Moon, we only had about 40 hours of total training in there. We had essentially one week's training in the simulators.

But anyway, the first several training sessions went very well, and then Sim Sup looked at the team and decided we need to be taught a lesson, and he started increasing the pressure associated with the descent phase. Now, when you're going down to the Moon, just like landing an airplane, there is essentially a dead man's box. No matter what you do, you can throttle up, you can change your attitude, you're going to touch the ground before you start moving back off again, and it's the same kind of condition, but it isn't a neatly drawn line; it's a set of variables,

and it depends upon the altitude and the speed at which you're descending down how this box is defined.

Well, then if you add in the effect of the lunar time delays, the fact is that everything we're seeing is about three seconds old, and then we have to figure out what our reaction time is and then voice some kind of instruction to the crew on what to do. You have to start defining a set of boundaries. You're going to have to make up your mind before you're actually into the problem. This gets to be very dicey.

Anyway, we're now in one month prior to launch, and as we're moving into this final month of training, Sim Sup really laid it to us, and it related to this dead man's box and this lunar time delay. We went through a series of scenarios that was almost—it seemed like forever. It was only a couple of weeks, but it seemed a lifetime where we could not do anything right. Everything we would do, we would either wait too long and crash or we would jump the gun and abort when we didn't have to, and the debriefings were absolutely brutal during that period of time.

[Richard] Dick Koos - a bit about Dick Koos as Sim Sup. He was one of the very early pioneers of the Space Task Group. He came in out of the Army Missile Command in Fort Bliss, Texas, because in those days you couldn't hire people with computer degrees. You just went after people who had the experience. Well, the Army was working with computers in their ground-to-air missile program, so he was either a corporal or a sergeant discharged from the Army out of Fort Bliss when they hired him into the Space Task Group, and virtually everybody that we had was hired on a paper basis. There were never any interviews conducted. You just fired in your application, the SF-57, I believe it was, and they'd look at it and say, "Oh, yeah. These people would fit here," and they would just bring you on board, and, well, it was like,

"You'll go to training, and you'll go to operations, and you're going to go to engineering," and it was that kind of a sequence.

Well, Koos was one of the guys who ended up in training in the very early days, and training in the early days was incredibly rudimentary, but by the time that we got to the Apollo Program, it really had become quite sophisticated. Training in Apollo was about as real—I mean, you would get the sweaty palms, you would have the—when the pressure was on in a training episode, it no longer was training, it was real, and the same emotions, the same feelings, the same energies, the same adrenaline would flow.

Koos was causing all this to happen, but he decided my team wasn't ready, so he kept beating us up and beating us up and beating us up. Over in the offices where George Low and Chris Kraft would sit, they would listen to our training exercises. They had these little squawk boxes, and they had the air-ground loop, and they had the flight director's loop, and every time we'd have a bad day or a bad session, they'd grit their teeth, until finally Kraft called up one day. It was sort of like this: "Can I help you?" Well, there wasn't any help this guy could give me. I mean, there was nothing. And the only help he could give me was to maintain his confidence that I was going to get it all together.

Behind the flight director's console we have a telephone. Well, what I did is I put a switch in to disable the ringing so that he could call all day long, but I would never hear it. All he would get was a signal that the phone was ringing. But eventually we pulled ourselves out of these pits that we had gotten ourselves into, and at times it got so bad that the prime crew, Apollo 11 crew, Armstrong and Aldrin, just didn't want to train with us anymore, and we didn't want to train with them, to the point where they'd go off in a different simulator and we'd work with the backup crew or work with the Apollo 12 crew.

So it was this kind of a fragmentation that you had to pick yourself up and get it all back together, and then somehow—and I think it's the competitive nature. It is the fact for the flight controller, failure is not an option. They are not going to be defeated by anything at any time, anyone, and one by one by one, people started picking up, and then pretty soon little groups would have their act together, and this group would act together, and somebody would be in trouble and another group would help them out. I mean, it was just this incredible formation that exists within this team, the intensity, the emotions, the time that we'd spend drinking beer together, the time we'd debrief together, the time we'd go back to our office and kick ourselves because we didn't do as well as we knew we were capable of.

But it finally came together, and it came together just in time, about the time that we were just about ready to finish up the training with the Apollo 11 crew. Then Sim Sup stuck it to us again. The final training runs, invariably, are supposed to be confidence-builders. It's to the point now this is the last time you're going to have an opportunity—generally things are going to go right during the course of the mission, so let's stay within the box, let's build the confidence of this team, etc.

Koos didn't see it that way, and we started our final day of training, and about midway through the day, we had done more aborts, and I was really starting—it was starting to get irritating to me, because what I wanted to do was practice the landing, continue to refine the timing of the landing, but we were aborting when I really felt—and I was really seething, I mean just really frustrated at Sim Sup, but there's no—I mean, he's the boss during training. He's going to call the shots.

I think it was either last or second to last training exercise—I'm not clear on this and no one is, in fact—but we started off, and midway through the descent training, we saw a series of

computer program alarms. We'd never seen these before in training. We'd never studied these before in training. My guidance officer, [Stephen] Steve Bales, looked at the alarms and decided we had to abort.

We aborted, and I was really ready to kill Koos at this time, I was so damned mad. We went into the debriefing, and all I wanted to do is get hold of him at the beer party afterwards and tell him, "This isn't the way we're supposed to train," and in the debriefing we thought we'd done everything right.

Koos comes in to us, and he says, "No, you didn't do everything right. You should not have aborted for those computer program alarms. What you should have done is taken a look at all of the function. Was the guidance still working? Was the navigation still working? Were you still firing your jets? And ignored those alarms. And only if you see something else wrong with that alarm should you start thinking about aborting." We told him he was full of baloney. In the meantime, I gave an action to Steve Bales to come up with a set of rules—now we're literally about two weeks from launch—a set of rules. We've had our final training run. A set of rules related to program alarms. I want a total expose, and I don't give a damn how long it's going to take him. If he has to work all night or all week or every day from now to the launch, he's going to understand these program alarms.

Well, he started off working that evening. I had gone home, and I got a call late at night, and Bales said, "Koos was right. We should not have aborted." They now understood these alarms better, and what they wanted to do was to run another training run the following day, exercising various type program alarms.

We set up another day training. Now, the Apollo 11 crew had gone, so Apollo 12 crew was the one that we were now working with. We conducted our final day of training, exercising

all kinds of various combinations, computer program alarms, right on down the line. Sim Sup—at this time I was literally ready—I just wanted to see him after the mission. We were going to have a talking—to about how training should be conducted in the final days. But again, Sim Sup's boss. Sim Sup is always right. The flight director has to take anything he dishes out, because that's the way training's done. Okay.

We went into the final couple of weeks of training, and the neat thing about the lead flight director is he takes all of the press conferences, etc., etc., so basically it gets to the point where each of the flight directors, except for the lead, has a couple days off so you can really start getting your mind in order, you could get your team in order, you can study the loose ends, you can build the intensity that you need when it comes time to fly.

Each of the controllers does this in an entirely different fashion. I'm an extremely organized guy. There's no way I could cope with the knowledge requirements of the job without total organization. So I have a series of books that I would build. I mean, they're incredibly indexed. I've got every detail you want. I know them by heart. And what I did to identify my books—it would not be allowed in today's days of all the harassment kind of things, but I would take the girls from the *Sports Illustrated* swimsuit edition, and the reason I did this is literally I was frightened to death some day, come mission time, I would have lost one of my books. So everybody knew if they saw a book with the swimsuit edition cover on it, it was Kranz's, and it would find its way back to me.

But anyway, I would super organize, super discipline, super instructor. Lunney was a soak. I mean, he was so damned smart, it was incredible. That guy had such a gift for being able to assimilate information, knowledge. I mean, it was just unbelievable. Cliff Charlesworth had the reputation—he carried the nickname within Mission Control as the Mississippi

Gambler. Cliff—nothing ever seemed to upset that guy. I mean, he was about as loose an individual as you have ever seen in your entire life. It didn't matter if he was going to do something for the first time, it was just no big deal, "Let's just go do it." Cliff was just absolutely almost carefree. He had an ability to—everybody's up here in intensity, and Cliff's way down here, and you wonder if he's ever going to get up for the mission, but that's the way he worked.

Gerry Griffin was, I think, closer—he was sort of a bridge between myself and Lunney. Griffin was very intense, very crisp, but being he was a military fighter pilot like myself, he sort of relied upon structure, procedures, discipline, etc. The days just seemed to—all of a sudden you're there, you're in launch day, and when mission day starts, there's this incredible relief that training is now behind you. There's no more Sim Sup. It's just you and the crew and whatever the heck you were told to do.

There's also—most people look at it as, you know, you're going to be all emotional, you're going to be this, you're going to be hyper. I always find that when time came for a mission, when time came to do something, there was just an incredible degree of just solitude. You just felt so comfortable. I'm trying to find the right word for this thing here, but basically it's just peace. You're at total peace with yourself, and when you reach this total peace, you're ready to go. It's interesting. The adrenaline's pumping, but you have this incredible confidence in your team and in yourself as a result of this training Sim Sup's given you. He's given you your confidence.

It's sort of like the first time you solo an airplane. It's the same doggoned feeling. This instructor has given you this absolute confidence in your ability to get the job done. You never think about, "If I get airborne, I've got to get back to ground. I may crash." It doesn't come

across that way. It's just, "Certainly." It's just peace in the business. I used to fly early supersonic fighters, and you'd get out to the end of the runway, and, boy, when you're cruising down the runway at 250 miles an hour and something goes wrong, you've just got to have confidence that you're going to be able to pull it off.

So it's this peace that comes when launch day finally gets there. This changes once you get into the mission because then you've got to build the intensity. But the neat thing was, Charlesworth launched this guy, and traditionally all flight directors show up in there, and you find a place to sit, and you're three or four deep. Every console's three or four deep. Nobody's going to miss the launch for the first lunar landing mission. Nobody.

You got through these days, and fortunately the Apollo 11 mission, like many missions, started off quite easy. Everything was normal. No major challenges. In fact, Lunney, in his log, was tracing what he calls "nits." The flight directors keep a log, and this is the minute-by-minute, second-by-second, blow-by-blow as to what's going on, and then at each shift you pretty much summarize for the next flight director.

You went through this routine the first couple days of the mission, then all of a sudden it's time to change shifts. We go through what they call a "wifferdil," and this is because, unlike Earth, we work on eight-hour shifts in Missions Control, or try to, but all the mission events don't fit neatly into these eight hours. So at times you have to make a time adjustment.

So we finished my last shift before the lunar landing, and I had a thirty-two-hour period until my next shift came up. So now when you do this wifferdil, you have to adjust all of your bodily functions. You've been sleeping here, and now you've got to sleep here. Okay. So not only do you have to do this, your entire team has to do this thing. But, finally, when you're doing this wifferdil, it finally sinks in that this next mission is what the whole program's been

about: landing on the Moon. And this is the only time, really, this 32-hour period, and just the first part of this thing, because you're just making time. You're pacing. You've got all this energy, and you don't have anything to do with it. You've got no focus. You can't sleep. Heck, we had six kids, and Marta's trying to figure out some way, "Gene, when are you going to settle down? When are you going to sleep? Are you going to go out to Mission Control Center to sleep? What are you going to do?" and you don't know.

You'd haunt Mission Control again and you'd fidget a bit to make sure your procedures are all ready. Then I guess this magic s_____ [unclear word], you know, actually just feeling so much at peace kicks in again, and you have the most wonderful eight hours' sleep that you've ever seen in your entire life, and this is the last time, because you're going to walk into Mission Control in a few hours, and your team is going to write the book about landing on the Moon.

I had this incredibly spectacular, I mean, just absolutely deep sleep, no dreams, no worries, no nothing, and get up, and the way I pump myself up each time I get ready to do something, "Stars and Stripes." I can hear "Stars and Stripes Forever," by John Philip Sousa. I've got probably thirty or forty records, tapes. Every time you see an opportunity and the kids want to get anything for Christmas or Father's Day or any special event, it's always another—a new march record.

At this time also we had eight-track recorders, so I had them in the car. Every place I'd go, I'd have John Philip Sousa. And this is the way I get up to speed, get the energy, get the adrenaline flowing. Driving to work, it's early in the morning, and the drive—there's times when you drive—and I don't know whether it's tired or preoccupation or whatever it is, you would leave someplace and you'd drive to the next and never remember going through League City and the stoplights and it's just—you just hope to God. You knew somebody was looking

out for you, because you sure weren't looking out for yourself, and you wonder how you ever got there.

We'd always park behind the Mission Control, and the guards out there, the first time that you know something's different this day is you have roving guards out in the parking lot, which is rare. I remember this one because one of my favorite guards was a guy by the name of Moody. He was a short Negro, sharp, crisp, military, I mean starched, impeccably starched, gold tooth in there, and the most effervescent smile you've ever seen in your entire life. And he sort of greets you. And always he would greet you—he knew every flight controller. He knew every detail of every mission. He knew what was going on in every mission. He had exactly the right words to say to every person that would arrive. This was true of the entire guard force, because I think, as opposed to many other managers, people around JSC, these people felt very close to the flight control team.

So Moody gave me the highball, and it was, "You're going to do it today, Mr. Kranz." It was always "Mister." Mr. Lunney, Mr. Kranz, Mr. Kraft, etc. And you'd highball, and he would smile, and he just set you just right. You'd walk in from the parking lot down the pea gravel concrete down there. Walking into Mission Control has always been a favorite of military history. I've read, I think, stories of every major military leader from Julius Caesar all the way up to [Norman] Schwartzkopf, and [George] Patton has always been my favorite, because Patton felt that he was—he had been in the battlefields of Thermopoly, he had been with the Roman Legions, he'd been fighting at Sparta, he had this feeling of predestination. Well, I've always had the same feeling. It's sort of weird. But basically you walk down this hall in Mission Control, and again, I'm not thinking of lunar landing, I just feel that myself and the

team I've got, from the time that we were born, we were meant for this day. And it's funny how these things feel.

I'll tell you a bit about the team I've got. Incredible array of people. [Robert] Bob Carlton. Bob is about as dry, laconic—I think he comes from the Carolinas, and a Carolina accent. This guy, if you listen to this tape of the lunar landing, Carlton, it's like he's out picking cotton. I mean, he is absolutely unperturbed. There is nothing—and yet the thing that's interesting in the tape, Carlton is counting down to seconds of fuel remaining. He's telling me we've got 60 seconds of fuel, we've got 45 seconds of fuel, we've got 30 seconds of fuel, and he's right at the point where he's going to have to start a countdown, 15 seconds, we're running out of fuel, and he's just like an everyday occurrence. Remind me, if I don't, how we computed fuel at that day, because that was really scary. So that's Bob Carlton.

[Donald R.] Don Puddy is my lunar module guy. He's very quick. He'll become flight director. Very gifted, very quick. He's got what they call-he's telemu. He's basically got the life support systems, he's got the electrical power systems, he's got the pyrotechnics, these kind of things, also got communications. A college graduate, came in straight out of school, tall, lanky, sort of a self-appointed team leader for the people in the lunar module.

Down in the trench I've got Jay Greene, who's a Brooklyner, and he's got the Brooklyn accent that, I mean, it almost drenches you with this thing here. You feel you're walking the streets in the Northeast. And cocky. He is so cocky, it's incredible. He and I were the ones that were crashing spacecrafts on the Moon.

Sitting right next to him, on his left, is [Charles] Chuck Deiterich, who's a Texan, great big brush mustache, right on down the line with the drawl. Chuck is RETRO [Retrofire Officer]. He's also the guy that prepares a bunch of messages for them.

To Green's right is Steve Bales. He's one of the original computer nerds. I mean, he looks like one. He's got these big owlish-type plastic-rimmed glasses you got in there. I don't think any of them—they all look like they never needed to shave. I mean, they're baby-faced kind of people.

Cap Com [capsule communicator] is [Charles M.] Charlie Duke [Jr.], and he's probably the best of the best of the best from a standpoint of the astronauts. He was personally requested by Neil Armstrong to be the Cap Com for this mission, and you've got to respect Armstrong. You've got to respect Slayton, because Slayton also has to concur on this thing here. And Charlie Duke was just absolutely a master of timing. It seemed when we were in the pits, Duke always had the right words to say to just pull this team up and convince this team that we'd get it together. I'm sure he had to pump up the astronauts, because they were getting pretty discouraged at times.

And then on my left-hand side I've got a guy by the name of Chuck Lewis. Chuck Lewis is one of my flight controllers who grew up—I hired him fresh out of college. He was on board, like me, only a couple of weeks and he was sent into the heart of Africa at the start of an uprising when they had incredible rioting, the natives in Zanzibar, the ethnic groups, were fighting each other for freedom. The British were getting ready to turn them loose, and the controllers would be walking through town or out in the town, and they'd throw bloody roosters, decapitate them and throw them at them. This was the symbol of the Afro-shingazi [phonetic] Party. Lewis also, like in the movies, you'd come back at night, and they were told, "If you have any roadblocks, you see anybody there that's not in uniform, just keep going." Well, this is sort of tough to do in a little Volkswagen in there, and the people have got machine guns.

But anyway, this is the guy who's on my left side. He's pretty much my conscience, my assistant flight director. He's looking at what am I doing and the pace I'm doing it, and any overload I've got, he's going to have to pick up. He's my wing man.

Over to the left is [Edward] Ed Fendell and [Richard] Dick Brown, and we're in the process of transferring communications responsibilities from the systems guys, because it's just too much work over into a new console position.

So these are the key players we've got. Kraft is sitting behind me, along with Gilruth, and I believe George Low was up there. So you've now got this room. Okay, these are the players.

I sort of left you walking down the hall with George Patton in my mind. You walk into the room, and in Mission Control, when you walk into the room, it's sort of like you're getting the feeling for what's going on. You can feel the atmosphere immediately. You can look in the room, and if you see clusters of people around, we've got a few problems they're working on, but they're all pretty much distributed along the console. Everything is pretty much ops-normal. This room is bathed in this blue-gray light that you get from the screen, so it's sort of almost like you see in the movies kind of thing. You hang your coat up, and everybody had to wear—I don't know. Kraft always had everybody wear coats, suits, or sports jackets, and the first thing you do in Mission Control is take the thing off. So you've got these coats hanging up behind there.

I carry in my landing vest, because the vests started a tradition with the white team that goes all the way back to Gemini, and today—this was always a surprise for my controllers. Marta had made me a silver and white brocade vest, very fine silver thread running through this

thing. That's in a plastic bag. It's turned inside out because this is always a surprise for the controllers.

Then the rest of the room's atmosphere, it's the smell of the room, and you can tell people have been in there for a long period of time. There's enough stale pizza hanging around and stale sandwiches and the wastebaskets are full. You can smell the coffee that's been burned into the hot plate in there. But you also get this feeling that this is a place something's going to happen at. I mean, this is a place sort of like the docks where Columbus left, you know, when he sailed off to America or on the beaches when he came on landing.

So it's a place where you know something is going to happen. You feel the energy of the room, because, as you walk in, you pass little groups where there's little buzzes of conversation, and you don't waste too many words in Mission Control. You speak in funny syllables, in acronyms and short, brief sentences, and sometimes you use call signs, other times you use first names. It depends upon what the mood of the room is.

I went up to the console. Marta always makes me a lunch. I sort of eat my way through a shift. I think this is the way I show nerves. I have enough food to last—I could be there a week and still have food in there. Generally it's two or three of four of everything—candy bars, food, vegetables, sandwiches. I mean, this bag literally bursts. Put this in there and take and put a couple cans of soda in the refrigerator we had out in the hallway, continue on out and talk to the SPAN [Spacecraft Analysis Room].

SPAN is where we've got the engineering representatives from our contractors, and this is another good place to get the pulse of the room. There are things going right. You talk to the Tom Kellys, principal designer of the lunar modules, or the Dale Myers. He's in this room. Here you've the president of North American, vice president of North American. You know,

these aren't ordinary, run-of-the-mill people. These are the people that they ought to write more books about. So they're all in there. My controllers are in the other half of the room, and these people don't seem particularly uptight. It's really amazing. You get the feel that, gee whiz, this is just almost a normal day in Mission Control.

You go back to the console and find out it's been more normal than you'd ever expect, because you read the log, and you say, "Glynn, did anything happen?"

He says, "No." And he writes it right in the log. He says, "All we've been doing is chasing nits." Out of a couple hundred thousand pounds total mass of the spacecraft, 40,000 pounds in the spacecraft, he's trying to track down—they can't account for 150 pounds in the lunar module. Well, this is academic when it comes to performing maneuvers, but they have a weight discontinuity. So he's been pursuing this all night long, and it's sort of a distraction. You know, when everything's normal, you're very tuned to pick up anything that happens, so basically you just always stay busy. You're going to stay alert, let your team know that you're a perfectionist, you're after the details.

So, anyway, handover from Glynn, and it still doesn't sink in that today's real time, this is really it. And put on the vest. This has sort of been tradition in there, and the team sees it, and the reason it's always got white is because I'm the white team. Red, white, and blue are the first three flight directors. I've got the white team, and this is sort of a way to get the team loose, to get them, again, a bit relaxed, because you don't want people who are trigger-happy in this business.

We go through the first couple of orbits, and the crew's ahead of the timeline by at least a half-hour, and things are really percolating along, no anomalies. It's almost like a simulation. There's many times during this day when the thought would come to mind, it's like a simulation.

Finally we get down to the point now where it is time to finish. We get the crew and both spacecraft timed, undock the spacecraft, and now, instead of being a half hour ahead, we've got to be right on the timeline. There's no more getting ahead of this timeline. We're in our final orbit around the Moon, which is two hours, and roughly for about an hour-twenty, we see the crew, and then forty minutes they're out of sight for us. We're into the final orbit. The crew goes behind the Moon.

Kranz: There are certain things in Mission Control, and there are two of them [that] happened, one now and then one later on, that really now indicated that this was not a normal day, or not a normal simulation day. The first one—and this was one of the triggering events—the spacecraft is now behind the Moon, and the control team, the adrenaline, I mean, just really was—no matter how you tried to hide it, the fact is that you were really starting to pump. It seems that every controller has a common set of characteristics, is they've got to go to the bathroom. I mean, it's just to the point where you just need this break. That's all there is to it. It's literally a rush to get to the bathroom. You're standing in line, and for a change, there isn't the normal banter, no jokes, etc. I mean, the level of preoccupation in these people—and these are kids. The average age of my team was twenty-six years old. Basically I'm thirty-six; I'm ten years older. I'm the oldest guy on this entire team.

This preoccupation is the first thing that hits you. All of a sudden, this is different. Then you walk back into the room, and Doug Ward—you hear the voice of the mission commentator, and he talks, and he's commenting that the Mission Control team has returned from their break and they're now going to be in the room through the lunar landing.

Immediately that triggers my thought that this team, this day, is either going to land, abort, or crash. Those are the only three alternatives.

So it's really starting to sink in, and I have this feeling I've got to talk to my people. The neat thing about the Mission Control is we have a very private voice loop that is never recorded and never goes anywhere. It's what we call AFD [Assistant Flight Director] Conference [Loop]. It was put in there for a very specific set of purposes, because we know that any of the common voice loops can be piped into any of the offices at Johnson. They can be piped into the media, they can be piped into the viewing room, and what we want is an incredibly private loop where we can talk to the controllers when we need to, but in particular it was set up for debriefing, because debriefings are brutal. It was set up for debriefing between the flight control team and Sim Sup.

It also is the loop where, if you've got a flight controller who is errant, you can sit down and say, "Hey, GNC [Guidance and Navigation Computer], meet in AFD Conference," and everybody knows, (A), they're not supposed to listen in, but that guy is going to catch hell for something, because you don't chew anybody out in public. It's all a very private affair.

So I called the controllers, told my team, "Okay, all flight controllers, listen up and go over to AFD Conference." And all of a sudden, the people in the viewing room are used to hearing all these people talking, and all of a sudden there's nobody talking anymore. But I had to tell these kids how proud I was of the work that they had done, that from this day, from the time that they were born, they were destined to be here and they're destined to do this job, and it's the best team that has ever been assembled, and today, without a doubt, we are going to write the history books and we're going to be the team that takes an American to the Moon, and that

whatever happens on this day, whatever decisions they make, whatever decisions as a team we make, I will always be standing with them, no one's ever going to second-guess us. So that's it.

I finished the discussion and tell the controllers now to return to the flight director's loop where, again, we continue our business. I didn't think about it at this time. After the fact, Steve Bales told it, the next thing I do is I have the doors of Mission Control locked, and I never really realized—we do this for all critical mission phases, but I never really realized how this sunk in to these young kids, and this was the final thing that sunk in in the controllers that, hey, this is again something different from training, these doors are locked, we are out of here now. I mean, we've got a job to do.

Then the thing that sinks in on the rest of the M&O [Mission and Operations] staff is a very similar event; we go to what we call "battle short." Battle short is where we physically block all the main building circuit breakers in there. We would rather burn the building down than let a circuit breaker open inadvertently and cause us a loss of power. So now we're in the doors-locked, battle short condition, and the communications intensity starts building up because we know we're now approaching acquisition of signal of the spacecraft, and this is the time we're all going to have to make some decisions.

In the meantime, one of the mission rules that was most controversial approaching the launch, and it has become a personal mission role for me, is NASA management had to have some kind of a ground rule on how much communications and telemetry we must have in order to allow the mission to continue. Kraft and I had lobbied for a very open loop. The flight director will make this decision, where a lot of people wanted very precise. We have to have it at the time of these events. And what they were concerned about, sort of like a crash recorded

on an airplane, if we crashed, we wanted to know why we crashed. Okay. So Kraft and I won. We had this very loose mission role.

This is the only one that really bothers me, because it's a pure judgment call. Everything else is not black and white. But basically we've got telemetry, we've got people working on, but this is the unique call of the flight director. We get acquisition of the spacecraft, and from the time that the spacecraft cracks the hill until the time we're on the surface is about a half-hour long. It's about 18 minutes to look at the spacecraft and the telemetry and then 12 minutes from there to the surface of the Moon from the time that we start the powered descent. Immediately, as soon as we acquire telemetry, we're in trouble because the spacecraft communications are absolutely lousy. We can't communicate to them; they can't communicate to us. The telemetry is very broken. We have to call [Michael] Mike Collins in the command module to relay data down into the lunar module, and immediately this mission role has come into mind because it's decision time, go/no go time.

It just continues, broken, through about the first five minutes after we've acquired the data, but we get enough data so the controllers can make their calls, their decisions. Are we good? Are we properly configured? Are we basically at the point in the procedures where we should be?

We move closer now to what we call the "powered descent go/no go." This is where it's now time to say are we going down to the lunar surface or not. Now, I have one wave-off opportunity, and just only one, and if I wave off on this powered descent, then I have one shot in the next rev [revolution] and then the lunar mission's all over. So you don't squander your go/no go's when you've only got one more shot at it.

Come right up to the go/no go, and we lose all data again. So I delay the go/no go with the team for roughly about forty seconds, had to get a data back briefly, and I make the decision to press on; we're going to go on this one here. So I have my controllers make their go/no go's on the last valid data set that they had. I know it's stale, but the fact is that it's not time to wave off.

So, each of the controllers goes through and assesses his systems right on down the line, and we get a go except for one where we get a qualified go, and that's Steve Bales down at the guidance officer console, because he comes on the loop, and he says, "Flight, we're out on our radial velocity, we're halfway to our abort limits. I don't know what's caused it, but I'm going to keep watching it." So all of a sudden, boom! We've sure got my attention when you say you're halfway to your abort limits.

We didn't know this until after the mission, but the crew had not fully depressed the tunnel between the two spacecrafts. They should have gone down to a vacuum in there, and they weren't. So when they blew the bolts, when they released the latches between the spacecraft, there was a little residual air in there, sort of like popping a cork on a bottle. It gave us velocity separating these two spacecrafts. So now we're moving a little bit faster by the order of fractions of feet per second than we should have at this time. So we don't know it, but this is what's causing the problem. It's now a problem.

In the meantime, we've had an electrical problem show up on board the spacecraft, and we've determined that this is a bad meter that we've got for the AC instrumentation. AC, alternating current, is very important on board the spacecraft, because that powers our gyro's landing radar right on down the line. We're now going to be looking at this from the standpoint of the ground so that Buzz won't have to look after it.

So we keep working through these kinds of things, and we give them the go for a powered descent, and immediately, as soon as we go, we can't even give it to the crew directly; we've got to voice this through Mike Collins down to the spacecraft. All through this time, my mind is really running. Is this enough data to keep going, going, going, going? Because I know what I'm going to do in this role. I'm going to be second-guessed, but that isn't bothering me.

We now get to the point where it's time to start engines. We've got telemetry back again. As soon as the engine starts, we lose it again. This is an incredibly important time to have our telemetry because as soon as we get acceleration, we settle our propellants in the tanks, and now we can measure them, but the problem is, we've missed this point. So now we have to go with what we think are the quantities loaded pre-launch. So we're now back to nominals. Instead of having actuals, we've got our nominals in there. So we're in the process of continuing down.

We've now started down, and Bales calls and he says we're not seeing anymore down-track air. His concern was, was it a guidance problem or was it a navigation problem. The difference is, if it was a guidance problem, it will probably continue to be worse. If it was a navigation problem, it will probably remain constant. Well, now he's seen that this residual air, this radial component he's seeing, has not continued to grow any. It's remained constant. Well, even though this is looking now like it's going to be a go, it's going to cause a problem because it's going to move us down. Instead of being at the landing point we had planned, we're now moving further down range to the toe of our footprint. Right now it's very rocky.

So now we're fighting—we've got this new landing area that we're going to be going into, we're fighting the communications, we've got the problem with the communications, and we've got the AC problem that we're now tracking for the crew, and now a new problem creeps

into this thing, which is this series of program alarms. There's two types of alarms. These are the exact ones that we blew in the training session on our final training day, twelve-oh-one [12-0-1]. Twelve-oh-one is what we call a bail-out type of alarm. It's telling us the computer doesn't have enough time to do all of the jobs that it has to do, and it's now moving into a priority scheme where it's going to fire jets, it's going to do navigation, it's going to provide guidance, but it's basically telling us to do something because it's running out of time to accomplish all the functions it should.

The other kind of alarm is what we call a DP00: "do program zero zero," which essentially is the computer's going to halt and wait for further instructions. If this occurs before we're very close to the surface, this [is] an immediate abort. So what we have to do is we have to prevent this computer from going to these bail-out-type alarms into this DP00-type alarm, and once you get this DP00, it's got to be three strikes in a row where it says, "I'm going to idle, I'm going to idle, I'm really going to idle now."

So, Steve Bales is now starting to fight this kind of a problem. Now, it's sort of like—you've seen people driving cars where they end up with this fork in the road and they don't know which way to go, because at the time we're getting these alarms, we also have another very critical thing that we have to do, which is accept landing radar, because without landing radar, we can't update our knowledge. The only knowledge that the crew has of altitude is that which we gave them from Earth, and this is our best guess based on tracking.

Now, in order to get to the surface of the Moon, they have to get an actual altitude, and the actual altitude could be as much as eight or ten thousand feet off. So what we have to do is we've got to get this landing radar in there to update their knowledge of where they are. Well, what they do is, when the computer starts seeing data—I mean, when the radar starts seeing

data, it is telemetered to the ground. We compare this knowledge of where the radar thinks it is with where we think it is and tell the crew whether to accept this radar or not. We think it's good, accept it, put it in your computer, because once you get it in your computer, you're stuck with it.

So I've got half my team trying to look at this radar and decide to go here. I've got the other half that is finally recognizing the significance of these computer program alarms. It's really miraculous to watch this team go, because we now start working these two incredibly complex problems simultaneously. One part of the team is working this, the other part of the team is doing this, and I'm trying to put all the pieces together with Charlie Duke, who's picking the right fragments of conversation up to send up to the crew.

Bales, in the meantime, is now on the loop with his controller in the back room, who's one of the experts on the MIT [Massachusetts Institute of Technology] Draper Labs-provided guidance system, and he is conversing. Do they see any problems in guidance navigation, control, etc.? We don't see it. See, this is what we didn't do in training. We don't see it, so therefore we're going this alarm to continue.

So we go through this kind of an exercise at the same time we're accepting this radar data. We tell them we're going the alarms, we tell them to accept radar, go on the alarms, you know, radar's good, getting close-you know, we're continuing to work our way down to the surface. Now, fortunately the communications have improved dramatically. Communications are no longer a concern of mine, but they were for about the first six or eight minutes of our descent. But now we're about four minutes off the surface. Communications are just a dream.

Now things are happening, and this team is incredible. Some person—and we've never been able to identify it in the voice loop—comes up and says, "This is just like a simulation,"

and everybody relaxes. Here you're fighting problems that are just unbelievable and you keep working your way to the surface, to the surface, to the surface.

Now, inside the tanks we don't have a gas gauge like you have in a car, even an aircraft. Once you get at the point, you have a cylindrical tank that's got a round dome at the top and the bottom. The fuel is sloshing around back and forth in this tank, and you have what they call a "point sensor," and this point sensor says that we have 120 seconds of fuel remaining if we're at a hover throttle setting. This is roughly around 30, 35 percent throttle. But now we're no longer hovering, and we hit this point sensor, and this is the first thing Carlton calls out, and it's just like he—every day he calls out "low level." Well, normally by the time he calls out "low level," we have landed in training, and we're not even close to landing here, but he calls out "low level" just like it's an everyday occurrence.

Now, in his back room he has a controller by the name of Bob Nance, and Bob Nance is looking at a recorder which is tracing out actually the throttle position that Armstrong's using, above hover throttle, below hover throttle, above hover throttle, below hover throttle, and he is mentally integrating now how many seconds he is above hover throttle and subtracting that from the minutes below hover throttle, trying to give us a new number for how many seconds of fuel we've got. Nance got so good at this thing in training that he could hit it within ten seconds. Now, this is a guy who's eyeballing fuel remaining, and we're getting ready to call an abort on it. So we get down to the point—and we know it's tough down there, because the toe of the footprint is really a boulder field, so Armstrong has to pick out a landing site, and he's very close to the surface. Instead of moving slowly horizontal, he's moving very rapidly, and ten and fifteen feet per second, I mean, we've never seen anybody flying it this way in training. Now Carlton calls out "sixty seconds," and we're still not close to the surface yet, and now I'm

thinking, okay, we've got this last altitude hack from the crew, which is about 150 feet, which now means that we've got to average roughly about three feet per second rate of descent, and I see he's at zero. So I say, "Boy, he's going to really have to let the bottom out of this pretty soon."

So, it's watching this horse race between the calls of the controllers, watching what the crew's doing, and then Charlie Duke comes in. He says, "You know, I think we'd better keep quiet from now." Everybody in the room—you don't have to say that, because this room is deathly silent except for what is on the voice loops, and we're only listening to Carlton's call, and he's just—the last call was "sixty seconds," and his next call, the only word that's going to be said is "thirty seconds."

So I advised controllers no more calls, because we're now operating in what we call negative reporting. We're not saying a word to the crew, because they're just busier than hell right now, and the only reason for us to abort is fuel. So Carlton called out sixty seconds. Now he hits thirty seconds. Now we're thirty seconds off the surface of the Moon, and very—I mean, incredibly rapidly I go through the decision process. No matter what happens, I'm not going to call an abort. The crew is close enough to the surface I'm going to let them give it their best shot.

At the same time, the crew identifies they're kicking up some dust, so we know we're close, but we don't know how close because we don't know at what altitude they'd start kicking up the dust, and then we're to the point where we're mentally starting, waiting for the fifteen-second call, and Carlton was just ready to say, "Fifteen seconds," and then we hear the crew saying, "Contact."

Well, what happens, we have a three-foot-long probe stick underneath each of the landing pads. When one of those touches the lunar surface, it turns on a blue light in the cockpit, and when it turns on that blue light, that's lunar contact, their job is to shut the engine down, and they literally fall the last three feet to the surface of the Moon. So you hear the "lunar contact," and then you hear, "ACA [Attitude Control Assembly] out of Detent [out of center position]." They're in the process of shutting down the engine at the time that Carlton says "Fifteen seconds," and then you hear Carlton come back almost immediately after that fifteen-seconds call and say, "Engine shutdown," and the crew is now continuing this process of going through the procedures, shutting down the engine.

Now the viewing room behind me—and this is again one of these other things in training, there's nothing in training that every prepared you for that second, because the viewing room behind me starts cheering. Our instructors, which are over in the Sim Sup area, sim room over to the right, they start cheering, but we've got to be cool because we have to now go through all of the shutdown activity, but we have to go through a series of what we call "stay/no stay" decisions, because forty seconds after we've touched down on the Moon, we have to be ready to lift back off again. And every controller, I think, went through his emotional climax that second. I was so hung up by this cheering coming in from the lunar room that I could not speak, and pure frustration, because I had to get going on the stay/no stay. I just rapped my arm down on the console there, just absolutely frustrated. I broke my pencil, the pencil flies up in the air. Charlie Duke's next to me, and he's looking and wondering what the hell has happened here.

And all of a sudden it hurt so much that I got back on track and started, "Go. Okay. All flight controllers stand by for T-one stay/no stay--" you know, and we went through this, and I think every controller went through his climax at that second.

Then, as soon as we finished that, we had another stay/no stay, T-two stay/no stay we had to do, I think it was ten or twelve minutes later, and these were opportunities for liftoff and go back up, and immediate rendezvous. Once we went beyond T-two, then we had to go through a T-three. While we're doing all this stuff, Charlie Duke's still talking to the crew and "thank you", you know, "Eagle," you know, you've got a bunch of controllers down here about ready to turn blue. Well, the fact is, I don't think any of us breathed for that last sixty seconds.

You hear Armstrong talk, "Eagle has landed," right on down the line. "Houston, Tranquility Base here. The Eagle has landed." And these are all seeping in, and in the meantime we're just busier than hell doing our stay/no stay kind of stuff. We're in between T-two and T-three, and we use a cryogenic bottle, super critical helium, to pressurize our descent engine. Again, one of the things you can never test, the heat soak-back from the engine and the surface now is raising the pressure in that bottle very dramatically, and now we're wondering if this damned thing's going to explode and what the hell are we going to do about it. The fortunate thing was that they had designed some relief valves. They had a pressure disc in there. If the pressure got so high, it actually blows the disc and the valve, rather than blowing the bottle up.

So we're all sweating this thing out here. We're trying to get everything re-synced for the next lift-off, and it's just time, which is almost two hours, between T-two and T-three stay/no stay, it just goes through incredibly quick. Throughout this whole period of time, except for the

instant of hearing the cheering, you never got a chance to really think, "We've landed on the Moon."

We get handed over to Charlesworth's team, and it was then I'm going over to the press conference, and walking over to the press conference with Doug [Ward] was the first time, actually, you really had the chance to unwind and think about, "Today we really landed on the Moon." It's the goddamnedest thing you'd ever seen in your entire life is that you were right there, you were doing all of these things, but every American went through their thing, and we were only limited to a second where we could really imagine and be happy with what we did. It was an incredible feeling.

Anyway, we had gotten to the point where all I wanted to do was finish the press conference, because the phony thing about setting up this mission was, I don't think any human being alive ever felt that Armstrong and Aldrin would get down to the surface of the Moon, they'd make their report, and then they'd go to sleep, but this was the basic plan. Okay, the crew was supposed to rest and get their sleep before going out and doing their EVA [extravehicular activity].

Well, Charlesworth and Kraft and Low had already made their mind up, and I think Neil Armstrong had made their mind up that, "Hey, there's no way we're going to go to sleep. What we're going to do is, we're going to take a look at the systems, we're going to go through the stay/no stay. As soon as we've gone through that, then we're going to say, 'Hey, we'd like to do EVA.'"

So at the time I was finishing my T-three stay/no stay, I had two teams of controllers. I had [Milton] Milt Windler's team who had come in to spell us at this time, and Milt was at the point of—his team was trying to decide whether to just continue this sleep period, or I had Cliff

Charlesworth's team, which was, are we going to do the EVA? So this whole control center is almost cast. Everybody's euphoric that we've landed on the Moon, but now it's a question of which team is the one that's going to pick up and do the job.

I came back from the press conference—in fact, let me go back a little bit even before we went down to land. When I came into the control center for the start of the shift, I went to the flight directors, went over to SPAN, then I went into the training room, because I wanted to thank my training team for getting us ready for the lunar landing. And the thing that was anomalous about this was Dick Koos, our Sim Sup, was not there. Everybody was surprised, but everybody was sure that he'd show up in time for the landing.

Came back after the press conference, and Koos was there. What we found out is that in the process of leaving his home and coming to work that morning, he had rolled his brand-new TR3 and had pretty much lost the car, but he still managed to get into Mission Control for the landing. So it was interesting. We were all sort of pushing the edge in the way we lived and the things we did and the hours we worked and all that kind of stuff. And that was really neat, to sit back, "My job's over, and it's up to Charlesworth to do the EVAs, and then it's going to be up to Lunney to get the crew back off the surface, and then I've got to come back on duty to get them on their way back home."

But there is absolutely no question that that was a day that you're never going to forget, and it's really interesting to try to write that down and in some kind of a fashion where you don't lose your audience, you don't lose the people you're writing to, because the intensity, the quality of the training and the way we were prepared put us in a position to deal with problems that—and this was true not only in [Apollo] 11, it was 12, 13, 14, it was everything that we had learned from the very first Mercury mission until the day we came to be tested.

In one of my book interviews, [Apollo] Arnie Aldrich was talking about Apollo 13, and he says that, "You know, at the time that we were really tested," he says, "all the pieces were in place." He says, "The training had literally achieved perfection. The way we prepared ourselves by learning, by doing, all these battles with the contractors that we're going to do these things, nothing is ever given to us, we're going to have to go out and dig it and assemble it, put the pieces together, if somebody had said, 'Are you ready for this kind of a crisis?' you'd say yes, and they'd say, 'Prove it.'"

There's no way you could ever prove it, and yet in [Apollo] 11 we went through the—I mean, the intensity of these seconds with this young group of people, everything that we'd ever done before prepared us for and we were ready. In [Apollo] 12, we got struck by lightning, and we solved that problem in a couple of minutes, and we were ready. In Apollo 13, we had an oxygen tank explode, and this team was ready. In Apollo 14, we had a solder ball in an abort switch just as we were going to go down to the lunar surface, and we waved off and came up with a software patch and fixed that one. In Apollo 15, we had a solder ball in a different switch. It was trying to ignite the main propulsion engine on the way to the Moon. Apollo 16, we had the problems with the gimbals, which would have compromised the landing with [Thomas Kenneth] Ken Mattingly.

What was interesting is that once this team had achieved what I'd say—and I say this frankly and somewhat boldly—is that we had achieved literally perfection in this art of crisis management. There was nothing that would have ever stopped us. The interesting thing about the history in the book I'm trying to write, it really talks as much about how we got there as what we did once we got there, because it was getting there which was the tough thing, and it was the "tough and competent" coming out of the very searing experiences we had in Apollo 1. It was

the difficulties we had with the crew in the Gemini III, where we had literally a rebellion between ground control and the crew over a petty incident.

But it was each one of these things coming together under the incredibly gifted leadership of guys like Kraft and Low and Mueller that put all of this thing together. So when the time came for Apollo 11, we were ready, and we were ready every time from then on we were to be challenged.

WRIGHT: We've read and listened to your transcripts from before. The cohesiveness of your team—the emphasis of that keeps coming out; and we know that the emblem on your shirt, we actually have a [lapel] pin, we know that you wear the—

KRANZ: Yes, Mission Control logo.

WRIGHT: Would you give us the background of that and those principles that you all believed in that are featured on the [lapel] pin?

KRANZ: The Mission Control logo is an interesting one. At the conclusion of the Apollo 17 mission, we had established a set of values. You know, I talk to people all over the world now. I talk about leadership, the kinds of people we had, I talk about trust that developed between the team, I talk about the values of this team: commitment, teamwork, discipline, morale, tough, competent, risk, sacrifice. I can quote these terms out to these people.

It was these values that built the chemistry, because these are young people. They've never been tested, they've never been tried before, but it's the chemistry that builds within the

team so you know within a second whether a person needs help or not. It's a chemistry that builds intuitive communications. It's chemistry that locks people together when things get tough. It's the trust between controllers, flight directors, and crew and even program management that allows us, when things get tight, to make the seconds count, to pick directions and move off in this direction with only a fraction of a second's thought about it and nobody pulling off in a different direction. So it's this amazing place called Mission Control, which is an incredible leadership laboratory. People talk about pass/fail. Well, this *is* the ultimate pass/fail.

As we were approaching the end of the Apollo Program, I was looking for some way to leave a legacy for everything that we had ever learned in Mission Control for the next generation of controllers, as Kraft had left the legacy of the flight director. A flight director's got probably the most interesting job description in history. It's only one sentence long: "A flight director may take any action necessary for crew safety and mission success." That's it. I think in American life today in the military there is no job description that is that simple and so frank and so straightforward, no ambiguity. So, Kraft had basically left that legacy.

I wanted to leave now the legacy of Mission Control, and I was trying to find a way that everything that Kraft and myself and Lunney and Charlesworth and Griffin and [Peter] Frank and Windler—I mean, everything we had learned, everything that we packaged in these first 13 years of space. I was up in the viewing room. This was during Pete Frank's EVA. He ran the EVA for the final missions. I would launch off the Earth and I'd launch off the surface of the Moon.

So I was sitting in the viewing room just watching what was going on, and there's a very gifted artist, [Robert] Bob McCall, and Bob McCall would come into Mission Control, and he

had the ability—you had to really avoid being distracted by Bob because he'd sit there, and at times you'd be looking over his shoulder, and he could pen out a sketch in charcoal, pencil sketch, in an instant. He'd be watching the EVA on the big TV we've got, and within literally sixty seconds he'd have a sketch of that EVA or he'd be sketching a controller at a console.

I was watching McCall sketch, and it came to mind, I was military, a fighter pilot, and I had designed the insignia for the 355th Fighter Bomber that was had at Myrtle Beach, and got a gifted outdoors artist to draw a peregrine falcon on the attack, and this is the emblem that we used for our fighter squadron. I decided Mission Control—the crew had their patches, but Mission Control had none. The controllers didn't have one. We would wear the crew's patches during their mission, but we had none for ourselves. So Bob McCall—we were in between EVAs. We had three EVAs in that mission.

We had sort of a coffee shop, and went down to the coffee shop. Started talking to Bob, and I don't think Bob was surprised when I said, "Bob, I'd like you to design an emblem for Mission Control." He had just finished the one for the Apollo 17 crew. This was the end of the program, and I said, "Bob, I'd like you to design a patch for us." So we started talking about what this patch should involve, and I started talking about the characteristics, the individual commitment, the putting yourself on the line, the individual "never surrender." I said, "This I want to represent."

So we selected—in those days it was the form—it's this patch right here. This is the original Mission Control patch (pointing to a photo in ***All We did was Fly to the Moon***, *refer to figure 1*). It's the form of a rocket in the letter "I" representing the commitment, and if you look very closely at this "I," it's truncated at the bottom and the top here. So you can look at that as a stylized letter "I," which is what we bring to the mission.

Then there is this thing called the team, because the "I" has to become a "we" in order to succeed. So we stole the Sigma from Wally Schirra's Sigma 7 mission, his flight, and these two touch each other, because at any time in the mission we work as a team, but we have individuals who must step forward from their team, make their commitment, lead, come up with the answers, and then after that's done, return to their role as a team member. So these two touch each other, and they're always interweaved in whatever emblem we've got. So this is the "I' and the "we."

Then we had four stars down at the bottom, which talked about the tough lessons that we had learned in the early days of space flight: discipline, which came out of the Gemini III mission, where we had a fracas emerge, a petty incident, out at one of the remote sites between an astronaut who was sent out to the site and one of my controllers, and we couldn't agree who was in charge. This led to a series of minor incidents between crews and controllers, and the fact was that we were not in the right mental frame of mind for that mission and it must never happen again. The mission, our objective, must always be dominant in what we're doing.

Then there's the morale, because throughout the entire program we were faced with setback, setback, setback, setbacks, and it was only our belief in ourselves and our ability to survive and solve the problem that would get us through the very difficult times that we knew were involved in space. President [John F.] Kennedy used some interesting words when he set out the lunar goal: "We choose to go to the Moon. We choose to go in this decade and do other things, not because they're easy, but because they're hard." And he recognized how difficult this challenge was going to be, and it was only the morale, the second star in our emblem, that really kept us going through many difficult times, because blowing up rockets, coming back in, getting your act together, seeing missions fail, seeing our target, our Agena targets, go in the drink on

Gemini VI and Gemini IX, and coming with alternatives for those things—morale, believing in ourselves was essential.

There's another element of morale, because our controllers, contractors, at the end of Gemini, had to be with us to the next mission, and then they were out of a job, and you want to talk about a very difficult time for my organization, for the controllers, because all the Apollo controllers had been hired. So it was a very difficult time for our contractors, particularly our Martin contractors at that time.

Then we talked about the tough and competent. "Tough and competent" came out of the Apollo 1 fire. It was basically seared into us. We were tempered in that time frame, "tough" meaning we are forever accountable for what we do or what we fail to do, and that has to be a characteristic of the controllers. And "competent," we can never stop learning, never take anything for granted, never be less than perfect.

So, by the time that we got into the Apollo manned program, these values that we had established as controllers had matured. They had gelled. They then put us to the point where absolutely nothing-nothing-would ever defeat us. If you go through the history of the Apollo Programs, that was it. This is a living insignia. We changed the characteristics as our organization continued to grow from Mission Control into Mission Operations. I always would meet with my people at least a couple of times a year, and some of the people that I had in the organization felt they were left out because they didn't work in Mission Control; they worked in Flight Design. So basically what we wanted to do—they worked in the software reconfiguration business. And it was a darned good idea. So, basically we changed this Mission Control to Mission Operations. We changed it [Saturn V rocket] to be the Shuttle.

And then, to make sure, again, since this is living and it continues to live, at the time of the Challenger accident, we had another generation of young people who went through the same very difficult learning process, living through catastrophe and having to emerge from the other side, only this group of young people had not been associated with flight tests, they had never had a mission that had failed before. They had flown 24 straight successful Shuttle missions. We had brought our crew back every time, and all of a sudden they lost a crew. So this, we added in a meteor, a dying star, to represent the risk and the sacrifice to the components.

Basically, this insignia is the sum of all of the knowledge that we have ever had and developed that we believe is essential to success in our business. Our motto at the top of this insignia has never changed. It's been "Res Gesta Par Excellentiam," which is "Achievement Through Excellence," and again, this sort of sets the framework for expectations of what we demand of ourselves and what we demand of the people around us.

Mission Control and the Mission Control Team is probably the most successful long-term risk management organization in American history, maybe world history, because we have gone from 1960 through almost 1999, and as a result of anything directly under our control, we've never lost a man in space or a woman in space. The design flaws of Challenger were beyond our capability. There is nothing that we could have done. We had no options. If we had had a few seconds more, we might have had an option, but we never had an option there.

So, the emblem is very, very important to us now. One of our flight directors, Pete Frank, took and translated the values "discipline, morale, tough, and competent now" into a statement in words that we call the foundations of flight control. Now it's called the foundations of Mission Operation. It puts these down very succinctly so that each controller has an opportunity to reflect as he approaches his role and responsibility in each mission and as they're

tempted to compromise and maybe look at something as good enough, to go back in and say, "This is what we stand for. This is what we've got to press forward."

So it's an interesting cultural set that was established for the controllers and the control team. It's one that's very successful. I take, and every time I speak, I speak about, I'd say, between 70 - 100 times a year. I'm on the road frequently, and I use this value statement for grade-school kids all the way through presidents of corporations. This value set is universal, and it's the kind of statement that if you can live by, you can say you conduct yourself professionally. That's about it.

WRIGHT: Okay. We thank you.

[End of interview]