NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY TRANSCRIPT

JOHN D. "DENNY" HOLT
INTERVIEWED BY REBECCA WRIGHT
HOUSTON, TEXAS – 3 NOVEMBER 2004

WRIGHT: Today is November 3rd, 2004. This oral history with Denny Holt is being conducted for the Johnson Space Center Oral History Project in Houston, Texas. Rebecca Wright is the interviewer and she is assisted by Sandra Johnson and Jennifer Ross-Nazzal.

Thanks again for coming in this afternoon to speak with us.

HOLT: Delighted.

WRIGHT: I would like to begin today by asking you how you became employed with NASA.

HOLT: In 1967, I was a senior at Tennessee Tech [Technological University] in Cookeville, Tennessee, and was planning, actually, to go to work for Anaconda Aluminum, which would have been a hardhat job in Montana to start with. But NASA was interviewing; Kennedy [Space Center, Florida], Marshall [Space Flight Center, Huntsville, Alabama], and Manned Spacecraft Center [Houston, Texas] all interviewed at the same time, and I interviewed. Didn't hear anything back. Was told by Marshall that I probably didn't have what they were looking for. They were looking for mechanical engineers, and my degree is math. Never heard from Kennedy, but had a couple of friends that did go to work there. After the hiring freeze broke, all of a sudden I got four phone calls from JSC. It was, "We run computer decks," and another one, "We do analyses."

Then I got a call from the Landing and Recovery Division, Apollo, then it was, and by the time I broke the code on what interfacing with the DoD [Department of Defense] was, it really turned out that says, "Well, we travel a lot." Well, I'm twenty-two years old and I'm from Tennessee. That was a pretty good deal, and about 125,000 air miles in two years, four long boat rides, one of them twenty days, nonstop to a point in the middle of the Atlantic Ocean and back. But I got to Brazil; I got to Europe; I got to Japan a couple of times; I got to the Philippines; to Guam—not everything's good; the Azores; Bermuda. The best part was I got to see the first Saturn V launch, November 1967.

So it was everything I had anticipated. So I pretty much came on a lark and also, back at that time, came uncommitted. I had not really told Mona Kasmierski [Personnel, Recruiting and Staffing] what job I was going to do, and at that time there were a hundred of us that processed in at the Johnson Space Center, or at Ellington Field [Ellington Air Force Base, Houston, Texas]. I can remember they gave us courses on our benefits, our retirement plan, which really impressed a lot of us twenty-two-year-olds. Then they had somebody come in and try to teach English to all these engineers in about a three-hour session one afternoon; put everybody to sleep.

But we couldn't wait to get on site. JSC was just young. So here you are in the middle of this cow pasture down here. The Clear Lake City boundaries were El Camino Real on one end and El Dorado [Boulevard] on the other; nothing crossed NASA [Road] 1. Webster [Texas] was a pizza joint and a couple of service stations, and there really just wasn't much out here. We all lived up around the airport, because that's where the apartments were and that's where the stewardesses were and the parties were. And there weren't any women out here, except secretaries. In fact, Anne [L.] Accola could probably fill you in on that. She's in [Washington]

D.C. now, but at one time, right before Skylab, we had to get ready. We had a big all-hands meeting and she was the only woman engineer in the audience, out of 350 people.

So the changes have been quite dramatic over the years, but back in those days, we were the ultimate white-shirt-and-tie type of guys. Some of them actually did wear pocket protectors. Don't let them tell you they didn't.

WRIGHT: But not you, huh? [Laughs]

HOLT: No. Mostly it was electrical engineers; the same guys that wore their slide rules on their belt in college. And they don't see slide rules anymore, either, right?

WRIGHT: That's right.

HOLT: But it was a marvelous place. So I just kind of stumbled into Landing and Recovery. Landing and Recovery was an interesting division in that it was all civil service; there weren't any contractors. As I remember, it became kind of the body pool for what [Christopher C.] Kraft wanted to do later on with the other divisions. We had five divisions at one time in the Landing and Recovery Division out of 128 people. We figured it up one time that there were two engineers for every supervisor or secretary in the division, so it was rife for a takeover and raid. And, sure enough, Dr. Kraft finally got around to doing that.

But we had great experiences. The strange thing you get into when you're twenty-two, twenty-three years old and you're running around foreign countries, so the ideas of training, you ask the question that you sent me, well, what about training? There wasn't any training. "You

go follow him around." So I carried [Ryborn R.] Rip Kirby's suitcase, literally, when we went places. That was my supervisor. And the suitcases in Recovery were not small. We had the big Halliburton metal-looking suitcases and everything, and they were full of ropes and winches and hooks and stuff like that, and vinyl tape, yellow vinyl tape. With yellow vinyl tape and a package of pictures about like that [gestures], you could get anything you really needed. That was the medium of exchange.

So you'd always get a special suitcase picked up by one of the guys, [T. E.] Ed O'Briant, who was roughly the Recovery supply sergeant, and he cut deals with every master sergeant and quartermaster in the whole of the Navy and the Air Force or whatever, so you always had to pick up Ed's special suitcase and you had to make sure that you didn't touch that suitcase; that it got delivered to the right guy. So there was an awful lot of horse trading that went on back in those days.

WRIGHT: What did you get in return?

HOLT: Whatever it was that Ed had gotten. We were the messenger service. We were pretty sure he wasn't running anything immoral, and we hoped it wasn't illegal. [Laughs] It was like most places; you have to grease the wheels in order to get things done. The kinds of things you could do with a picture were—from out at Clark Air Base, out in the Philippines, I've been out on recovery exercise out there, flying around at night on silver Subic Bay, watching guys jump out of [Lockheed] C-130s [Hercules] in full scuba gear from 500 feet. These are the same guys who said, "The only way back is by silk." Just exactly what I wasn't interested in, but on the

way back, all I wanted to do was sitting down, get over there to the runway and then let's go get off and do this right.

So we did that and then they said, "Well, we need a flotation collar; we don't have one." You remember the flotation collars that went around the Apollo Command Module. "We need a flotation collar down at Hickam [Air Force Base, Hawaii] so we can run some recovery exercises that you're going to do on your way back to Houston," which I didn't know I was going to do that either. That's typically the way things worked back then.

So, okay, a helicopter ride from Clark Air Base, with a cargo helicopter, and they put me out, kicked the collar and a big box out on the tarmac, waved goodbye to me. So I go in and try to figure out how to get this box from Clark Air Base, or from Manila, back to Hickam. Pan Am [Airlines] says, "Okay, where's your government TR [Transportation Request]?" Well, a government TR looked like a punchcard and you just wrote on there. With a government TR you could pretty much do anything, go anywhere, settle any bill. Boy, they loved them. That was money. The only problem was, getting it out of the country was a bit of a problem, because the Philippine customs were no more excited about—they didn't know what was in the box, and it was a pretty good-sized box. It was the size of a coffin.

So I wasn't getting very far with getting it done. I'm walking up and down in the Manila airport in the heat, and finally a young guy stops me and he says, "What's your problem?"

I'm twenty-three years old and I'm wandering around a strange airport. So I just kind of looked out—and you could see the box through the terminal, a 1960s terminal, and I said, "Well, I'm trying to get that box to Hickam Air Base."

"Well, what is it?"

I took out a picture and said, "It's one of these."

He said, "Oh. How many of those pictures you got?"

I said, "I got a couple of them."

He says, "Can I have that?"

I says, "Sure."

So he walks out, finds the lady that's in customs, and they have this conversation, and I'm just kind of watching through this door. She takes a piece of chalk, walks over to the box, puts a great big chalk mark on it. He hands her the picture and comes back in. Then she starts running after him, hands him the picture back. He comes in and he says, "She wants the picture signed."

I said, "Okay." I said, "How does she want it signed?"

She says, "Well, you're [Alan B.] Al Shepard, aren't you?" [Laughs] Well, Al's not with us anymore. He loved the story.

WRIGHT: I'm sure she still has that picture.

HOLT: This guy turned out to be a travel agent in Manila and he got an Al Shepard, too. [Laughs]

So you just kind of had to learn to improvise along the way. So here we are, a bunch of twenty-three-year-old kids who have just been literally just dumped into this system that says, "Go ahead and go do it." It's like, "Well, how do you do it?" Well, the answer is, "Well, I don't have time to explain it to you; go figure it out." It was a sink-or-swim operation. If you thrived in that environment and you didn't mind a little uncertainty in your life and you didn't mind just going out and living on the edge with "It's easier to seek forgiveness than it is to ask permission"

as a mantra, then you did okay. There were a lot of us that pretty much carried through that for a whole career. [Laughs] Sometimes it worked and sometimes you ended up explaining yourself in places that you'd just rather not have been.

WRIGHT: Any of those you'd like to share with us?

HOLT: Well, maybe along the way. Sometimes there were these moments that your management or whatever would often say, "That one, you stepped over the line."

So, training for the job, well, it was pretty sparse. You followed people around. You asked a lot of questions. We were the on-scene advisors. We ended up literally—had one Gemini flight actually landed in the wrong ocean. That was the flight that spun up, came off the [Gemini] Agena [Target Vehicle], [David R. Scott] and Neil [A.] Armstrong, and they put it down 600 miles from the nearest recovery ship. And the guy on board who was the recovery expert—well, about all you had was a manual, and he wasn't quite as prepared as he probably should have been, since the manual is only 600 pages thick, and it had every operating procedure for a whole Command Module, and you hope like hell that—the things we'd do in a contingency area were not much.

This guy apparently made the fatal mistake of letting them close the hatch on the Gemini spacecraft with the thing still armed, and the problem was, once you closed it, you couldn't reopen it without the tool, and he couldn't find the tool. So they sat there with a hot spacecraft until they could get it back to port, and that was not well received. My understanding is, since I never met him—I was here after Gemini—but the guy was gone, but he just didn't bother reporting back to work, because he didn't figure he needed to go talk to Dr. Kraft after that.

WRIGHT: That must have been a good story to pass on to the new guys.

HOLT: We all heard it, yes. It was one of those things that says, "If you think you're not going to read the book, you better start praying that they never come your way."

But the kind of environment you got, you were going to go work with the military as the on-scene advisors. So the Recovery team leader, even if there was just one of you and you were a representative, the first person you were going to meet was either the executive officer or the operating officer on a ship. The next they were going to do is they were going to run you in to see the captain of the ship, and he was going to explain to you that you were not in charge, that he was. But you had a pretty good idea that that was the case to start with.

Then you had to find out who really got things done, and as soon as you found out who the chief master sergeant was at the air bases and who the chief of chiefs was on the ship, and they had their patches and pictures, then things got pretty smooth. You just had to stay ahead of the game.

So most of us lived through those kinds of things on a day-to-day basis, and there are a lot of stories like that. All of us had those. It was kind of a dream job. It was more like [Walt] Disney World than it was anything else you could think of at the time. It was fun. We were all single; we were all on the economy most of the time. I was on TDY[Temporary Duty] forty-two percent of the time for two years. So I was in and out of [William P.] Hobby Airport [Houston] a whole lot. I lived right up the road. Today it's the Park and Ride. [Laughs]

WRIGHT: Did you go ahead and maintain an apartment while you were here?

HOLT: Oh yes, well, we all roomed together. I had two roommates. None of us had enough money to go rent an apartment on our own, and we were doing okay. For guys that got out of college thinking that, "God, we'll never make $10,000 a year," and all of a sudden the government was going to pay us $7,729 a year to start, and the next thing you know, you've got a promotion and then you got another promotion, and it was like, god, we were awash in cash. So we didn't know any better.

WRIGHT: And weren't home to spend it.

HOLT: No, we were having fun, and we were traveling. And it wasn't the real government back in those days, either. The government didn't really catch up with NASA until after Apollo, and then they did it with a vengeance. We really became part of the government here in Skylab. But it was one of those things.

Just like watching the first Saturn V, the week they launched the first Saturn V, they launched the last Lunar Explorer on Atlas. That was a night launch. I was one mile away from it on some little back road that Kirby knew how to find down at the Cape [Canaveral, Florida]. We had a Minuteman [ballistic missile] launch that week. We had a Polaris [ballistic missile] submarine launch that week, real screamers; they get out of there in a hurry. And then we saw the Saturn V, and the Saturn V launch—if you've been to the Cape, it's right around the Titan launch pads, is where we were located. They put the Recovery guys well out of the way, because the only thing we were there for was a disaster anyhow.

So right before launch, my good friend Rip Kirby says, "Look, run outside and watch it. You haven't seen one of these." Well, nobody'd seen one. So I ran out to the reviewing stand, which was just right out the doorstep, and there were about five of us on this reviewing stand. There was General Henry, who was the [US Air Force] Air Rescue Commander, and then [Rear] Admiral Christopher, who was the Commander of the Atlantic Task Force, and I'm standing there, just this twenty-two-year-old kid, wet behind the ears. And as soon as they lit off—and it was about seven o'clock in the morning, real nice, clear day—the first thing that happened was all we saw was smoke, because it turned out we were lined up with the flame exhaust, so all we saw was a huge column of smoke. Apollo, they held down for nine seconds, just to let it [build] up thrust, and then it just kind of started crawling out.

Well, as soon as the big cloud of smoke comes up, both Admiral Christopher and General Henry turned around and looked at me, and I said, "I think it's okay," and they turned back around, like, "He don't know." [Laughs] So we watched it. All of a sudden it just kind of crawled out of there, then it started crawling down range. The sun was just coming up, and it's a marvelous sight. At about a minute later, you look out front and you can see the underbrush down there starting to stand and wave. You knew the sound was coming your way. And the sound, I've never heard a loud sound that deep. I've seen several Shuttle launches from closer than that. Shuttle is loud, but there's nothing to compare to what the Apollo Moon rocket was like. It was one impressive operation. And the guys that have been down in Florida will all tell you that—the guys that saw them all said, no, you could have been anywhere and that was unmistakable. The closest thing you'll ever get to that is something like a volcano.

So it was a tremendous—like, well, that will hook you, and it did, pretty much. I came down here on a lark, to go get some good travel and have some fun while I was at it, and stayed for thirty-four years.

What Recovery got most of us that were in Recovery, guys like [Brock] Randy Stone, [Ronald C.] Ron Epps, and those of us that became the cannon fodder for the rest of Flight Ops [Operations] when Kraft decided that he was going to cut it down, what the terms were; we weren't going to deemphasize Recovery; we were only going to allow attrition to reduce it by a third. [Laughs] And the answer was, "There are books of job positions that are open in Flight Control Division, Flight Support Division, and Mission Planning and Analysis, and you ought to go look at those before you do too much more."

So I left on a recovery deployment on a tub—the only way to say it. It was a 1938 troop carrier out of Norfolk [Virginia], went ten days out to the middle of nowhere and ten days back. Got off the ship, came back to Houston, and reported to duty in Flight Control Division on the next Monday. So I spent exactly two years in Recovery.

Flight Control was a different animal. I actually went to work in Flight Control on the Skylab experiments. It was before it was Skylab; it was the Apollo Applications Program at that time. [James E.] Jim Saultz was the Branch Chief at that time, and they'd just set it up. They had ALSEP [Apollo Lunar Surface Experiment Package] experiments in there. They had all the experiments that were getting ready to come along. They put Jim in charge of all experiments in Flight Control.

So we were just at the point of trying to figure out what we were going to be doing with this thing. We got eighteen months from launch on Skylab before everybody came to their collective senses and the [President Richard M.] Nixon White House let NASA make the

decision between either stopping everything or trading in the last Moon rocket to go launch Skylab with. So eighteen months from launch and they got us all together who'd been working on the program and says, "Remember the program you used to work on? Well, it doesn't look like that anymore. It all rides on a Saturn V, and this Apollo telescope mount solar experiments," that I'd been working with, "they're going to be launched on the top on this great big swing arm, and we're going to snap out to the side, and then the Command Module is going to come in and dock to this end, and it's going to be this big dumbbell that flies around in space, and we don't think that'll take too much longer." Well, that was a lie. It was about three years.

So that was kind of my introduction to how hard it is to develop something. And the real reason for doing it was the fact that Skylab really couldn't have been put together in space. Skylab was a program that was generated to keep Marshall in business, because George [E.] Mueller came up with that. There's a pretty good history that I've read of the Skylab Program, and it's mostly out of Marshall and out of [NASA] Headquarters [Washington, D.C.], and it was successful; the vehicle worked. They had a little problem with the solar wing, minor problems here and there.

But you never would have been able to put the Apollo Applications Program together the way they had planned, because you would have had to take the Apollo telescope mount as its own vehicle and rendezvous and dock with workshop out over the Indian Ocean, automated fashion. You had no way to do the logistics, because the U.S. didn't build logistics like the Russians. You had to have a program that looked like the Russians' program. So it just came down to where you would have used a hot Saturn V booster [SIVB stage], would have become the laboratory. You'd have had crews in there, making and breaking connectors in what had been a hydrogen-rich atmosphere, so there were some real issues. Everybody that worked on it

knew it was not going to work, but it was kind of a holding pattern that says it's something to work on until we figure out what we're really going to do. The lab we launched was fully outfitted. It had all the water, all the food, everything else. It had all the experiments in place, and we had three years to get ready.

So the way that worked is, oh, about maybe a couple of months before we started training, we all had to get together in a crash effort in Building 36 and start writing procedures, since we didn't have any. [Laughs] So [Eugene F.] Gene Kranz went through and decided to do a review of our readiness for the Skylab Program—this was somewhere around Apollo 15 or 14, somewhere back in that time frame—and quickly concluded that not only weren't we ready, we were just flat on the floor. So it was kind of like, "Well, we better go get ready."

So some of the guys were transferred out of the Command Module world and out of the Lunar Module world, that had been doing day-to-day operations, and out of the communications, to go shore up the other side. So we built a cadre of guys to go off and do Skylab.

When we launched Skylab, we had about three teams of trained flight controllers and literally were going to run ourselves ragged trying to keep up, because we didn't have time to train more than that. It actually turned out we needed five, and we put five teams in place by the time we started the next set of flights.

But Skylab was a unique animal and the training there was—we had a simulator, we did a lot of simulations, wrote a lot of procedures. We broke it in two pieces. The guys who did the activation sequence on bringing up the lab and all, they trained one way, and then we had been in mission simulation, so how to deal with the PIs [principal investigators] and the conflicts, the priorities and all, which was quite a shock to the system, and something that Flight Control hadn't had to do that much on the ALSEP Program, because they were all self-contained and

they were all looking at the Moon and they were all there for one thing. And all of a sudden, you have a workshop with a whole different set of experiments. One of them wants to look at the sun, the other guys want to look at the Earth. Then you have guys who want medical and operations, run on treadmills. You've got microgravity that doesn't want to be bounced around.

So by the time you took all this and put it on and we tried to run the first few sims [simulations], it was painfully obvious that Flight Control Division was never going to have everything it needed in place to be able to make the tradeoffs of the scientific disciplines. So in that time frame, Carl [B.] Shelley; Owen [K.] Garriott; John [W.] O'Neill; and then Bill Keithley from Huntsville, who was the Apollo telescope mount manager; and I can't remember the guy that was in the biomed world out of Huntsville and also out of Houston; Carolyn [L.] Huntoon was the lead PI for biomedical. But they got together and decided that they had to have a mission scientist, so we had [John R.] Jack Sevier, who was later the head of the Lunar Planetary Institute, and you had [Robert A. R.] Bob Parker, who was science astronaut, a Ph.D. So they provided that function for the whole Skylab.

So they mediated the disputes among the PIs, they allocated time, set the priorities, and that framework for how we did Skylab is pretty much the way we conducted operations all the way through Shuttle and all the way into [International Space] Station today. You set priorities, and those priorities have to get established. You build rules around those priorities, then you set them up, and when you get down to where you actually got the plan, then you limit your options on the things that you go do. Then take snapshots and go back and rectify and try to make up for who's getting shorted this year and so forth.

During Skylab, we could never, ever predict the weather, so we'd go through all these horrendous planning exercises all night long, come up with these uplink procedures for the

crews, which were being printed out on a teleprinter. I think there was one thirty-eight-foot message we did for one of the big EVAs. [Laughs] That was when we were trying to free the solar arm. Pete Conrad says, "I don't care how we do it again, but I want it all on one set of procedures. I don't want to have to flip around books when I'm outside."

So we went through a lot of that and the process then of developing of what the PIs wanted, how you put that into the system, how you figured out all the pointing angles for things, figured out what attitude you had to be in. All that stuff was pretty well automated and it flowed pretty well. We did that for a year.

WRIGHT: What roles specifically did you have in the midst of all this?

HOLT: Well, when we started in Skylab, the first big argument was over who was going to operate the experiments, so once Marshall and JSC and Headquarters had their big soiree and it was decided that Flight Control was going to operate the experiments, then Carl Shelley got most of them and Jim Saultz got the Earth Resources, but all the ones that really required any ground command, or any real-time control, we all were working under Carl Shelley, and I worked for [Robert K.] Bob Holkan, and Merrill [A.] Lowe had the biomedical and [Axel M.] Skip Larsen, [Jr.] who's still out here with Shuttle Safety, had everything else. Anything that couldn't be categorized, Skip got those.

So we took—like the Apollo telescope mount. The Apollo telescope mount was a big can that had eight telescopes in it, all pointing at the sun. Some of them didn't like to point off very far because they didn't want light shafting back in it. They have one that's a coronagraph.

It would have been perfectly happy to sit there in the middle of the sun, take a few snapshots a day, and then wait for something big to explode so it could take a lot of pictures of the corona.

So we went through a lot of fits and starts of how would you operate the telescopes. It finally turned out that through a lot of trial and error and, I think, probably driven as much by Owen Garriott out of the crew as anybody that says, "We've got to get standardized on the procedures." So we came up with the PIs were asked to develop what they wanted to emphasize, and they had those in priority order, how they wanted to study the sun, corona or the surface, or what do you want to look at. The PIs then, the different instruments, then had participation in some, not others, depending on their instrument.

Then we came up with standardized building blocks of how many instruments operated at the same time, and then those building blocks were just used to fill in the time. Then we built a timeline up by you have only so many hours in the day, you're going to take an observation in the morning, take another one in the evening, and in the middle then you'll schedule out your operations. And your Earth Resources stuff would be an interruption because we're trying to go around like this and watch the sun all the time; the Earth Resources kind of wanted to have the back of the Skylab following it around, so we had to close our doors. So you had to work all that out and build plans, build alternate plans at night, and then uplink all that to the crew. You give them a summary earlier in the week, then as it got there, then they'd start to see and then finally they'd get the detailed plan the night before.

Our shifts were arranged to where you had a planning shift that worked from midnight to eight; you had the shift that was going to fill out the details on that plan of action came in at four o'clock in the afternoon; and then it was implemented by the team that came on at eight the next morning. So the plan then went over five shifts; from the initial summary and working out the

kinks, to putting the plan together, to executing the plan was over a five-shift period, and we did that every day.

We also damn near killed everybody. It turned out the way we were shifted, after the end of Skylab, I think they figured out that we did probably what was the worst circadian rhythm interruption that we could have possibly done, because it's not anything like what they do today. We did five days on, two days off, and then back on. That's a great theory, but what we did was you'd work the midnight-to-eight for five days. Then you'd get off and come back on the morning shift. You'd work five of those and then you'd come back on the evening shift, all the way through. Well, it turns out when you rotate the way we rotated, you're actually going in the very worst rotation for your circadian rhythm. We had some guys that literally didn't sleep. I know one guy on our team who had small kids at home and was a single parent, by the time he was in the fourth day, his supervisor usually relieved him on the last night, because he couldn't handle that for five nights, eight to midnight.

I probably survived it because my wife was a schoolteacher and we didn't have any kids. So when I worked the midnight shifts, we probably didn't see each other very much. It was a strange year.

But at least the experiments, and the people that worked with the crew, as soon as you landed, you got some relief. The guys that worked systems and had to watch it full time, it was just constant.

WRIGHT: Did you have a lot of turnover in manpower at that time?

HOLT: No, it actually wasn't that bad, because there wasn't anything else going on outside. About the only thing major that happened in space about that time was Pioneer [10 Spacecraft] did the Jupiter bypass. But there really was not a lot going on. This was back in [19]'73, '74, and the economy was in the tank, so nobody was really hiring, so it was the kind of thing where everybody just rode it to the end and then hoped like hell they could get a job on Shuttle as it was coming along. So that literally was the kind of environment.

From what I remember, the turnover in Apollo was much higher than people would ever imagine, simply because it was so furious and it was fast paced. At any one time there were 600,000 people in this country working on Apollo. You're building them up one at a time and launching them, it was an incredibly large manufacturing base that had come from nowhere in a very, very short period of time. And that mix of people was unique.

The book I really enjoy on the Apollo Program was one that was written by Charles Murray and Catherine Bly Cox, which was the twenty-year anniversary book. There are marvelous stories in that book of just how sporty it was back in those days, and how hard it was to do things for the first time. So, yes, anybody that underestimates Apollo, really, it may have looked easy, but it wasn't.

And Skylab was hard. Something broke every day. I remember back in one of the early discussions came up with the idea that they'd have a limit-sense routine running in the Control Center. If anything went out of limits on the night shift, then they would call the duty officer and he would decide what we needed to do with Skylab. This was during the unmanned periods while Skylab was going round and round. So the only thing I remember is Carl Shelley coming back, laughing about that, and he said, "Well, they briefed the quiescent-phase monitoring plan to Kraft, and after they put the first page up, and they started on the second page and Kraft says,

'Now let me get this straight.'" This is all paraphrased, since I wasn't there. "So you guys have come up with a limit-sense routine in the Control Center to avoid paying GS-15 [General Schedule] overtime, when I've got the only vehicle in the air and the whole future of manned spaceflight is riding on this, and we're not going to get a Shuttle launched after how many years? And you think that's something we need to worry about saving money on?"

Everybody said, "That's probably a good point," folded it up and walked out. [Laughs] So you could usually count on your management back in those days for moments of clarity, and they'd usually explain it to you in terms that you could really understand. There was not much politically correct about what the guys we worked for said, and it was really easy to understand what they meant. If they weren't happy, they didn't bother hiding that. So there were a lot of people who walked out of meetings with their head on a platter. [Laughs] And the kind of thing that says, okay, well, you can always go back tomorrow, and you could, literally. But you just got to a game that says, you just don't try to snow these people. They're not going to let you do that, and if they think you're snowing them, then you're in real trouble. If you're just stupid or just out to lunch, then, okay, you're going to get clobbered. But you can come back tomorrow once you get smart. So it was kind of interesting.

[James W.] Jim Bilodeau used to talk about Kraft; he said, "Well, the best you can do with Dr. Kraft is break even," he says, "and that's theoretical, because we're going to screw up once and you'll never get back." [Laughs]

WRIGHT: Like you said, everybody understood where they were.

HOLT: Everybody knew.   Within Flight Control, Kranz was accused of running the biggest section on site. We had nine divisions and 350 engineers, contractor and NASA, and it was like it was micromanaged. Well, it really wasn't, but it was an exercise in—you knew after a year there what was good and what was bad, and you could spot it in an instant. And you knew the people who got it could get it down on paper and not waste your time and get in and get it over with, tell you what you needed to know. If you could do that, then you were going to do okay in that organization. If you had to explain the minutia and the minute level of every little thing and little nit and gnat, and you had to say, "And, oh, by the way," in the middle of all these conversations, you were never going to get there in that organization. You might as well move off to someplace else and do analysis, because it wasn't that kind of job.

It was a radically different job than it is today. The lunar surface, they had continuous communications. When you're going round and round, the old guys who told you their remote-site stories, I'm sure, and some of their stories they won't ever tell, but those guys, you had to get your message in a hurry. All the way through Skylab, the longest site passes we had, where you were running across the U.S. and you had remote sites, you had maybe twenty minutes to talk to the crew. The rest of the time you had about five, three to seven, something like that. So economy of words was expected. Not only was it expected, if you couldn't produce, you weren't going to stay in that job very long. So the guys who sat in the Mission Control Center were able to very quickly reduce what they needed to a quick note on a piece of paper, NCR [No Carbon Required] paper, so you could rip off one and hand it to the Flight Director and hand the other one to the CapCom [Capsule Communicator] and sit there and answer questions.

So we did business on mission notes and you had to get your business done in a hurry, and if you didn't have an answer, you told them where you'd have the answer. So it was like a

CapCom saying, "Now we're coming up on LOS [Loss of Signal] and we'll have an answer for you at Carnarvon [remote communications and tracking station, Australia] at the next site in fifteen minutes." And if you told them you'd have one in fifteen minutes at Carnarvon, you'd better have one in fifteen minutes. If it was really thirty, the Flight Director was not going to be very happy with you.

WRIGHT: When you were developing the plans, how involved were the flight crews before they launched?

HOLT: Well, the crews were trained on the plans. For Skylab they were trained repetitiously for the building blocks and operations of the experiments. They knew the experiments very well. They understood the details, especially for the medical and for each of the experiments. Then they also had the system reference manuals up there if they needed them. So typically what we sent them was, we sent them what was agreed to on a pad, and the pad then had the data that they needed to go run a procedure. So for the most part, they were using grease pencils on cellophane; plastic, I guess, okay, grease pencils. It's been a long time. We were still running around with blackboards and chalk.

So they'd take down that information, and the daily plan would give them enough information about what the background was, but they'd been seeing that coming. And you'll see that even today, if you sit through about a week's worth of Control Center operations on a station, is the crew's got a general idea of what you want to accomplish over the next couple of days, and where something is time-critical, you flag them and tell them it's time-critical. Same type of thing in Shuttle; if you're going to launch a payload out of the Shuttle bay, then things

are going to stop and we're going to get this right. So it's that type of operation. And you always send them up the thing in the morning that says, "This is in your plan for today." And it's gotten better today because now you've got word processors on board. But in those days, you just had teleprinters, so you had to pre-identify the formats and then you filled in the data form.

WRIGHT: Are there aspects of those missions that you recall vividly that you'd like to share with us?

HOLT: Oh yes. There were guys who—we talked about economy of words and people who handled it. [Robert L.] Bob Crippen could sit on a console, and if you had fifteen seconds to get something to the crew before LOS, you could just start talking and Crippen would pick that up and he could get it in one ear and out his mouth and not miss a beat, and even if you said something backwards, he'd correct it. But ask him to read the news—they'd get a little thing on the nightly news and Crippen would sit there and try to read the news, and it would get to the point where it was just almost hilarious, because Crippen would trip all over himself. Bruce McCandless [II] could take fourteen pages and give him seven minutes, he could read the history of the world, just perfect narrative. So everybody on the team had their own strengths and their own faux pas.

When you go back to the first Skylab launch, we launched and we didn't know whether we had a program or not. Here we are running around, no power. We were wandering around in a fog for a couple days trying to figure out which end to do. The data system choked. Here we had all this data coming down, had a big compression routine that was brand-new, so we had to

get a team together just to go through and sort out how to go contend with the data. Because if we had actually launched everything on the schedule we had launched it on, the Control Center—we'd have choked so fast it wouldn't even have been funny. It took about a week or so just to get that back in place.

So we never really had a good shakedown cruise. It's just the ability you have to simulate everything. We didn't have that and we launched a whole program, up and running; there wasn't any steps along the way. But everybody had done it on Apollo and everybody figured they'd do it again. But it was kind of like going to the Moon on one shot, and it was not that way.

So at the same time that the solar wing came off and you've got half the power that you want, you're running on Apollo telescope-mount power and you're really not making power in the workshop. There were arguments between JSC and Marshall and teams within the Control Center and with Marshall, and guys over at Marshall who didn't agree. So we literally broke down the team structure and went two on, two off. We had two teams offline trying to save the thing with procedures and go run tests and get stuff together. Jack [A.] Kinzler had his guys over building solar shades, onsite here out in Tech [Technical] Services, and then the rest of us were coming in at night and just watching Skylab bore holes in the sky. So those of us doing experiments didn't do anything. I even volunteered to go down and plot voltage all night long, and temperatures for Craig Staresinich in the power world just to have something to do.

We didn't know whether we had a program or not until the crew got up there and did their thing. And of course that, when they get up there and the picture in your mind when [Charles] Conrad [Jr.], [Joseph P.] Kerwin, and Paul [J.] Weitz arrived at the Skylab, all we heard was the grunts and groans, but literally Joe Kerwin was holding Paul Weitz by the feet.

Conrad was snugging the command service module up and underneath the wing as much as he could, up and underneath, trying to hold steady, and P.J. was out there with a pair of cutters, trying to get that little piece of thing that was holding that one wing. P.J. was a sailor, and some of the language he used was somewhat colorful. And it didn't work. So they docked and went out, and on the day they finally did get the little piece off of there, Joe Kerwin can tell you that— I don't remember who was on the wing out there, but it actually kind of launched them. They were tethered; they had the umbilical tethers with all of them. It wasn't backpacks and Shuttle EVAs [extravehicular activities], but it was a little different deal.

So once we got the power back, then all of a sudden everybody breathed a sigh of relief, because we were back in business. Had we not gotten the power back—and we had anarchy, because all of those interwoven plans and agreements between PI groups and everything, it was never going to work, because you didn't have enough power to simultaneously operate everything. So it would have just been a slugfest, an argument over who got to do what, and it would have been very tight.

But by the end of the first Skylab flight, the crew was taking data at a remarkable rate. And on the next flight, [Alan L.] Al Bean and Jack [R.] Lousma and Owen Garriott, well, we were in hog heaven. There wasn't hardly anything we'd ask them that they couldn't do.

Then we got to the rookie crew and that was [Gerald P.] Gerry Carr and [William R.] Bill Pogue and [Edward G.] Ed Gibson, and we had never really had integrated training with those guys. We'd been over running the Control Center for all this time. The only sims they got were launch and landing, so they showed up with a team on the ground that was ready to operate and expected them to perform at the same level that the last guys did, and they were running ragged. Finally, they just pretty much rebelled. I think they chewed on the flight surgeons during the

private medical conferences. We all knew something was going on; we weren't quite sure what. But if you're sitting there at midnight and all of a sudden Kraft walks in and [Donald K.] Deke Slayton walks in and the Skylab program managers walk in and Kranz is there and all your divisions chiefs, you say, "It's sure getting warm in here." So we knew something was coming.

So [Richard H.] Dick Truly was the CapCom and he's going through the nightly news and putting them to bed and all, and he says, "Gerry, you asked the question earlier about how hard we were working you guys, so we're going to give you the statistics." Well, they'd been off working on it for about three or four or five days and they had all the statistics. [Dick] read it to them, and he says, "And Deke is here and Chris is here, and if you have any questions," and at the end of it, Gerry says, "No, I don't think we've got any questions. I think we've got the message." [Laughs] It was a little heavy-handed, probably. And we did let up; we had to some, because they really were to the point where they were getting behind and then they were rushing things and they just hadn't had—their OJT [on the job training] just wasn't as good, plus Jack Lousma ate all the sugar cookies on the flight before, so there weren't any left.

I've worked with Ed Gibson some since then, and Ed's got some really great stories about just what went on onboard. He says, "You know, eighty-four days with people that you know and love is still eighty-four days." [Laughs] It's kind of like family, I suppose. You know, fish and family start to smell after five days.

WRIGHT: That's what I've heard.

Mr. Holt, we've been at this for just about an hour. Let's stop for a second and give you a break.

[pause]

WRIGHT: Right after we stopped and took a break, you made a comment about Skylab never seemed to end.

HOLT: Right.

WRIGHT: What do you mean by that?

HOLT: Well, 'round the clock, 'round the clock. Five days on, what looked like two days off that actually turned out to be exactly forty-eight hours. So it was constant, and it was the kind of thing to where those of us who lived through Skylab really never, as we got older, none of us ever had any intention of ever doing that kind of work on the Space Station.

WRIGHT: That leads me up to my next question. You mentioned about the shifts, what you learned about that. What other lessons did feel like Skylab passed on?

HOLT: That was one of the real strengths of guys like Kranz. Gene would never let a lesson-learned opportunity go by, so after Skylab, coming up on Shuttle, Gene made us go back across all of the discipline areas in Flight Operations and Flight Control primarily, and write down a book of all of the lessons learned. He called it John Commonsense. And some of it really was applicable to other programs. Some of it was very, very—you tended to get kind of picky. But it

was that type of thing. You had to revisit what you did, and you had to revisit the ideas, and you had to go back and recapture a lot of the why you did it the way you did it.

I think the exercise for most of us who lived with the upcoming programs and all, just having done it, you knew that any time you got into one of those kind of operations, you had to stop and go back and capture what you did right and what you did wrong and what you needed to work on. And the process improvement ideas, we were doing process improvement before it got to be a religion, and with Kranz it was a religion anyhow.

But we weren't the only ones; the Cape did it that way. Everybody who was in our business was kind of fanatic about making sure that you didn't miss something. It was easy to do, and it was hard to make sure that you cross-checked and re-cross-checked. So, yes, from that standpoint, Skylab was just on all night, it was on all day, it was on—we came in New Year's Eve. We went through, we got off at eight a.m. and went over to [Donald R.] Don Puddy's house and the whole team had breakfast at Don's place. He didn't realize he was going to do that, but Frank Hughes and a few others came up with the idea, and as we went off our shift before that, we were putting up the crew pads and going through and reviewing them and we put up the last message, and Don says, "Okay, let's see. We got anything else? I just got one other thing." He pulls it up and it says that he'd just invited everybody to his house. Don looked around and he says, "Yes, and I'm going to assess everybody in this room." So we all paid up, but it was a pretty nice party and our wives drove us home, because we were beat. [Laughs]

And we had the academics in there. I worked a lot with the guys from Harvard College Observatory [Cambridge, Massachusetts]. Dr. Ed Reeves was the PI on SO-55. We called them that because the real names were something like the "extreme ultraviolet scanning polychromometer spectroheliometer," and nobody really cared about that, except the guy that

wrote the paper. But they had good people. Harvard doesn't have shabby educations, and the guys who were working the program, and the guys out of Ball Brothers Research [now Ball Aerospace & Technologies Corporation] out at Denver [Colorado], they were a research laboratory that built a lot of their own experiments, these guys have been doing solar observations and sounding rockets and satellite programs for years. Even today, every so often I'll be watching a C-SPAN or a Discovery Channel or whatever, and some of the guys who were backroom support to the PIs are now running the High-Altitude Observatory out in Colorado, at Boulder, and George Withbroe, who worked for Reeves, ran the Solar Physics Division at NASA Headquarters until about a year ago, when he retired. So you knew guys over your career and you've run into them.

So space, from that standpoint, is a small space, and the same people keep popping up over and over and over again. So when you spend thirty-some-odd years in a game, and a lot of other people spent that much time, it doesn't take long to find associations. That, I think, is a strength to what we've done, because you can very quickly move to where you understand each other and you can speak a common language. Guys that even today are out—like Craig Staresinich, who I mentioned earlier, who was sitting on the power console, was the project manager on the Chandra [X-ray Observatory] spacecraft and got a National Rotary [International] award with that job. Did a great job. Some of the guys who were out at TRW [Inc.], I guess they're now—where are they now? They're probably at Northrop Grumman [Corporation] by now, but some of those guys who did the military programs, we run into them over the years. Some of them left and went out there. They brought their payloads back and we did work with them on Shuttle and now you see them in different places. And DoD has got a

bigger program than NASA does, by far, these days, but the NASA programs have got an awful lot of people who have continued to do the work, so you keep running into them.

WRIGHT: Could you tell us how your job changed from the time that you were assigned to Skylab to before the time that you left; what type of different duties and responsibilities?

HOLT: From Apollo to Skylab?

WRIGHT: Yes, through Skylab. Once you got involved with Skylab, just how your tasks were changing.

HOLT: I changed divisions; that was the biggest single change. Recovery was one type of work and then when I got to Flight Control, Apollo was up and running. I did some OJT on some flights and I also supported the radiation monitoring effort. They put a flight controller back there with the medical guys and the radiation team; somebody had to be den mother and do crowd control, so we did that. But most of the Control Center configuration, all that kind of stuff was already done, so I didn't really get into what it took to go do all the computations in the Control Center and all the parameters that you had to monitor. So I'd never done that. All of a sudden, in Skylab that was the job. What do you set up, what do you look at, and what do you make decisions on?

In that case, we also did contracts with Martin [Marietta Corporation] out of Denver, who had some of the support systems. They were the Marshall contractor for the support systems. We had Ball Brothers Research and NRL [United States Naval Research Laboratory,

Washington, D.C.] and all those other places. So we had contracts and contractors then populate our branch and our sections at that time for all the hardware. So with a mixed team of NASA and contractor, then staffed the Control Center. So we had to go build the procedures and build the flight rules and do the data packs for how you configure the Control Center and interpret the telemetry and all that, build this place. So the team-formation-type activities.

We had to go figure out how many team positions we wanted to do, and we weren't going to have enough consoles for every telescope to have its own console position, so we mixed them and matched them a little bit. So we had cross-training there. Typically, the contractors we brought in for that were guys who didn't have ops [operations] experience; they were development engineers. They'd done a lot of tests and some of them had done extensive design work, and they weren't really that enthusiastic about sitting on a console. So getting them to write operations procedures with the same fervor that they designed things was not really—their company sent them down here because there wasn't any other work, and they took the job because they thought the Houston market might be better than where they were, so we had some of that also.

But we built good teams, because it was the kind of thing that says if you can't handle the team, then you just need to leave. In fact, [Dr.] John McCoy, the first guy down here from the Harvard College Observatory, who had been a PI on some experiments, showed up in our organization, and we were crammed into the second floor of Building 30, and I mentioned that Kranz, we had about 350 total people. Well, the Center never did like the way MOD [Mission Operations Directorate]—Flight Ops at that time, Flight Operations—managed their contractors. We got allocated all our floor space based on how many civil service we had, and Kranz insisted

that the contractors are co-located with him, so if you had one contractor for every civil servant, you have half as much floor space. [Laughs] So floor space was always at a premium.

In fact, I remember Bob Holkan was—we had an office area that was on a raised platform computer floor on the second floor of Building 30, and we had junior partitions, literally, so it was the forerunner of what's standard operating procedure today, but we still had all the old government-gray furniture that didn't fit this mode of operation. Bob's section head office actually was a junior partition also, and Holkan's pretty loud. He couldn't even scream at people.

But Bob came in one morning and he realized he couldn't get around the corner to get in his office very well. So the next day he came in and it was worse. So he started looking and there were holes on the floor where somebody had actually moved his junior partition about two inches, and he figured that had been going on a while, and it finally got to where—Bob's about six-seven, he's a pretty good-sized old boy, so he just called everybody's attention. There were twenty-eight of us at this time and we were sitting in floor spaces probably good enough for about twelve. So we literally had guys who were sitting at little tables. And if you were on leave, you could expect, if you came in early, somebody would be sitting at your desk.

So we finally moved to Building 45. But Holkan hollered at everybody and told them that he wanted it moved back at least two, and he was going to be gone for a little while, but he expected it to be that way when he came back. So we had our moments. Kranz managed to finally get us—but MOD was always that way. That has never changed. It was run as a badgeless society. You were nobody until you proved that you were somebody, and it didn't make any difference who you worked for; if you were good, you were good. So it came down to either you could do it or you couldn't.

We got trained by some of the saltiest Philco [-Ford Corporation] tech reps [technical representatives] that you've ever—you know, interesting guys. Guys like [Robert D.] Bob Legler, who were in the Suez Canal crisis back in the fifties, who were installing communications gear over there for the U.N. [United Nations]. So these guys had been around the world working at this stuff. A lot of them weren't degreed; they'd been trained in the military and everything, and that didn't matter either. It was a thing that says either you're good or you're not good, and the only thing it did is it limited a bunch of them from ever working for NASA, because the government wouldn't hire them if they didn't have a degree in the classification we were in. So to a great degree, guys that were a lot better than we were had to train us, and they reminded us daily. Bob Legler still reminds me, you know. He's seventy-five years old. I get reminded of that every time I run into him. [Laughs] So they always remember who you were and when you were that, so it keeps you grounded.

WRIGHT: What part of your Skylab experience do you feel you enjoyed the most?

HOLT: I enjoyed working with the PIs. They're a hoot, because the principal investigators, they're not structured people. They generally just want to get things done. You know, the shortest distance between two points; the fewest numbers of procedures. So it was quite a challenge getting them to accept the fact that we were going to operate Skylab pretty much like we operated Apollo. And for Shuttle, we broke that mold. There was no way we were going to try to do Shuttle like we did Skylab or like we did Apollo.

So in today's operation, you'll find that the customer, the PI team or the military, whoever brought the—has also got to be the operating element for their device. We had a full-

service option in some of the early Shuttle. We used it one time and pretty much it's a "We will give you the operating parameters, we will support you and we will work this all out with you, but when the time comes, you're going to have to answer for your own devices." We did that for the PIs and for Marshall as a contract job, and Kranz never wanted to ever do that again, because it was always in the game that says, we ought to be a flight test organization and not—we ought to be in the systems world and we ought to take care of the basic system, but if somebody wants to use it, then we will figure out how to help them do their thing.

That's the way Glynn [S.] Lunney and [Leonard S.] Nicholson and the guys set up the Shuttle Program, was with a set of requirements then that you took the customers in, and through a payload integration plan you figured out how to put them into your operation. I got to play with some of that back when I got in the payloads business later on in Shuttle. So it was different, but the fundamentals are still there; the way you plan, the way you execute, the way you train. The only real difference was this time you expected the customer to bring his smarts with him and be in the Control Center and answer for his equipment. So Skylab was quite an eye-opener for JSC, for those of us that lived through it.

Most of JSC was off working on the Shuttle and working on Space Station. In 1968, Engineering had a Space Station branch. [Robert J.] Bob Wren ran the Engineering Branch for [Maxime A.] Faget. Thought we were going to build a space station; we figured in 1971 we'd be building a space station. We thought Skylab was just a waypoint. And that was the other reason people didn't just wholesale bail out, is you just couldn't imagine that Apollo was over and that that wasn't just the start of something instead of that being the pinnacle. I guess we were in denial, big-time denial.

WRIGHT: Personally, what part of your job with Skylab did you find to be the most challenging?

HOLT: The preflight actually was harder than the flight, which has pretty much been the case almost everywhere. If you get it planned out right and you get good processes and you get things in place, then you can turn the crank. Skylab, I guess literally the responsibilities that I had early on was just figuring out how we were going to operate with the PIs, because I had most of the lead work in that, for taking the plans and turning them into reality. I did a lot of that work.

I guess the one I enjoyed the most was during the unmanned phase, Mercury, the Mercury orbit took it across the face of the sun. So we've got all the solar telescopes and it's like—well, normally, originally that would have happened with a crew there, and the crew would have just tracked it across with their telescopes, no problem at all. But the problem with that is that unmanned, we had about a degree of uncertainty in what the attitude was around the axis that pointed at the sun. Mercury didn't cross exactly right through the center; it was actually a little up from that, so it cut a cord through the sun. And it also occurred over the southern Atlantic, in terms of our orbit, which was some of the crappiest site coverage we had, and we were like an hour between site passes.

It was on the Fourth of July in 1973, '73 or '74, whichever it was, so it couldn't hardly have been planned at a worse time in terms of our ability to go try to figure out how to support it. I can remember I had a telephone call with Headquarters, and I can't remember who it was, but the guy up at Headquarters says, "So it looks like it's pretty good, huh?"

I said, "Well, I just want to couch it for you this way." We were sitting with Carl Shelley and Kranz, and I said, "Other than the fact that we've got the worst site coverage that we could possibly get, we don't know the roll angle to within a degree, and we probably can't lead this

thing, and we're trying to hit a 15 arc-second object with a 5 arc-second slit, I'd say it's just perfect." Carl just kind of cringed a little bit, then he explained to me how you really talk to people at Headquarters after that. But there was no doubt left in anybody's mind. So during the flight, sure enough, we hit dead center, the 15 arc-second object with a 5 arc-second slit.

We were sitting there, Don Puddy had asked me before we started that operation, he says, "So what are you going to be doing?" I explained it to him. He says, "Okay, well, you tell me if anything happens." So we were just cruising along and we come AOS [Acquisition of Signal] and we're sitting there, and I look and the detector column, you had all these numbers bouncing around, and all of a sudden they go to dead zero. And I looked at that and [Eugene B.] Gene Chmielewski in the back room and [Reginald] Rege Dawson is in the back room and they said, "Holy Christmas, would you look at that?"

I said, "Yeah, I think I just saw that." I turned around and told Don, "Don."

"Yeah."

I says, "You need to look at—."

He says, "Does that mean you hit it?"

I says, "Yeah."

He says, "How'd that happen?"

I says, "Hell, I don't have any idea." [Laughs]

Actually, I do know how it happened. I sat out there and just tried to act calm during all this operation. When I'd gone out the door, just to go check on the back room, I opened the door and there is about fifteen guys, and they had a printout running from one end of the Control Center all the way to the other, and they were on their hands and knees out there, running around looking for places to where the Mercury would have been in the data, because of dropouts,

because this thing scanned. So all I saw was rear ends and elbows. Finally, one guy down here says, "I've found it!" and I just closed the door and went back to the Control Center and sat down.

Don said, "How's it going?"

I said, "Oh, it's going great." [Laughs] So that was pretty much—serendipity counts for a lot.

We fought like dogs and cats. The teams argued among each other. It was the typical things; we just worked against each other for a common purpose for about a year or so there. And they had the usual arguments with Marshall over things. We just never agreed with Marshall over anything.

WRIGHT: Were you involved in any of that?

HOLT: Oh yes. Actually, I think the Center—I don't know who did this. It was probably [Clifford E.] Charlesworth. But they got us an Electra, four-place airplane out here, and it flew back and forth between here and Huntsville. So we'd leave Ellington, and that was when it was still an Air Force base, and flew up to the Redstone Arsenal [Alabama], and it went up there and back every day during this time. So we'd get on this four-place propjet Electra and we'd fly up, and then we'd turn around and fight the wind coming back. So going up might take a couple hours; coming back would take another hour because you had to fight the winds. But that thing, it was full all the time, and I was up there every other week for some working group that I got assigned to. So we sat down literally and we had an eight-hour argument, then we packed up and we went home, and we went back two weeks later, had another eight-hour argument.

That's pretty much traditional; it's not just Marshall. Flight Control had those same arguments with Mission Planning and Analysis [Division]. We had those arguments with the guys that built the command system in Flight Support Division. We had them big time with JSC Engineering. We had them with the docs. So Flight Control pretty much was viewed as probably the most arrogant organization within NASA, and we probably were. But it was the kind of thing that says, but we know how it's going to have to get done, and if you work with us, we'll get it done right. And if you won't work with us, we'll just fight you until we have to get to the table.

WRIGHT: I was going to ask you how some of the arguments got resolved.

HOLT: Typically, within the organization. I mentioned the idea that Kranz ran the biggest section going. Actually, Gene served to limit the debate. He'd let the debate rage until it got to a point in time where somebody needed to make a decision, then if it got to him, he'd make the decision. So literally, that's why I say as long as it was reasonably civil and nobody threw rocks at each other, then the debate was allowed to rage until there was enough data on the table to resolve the issue, because it was always the data that was the only thing that counted. It was like the Mission Evaluation Room over there. You need to talk to [Joseph E.] Joe Mechelay and [Donald D.] Don Arabian; their mantra was always that "In God we trust; all others bring data," and literally it was that type of a game. You had to force them to give you the data.

In Shuttle, we had the same thing with Rockwell International and with JSC Engineering. The biggest problems came when the Flight Ops guys, like controllers, got between the NASA Engineering organization and the contractor that they were charged with holding to a

specification and all this other stuff. Flight controllers didn't care who had a contract; they just only wanted to know how it worked and what it could do, and the engineering guys worried about voiding the warranty. [Laughs]

WRIGHT: Do you feel like you brought any lessons out of the Recovery Division that proved to be very useful working in Skylab?

HOLT: Yes. The thing that says it's a sink-or-swim operation and you're either a sinker or a swimmer. Most of these things, they were all start-ups. We just pretty much knew one day or the next, and even if it wasn't, there was enough people in that had never done it to where you had to do it for the first time, among the people you were with. So the history was kind of light. So you always were trying to do it better on a day-to-day basis.

You fought action items like crazy. Action items probably were the bane of everybody's existence. Literally, you could get action items that would stack up to the point in time where you'd pick that up and say, "There's no way I can work all that off." So you pretty much figured out what the priorities were. You figured out how to survive and figured out how to do the right thing, and when you didn't do the right thing, then they explained it to you that you'd missed something that was in that priority stack.

For Skylab, literally, the Flight Operations management had to change radically from what it had been during Apollo. Apollo, I've got to have immediate access to Engineering, I've got to go fix my problem right now, I'm going to run out of consumables, I need to get home. Shuttle has that same dimension to it today. Skylab was, I've got time to work with the problem.

I need to get an answer and I need to continue operations while I'm working on this problem. And you get that with Station as well.

You've got that with Shuttle on orbit operations. It says if something comes up that's got something to do with de-orbit, something that happened during launch with the hydraulic system or whatever, then you figure out when you've got to make a decision and when you've got to check it out and when you've got to leave yourself enough margin to come home, and you try to get as much of your on-orbit operation done without compromising that activity. So you keep the mission going and you're always looking in front of you, that says, I know where I've got to make a decision. So if I've got to make a decision the day after it happens, I make the decision then if I've got time.

I remember on Apollo 16, when I was literally OJTing in the Control Center, watching [Franklin W.] Bill Brizzolara [Jr.] eat this most incredible lunch every day. We had a shift changeover and had just gotten to the Moon, and they go around and the crew comes around and John [W.] Young says, "We got a PGNS [Primary Guidance and Navigation System] and AGS [Abort Guidance System] disagreement." What that meant is the Lunar Module primary and alternate guidance systems didn't agree. Well, they had to agree or you had a problem. So all of a sudden, you don't land under those conditions.

I remember Kraft walking through the door, and Harold [M.] Draughon, who replaced Briz was sitting there, and as soon as Chris walked through the door, Harold says, "Well, what are you going to do, Chris?"

Chris says, "I don't know, but you better figure out how we're going to operate those experiments in the sim bay on the way home in case we don't land." So it was like, okay, the guy's already three days down the road that says, "I'm going to have to go do something to

recover as much of this mission as I can, and I haven't figured out what I'm going to go do, but you better not slow me down."

So the first thing Harold did was turn right around and say, "Okay, I want this, this, this, this, and this, and we'll need this in four hours." So it was that type of thing that says they're engaged. And the management had a good clarity of that type of stuff that says, "I don't know what your job is, but I know what you do for a living, and you better have a plan."

WRIGHT: Were you involved in the plans that brought Apollo 13 home?

HOLT: No. No, I was sitting up in the radiation room. We were in the weather room up there, doing the solar weather. So I was a peripheral. I got to listen to it all go on.

WRIGHT: Tell us about where you were for Apollo 11.

HOLT: Apollo 11, when it landed?

WRIGHT: Yes.

HOLT: I was at the Cotswold Village Apartments with my fiancée, watching it on TV that night. I'd just gotten off console. In fact, what you'll find is the people that were on console during Apollo 11 pulled rank on everybody that they could. There wasn't anybody that didn't realize that it was only going to happen for the first time once. So when you go look around right now for the people who were on console for Apollo 11, then they were in some kind of management

position and they flat made sure they were going to be sitting there on the day so they could tell their grandkids.

WRIGHT: I'm glad you straightened that out for us. [Laughs]

HOLT: All of us kids knew that we were on the third shift and we were going to have to watch it at home. Of course, I got to drink a beer with mine.

WRIGHT: You knew your place. [Laughs]

Let me ask you about the first time you saw a Saturn, or I should say the first time the Saturn launched, you happened to be there and you mentioned that you were there as part of the disaster team.

HOLT: We were part of the recovery. You see, launch site recovery, the only time you worry about launch site recovery is if the rocket blew and the Command Module took off, or for some reason you just had a launch site [abort]—so we'd been to the Cape, and the launch site recovery effort was kind of interesting. You had helicopters out of Patrick Air Force Base [Florida] with pararescue, scuba gear, and they would have gone in the water and put on the collar. We had a landing platform helicopter. It's a flat top, but it's not a carrier. They just had helicopters on the back. Maybe it was a heavy-lift helo. That was right off site; that could have picked up a Command Module as well. Then they also had swimmers.

That's all well and good if it landed in the water. If it didn't land in the water—the Command Module didn't like land landings. It was kind of like you were not going to get much

structure; it was not going to survive a land landing very much, but we had to be able to get in and get it out. If you've been to the Cape, the Cape's mangrove swamps and Lord only knows what else down there. So we had a squadron of Marines out of Camp Lejeune [North Carolina] and one of these duck vehicles, kind of like the thing down in Galveston [Texas] that runs in the water down there, does the tours. They were available then to go chase around and find them. Then we had a heavy-lift helicopter that we'd use, with a hook, to go pull it out. So, literally one of the exercises that we ran was we took a Command Module and we dropped it in different places, or set it down, and then we took the hook and went in and we pulled it out. So we played that game.

I got to see a lot of the Cape at that time. The Cape's a big place. I saw some tremendous-looking alligators. I saw a five-pound bass jump completely out of the water. It was kind of interesting.

Then one of the guys, John [H.] Cooper, was down there running one of the exercises, and at the end of their exercise, he and the Marines decided it would be a good idea to go take a closer look at the Saturn V. So they took their duck vehicle, the LARC [Landing Amphibious Recovery Craft], and drove up the barge canal. John was a former bush pilot, had been a Coast Guard pilot, but he also flew around down in the Caribbean for a few years. In the sixties, not too many people had facial hair, unless they lived in Haight-Ashbury [San Francisco, California], and John had a beard. So here's John Cooper, no shirt, a pair of cargo shorts, and sandals, in a LARC vehicle, with a group of Marines carrying weapons, driving up the barge canal in a LARC. When they got there, John says, "I knew this probably wasn't a good idea," because at that time the whole area around was ringed with security personnel, all with drawn weapons and some fairly large caliber stuff. So all I remember is we found out about it first and Rip Kirby

came out of his office and said, "I'm just going to kill him. I am going to kill him." He'd just gotten a call from the Cape and they wanted to know if Rip wanted John back. [Laughs]

So it was interesting. I rode a helicopter from Patrick Air Base up to the Cape. We counted sharks on the way up there one time. Phenomenal numbers, the sharks in the water out there. As we got up close to the pad, I can remember looking at the altimeter and it was reading 320 feet, and you had to look around and crane your neck to see the top of the Saturn V. By itself it was 360 feet, and I think it was up around 400 and something by the time you put it on the pad, so it was a monstrous vehicle. I've been on the pad around the Shuttle and been in the cargo bay when it was ready to launch and stood underneath it and all, and it's all impressive.

Apollo was such an overpowering feat that the agency has always tried to get back. But Apollo was done with an open pocketbook, and ever since then, NASA's been a zero-sum game. It's just not expansive. It's kind of like trying to live on a pension. Some of us understand that.

WRIGHT: Did you have an opportunity to see another Saturn launch?

HOLT: No, that was the only one I got to see. I didn't get to see another launch until, let's see, 1985, when I was down there, [STS-61B]. In fact, it was two flights before *Challenger*, so it was a night launch. Very impressive.

WRIGHT: I was going to ask Sandra and Jennifer if they had any questions for you about Skylab or Apollo. Do you have any?

ROSS-NAZZAL: I think I might have a few.

HOLT: Go ahead.

ROSS-NAZZAL: The first one I thought of was, what was your most memorable recovery mission?

HOLT: Oh, that's easy. First off, I was in Recovery Operation, and most of my recovery—I got into the wrong ocean every time. So I was out on some contingency ship somewhere, because you always want to land around a carrier, because there you had all the press, you had a hundred Rockwell techs, you had everything you needed to properly take care of the landing. The last place in the world they wanted to be was around one of those ships that they just brought it up and set it out there and waited on, and I was pretty much there. And Randy Stone and I were on the USS *Francis Marion*. We left Norfolk in a snowstorm right before Christmas in 1968, right before Apollo 8, and we're out in the middle of the Atlantic Ocean over Christmas. But on New Year's Eve, we pulled into Rio de Janeiro [Brazil] and got off the ship and watched whatever numbers of millions of people they have in Rio de Janeiro have a party down on the beach. So it was some small measure of revenge. Yes, that was an easy one.

The things I remember about recovery, literally, are the numbers of activities where you just flat had to go someplace because you were the recovery rep on scene. So I got a lot of that. I lost a suit coat out of a helicopter in Manila, but got it back. Had my passport and shot records and tickets and a few government TRs and everything. It's little things like that, that was kind of fun.

You had a thing here on the first Lunar Module flight and then for Apollo 6. I was flying airplanes out of Bermuda on the Lunar Module flight; that's Apollo 5. Of course, that flight, the first thing that happened was they ran out of gas, because they had the gain set wrong on the control system. Well, we were operating this little tracking box that Rockwell Collins built, and it was designed to track signal off of the spacecraft, and it was supposed to track the S-band [frequency spectrum near 2 GHz] signal through the blackout period for landing. That was all well and good, except that the way it was designed, it needed a signal that was considerably stronger than the one that was finally selected for the telescope. There was a VHF [Very High Frequency] antenna also, but supposedly during blackout it wouldn't work.

So [William A.] Bill Middleton and I were on this airplane with the Air Force and waiting for the Lunar Module. Never found it. Never found it. Never found it. So finally, Bill, in a fit of frenzy, says, "Flip it over to the VHF." So we flipped it over to the VHF, and about ten minutes of that and all of a sudden we get this big jagged signal that jumps out of the noise. "Well, that's got to be it. There's nothing else around." So we flipped it back over to try to find the S-band. And if you can imagine this is the grass, there's one little blade of grass that's sticking out a little bit above it, and that was the first time I'd ever seen an actual S-band signal that wasn't in a lab. I said, "Bill, we'll never see that."

He said, "Yeah, I know."

On the next flight, I'm out on Apollo 6 and we're in the Azores, flying down, going to intercept the ground track. Communications back in those days was not exactly what it is today. We didn't realize that [Saturn-V AS] 502 [Apollo 6], that had two engines out during launch, one of them actually had a problem, and then they were wired wrong and shut down the wrong engines, so you end up with two engines. You ought to get Jay [H.] Greene to tell you that story.

If you guys haven't talked to Jay Greene, you need to get Jay Greene over here. But that was one of the things that happened.

So we're out driving along, we never saw the signal, we never saw the signal, time went by and everything. So finally I told the operator, I says, "Flip it over to VHF. We're going to find it somehow, even if it's on the next rev [revolution]." So after about five minutes, all of a sudden we get this big jagged signal.

He says, "Do you recognize it."

I said, "I know that's it." But we were like ten minutes, fifteen minutes late. Had no idea that they'd had the problem and that was really where we were. So I had a paper tape of all this and put it in my suitcase. I had preapproved travel. Like I told you, the government hadn't quite caught up with us. I went to Lisbon [Portugal], Munich [Germany], and London [England] on the way home; dropped by Tennessee, visited my folks, and then came on home. And when I showed up, they said, "Well, where's the tape?"

I said, "What tape?"

They said, "The one off of—."

I said, "Oh, this?"

"We've been looking for this for a month." [Laughs] Like I said, there's times when you heard from your management that maybe—yeah, I heard from my management.

ROSS-NAZZAL: You mentioned that you were with Randy Stone in your memorable moment. Did you normally go in pairs for the recovery?

HOLT: No, that was the only time I ever rode ship with somebody else, and that was because we were the lunar abort line. That was the first lunar live ship, and had they run into problems, they'd have had to land either twelve hours early. If they couldn't get to the Pacific, they'd have had to land in the Atlantic, so they sent Randy out there. Randy was out of the Engineering satellite and I was out of the Operations end. The captain of the ship, [Captain] Gene Maseka, had been a classmate of [Walter M.] Wally Schirra's. He sent a guy down and says, "Mr. Holt, would you please come, the captain wants to talk to you." Well, since I was the Operations guy, I was the team leader. Randy and I have had this conversation a lot.

So I go up and I'm talking to the captain, and the captain says, "Son, when are they going to release us?"

I said, "Well, they'll release us when they know that they're going to land in the Pacific."

He said, "Well, yes, I know that. What's the timing on all that?" So we go through this little conversation and he finally says, "So if I'm on this station on such and such a time, then I'm okay?"

I said, "Yes, sir."

He said, "Well, son, what I'm thinking about doing is I'm thinking about maybe starting to steam for Rio just a little bit early so that we can get in there on New Year's Eve."

So I'm sitting there watching my career go by, so as we're turning around, I says, "Captain Maseka, it's your ship, but we never had this conversation." [Laughs]

ROSS-NAZZAL: I just have one more question. Since you worked in Flight Operations, I was curious about what you thought of the History Channel's documentary [*Failure is Not an Option*].

HOLT: The one Gene did?

ROSS-NAZZAL: Yes, that presentation.

HOLT: That was good.

ROSS-NAZZAL: Did you think that it was a good portrayal of what Flight Ops was like at the time?

HOLT: Yes, it probably was. Again, you're going to get everything through the eyes of the guys that did it. And like I say, Flight Control, that's one of the reasons why you go ask that question of people that weren't in Flight Operations, they'll give you a different answer. I told you earlier that Flight Control was probably one of the more arrogant organizations, and deservedly so.

But a lot of things that happened, it was just on the line. It's the kind of thing that says, "Sure. Wouldn't you always want to entrust everything you're doing to a bunch of twenty-seven-year-old kids?" [Stephen G.] Steve Bales was twenty-seven, twenty-eight years old when he was in the Control Center. Fortunately, they'd simed [simulated] that case, and [John R.] Jack Garman had seen it before and Jack was in the backroom, so they knew what they had. But still, I've heard from the guys that were sitting just behind Steve, that he didn't exactly announce that to the Flight Director in his calmest level of voice. Don Puddy told me, "The hair stood up on the back of my neck when Steve—." [Laughs] I worked for those guys back when Don was the Division Chief and Steve was my Branch Chief and Deputy Division Chief.

So Flight Ops definitely had an attitude, and we weren't the only ones. The Engineering Directorate had some prima donna organizations that they had, and Mission Planning and Analysis was the same type operations. So like I say, it was everybody working against each other for a common cause. It was competition for the best way to do things, and there was nobody going to give an inch until it was decided.

WRIGHT: Are there any other areas or anything else you can think of today that you'd like to mention about these two areas?

HOLT: On Apollo or Skylab?

WRIGHT: Yes.

HOLT: I'll take a quick look here and see if I wrote anything down. You've asked a little bit about the transition from Apollo, and Skylab literally was that transition. And the thing you remember so much about Skylab is that during the flight, anything that was on the news—and there wasn't much—always started with "the trouble with Skylab." [Laughs] So it was always, hey, we're never going to get a break on this program. Then Jules what's-his-name from ABC [American Broadcasting Company]—

WRIGHT: Bergman.

HOLT: Yes, Jules Bergman. Bergman did a hatchet job on us. The crews every so often would get up and do something. Al Bean's crew ran around the water tanks up there, and Jack rode the bike all around the world. Bill Pogue was up there on the anniversary of flight or something like that. Pogue was up there in an old aviator's leather helmet, flapping his arms like a bird, and Bergman uses this as the backdrop for his hatchet job. And it's like, oh, god, you know, it just can't get any worse than this. So we knew that Skylab got off on a rocky start and we knew it was going to live with us through the whole thing.

But the kinds of things that were really neat were mundane. Ed Gibson got up there with grape soda and a drop of water and he put them together. Well, when you put them together, they didn't mix. There was a line of grape soda's on this side and water's on that side, and it was like, wow, look at that. And it's not intuitive and it's nothing that could prepare you for it.

Then you also found out that things like you take a glob of water and reach over and touch it with a spoon, it'd stick to the spoon regardless. So surface tension is a very powerful force. And those little things like that, you knew, later on in your career, that it's like, oh, but surface tension is a more powerful force than what you're dealing with here. So it was those kind of things that says, don't talk to me about it, I saw it.

We played around with the comets. We did all the stuff with the sun and watched the Earth resources. So we had a pretty good idea of what you could do from space and we had a pretty good idea of what people could do. So I think from a grounding standpoint, a lot of what I did through my career, that was a perfect basis, because I didn't have unreal expectations of what you could do, and I also didn't have expectations of what PIs could do and what they couldn't do, and it helped a lot. Guys that suffered through Skylab tend to know that they suffered through Skylab. So there was a lot of things that just kind of happened as we wove our way into

the Shuttle Program, that probably happened really smoothly because so many of us had experienced that that says, yeah, we won't do that that way again.

WRIGHT: We look forward to the next session so we see how you applied that lesson, and all your work on Shuttle and Station.

HOLT: Sure. It was fun.

[End of Interview]