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ORAL HISTORY TRANSCRIPT

FRANCIS E. "FRANK" HUGHES
INTERVIEWED BY REBECCA WRIGHT
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This interview with Francis E. "Frank" Hughes was conducted on September 25, 2013, in Houston, Texas, for the NASA Johnson Space Center Oral History Project. The interviewer is Rebecca Wright assisted by Rebecca Hackler.

HUGHES: My kids got really interested in this business, just that fact that we're doing it, because it's that same thing. They were part of it. My kids would come over and fly the simulators.

WRIGHT: How fun.

HUGHES: It's true. I had my son, when he was five, I had some kind of meeting on a Saturday, and this is [Space] Shuttle stuff, of course, and we had the Shuttle Simulator, and it was up running because we were testing out software. He said, "Can I get in the cockpit?"

I said, "Sure."

The Raytheon guys, now, but the Link [Division of Singer Corporation] guys at the time said, "Oh, yes, we'll watch him. Put him in the commander's seat." Somebody rustled up a couple of phonebooks so he could sit there and look outside, and he's just sticking around (using the hand controller), watching the stars going around. Because we didn't need anybody in there, they were throwing switches and running the computer from downstairs, but it was an on-orbit kind of thing, so he was just flying around.

I finally got through with my meeting, and I went up and I said, "Come on down." I stuck my head up the stairs and said, "Okay, come on down, we got to go.

He said, "Oh, okay." He didn't want to leave, but it was out of fuel. He'd run it out of fuel, RCS [Reaction Control System]. I had told the guys not to refuel him because it would have been harder to get him out of there. He climbs down with me and then all of a sudden, he goes off through the cabinets going somewhere in a hurry.

I said, "Where are you going?"

He says, "I'm going back to see the engines."

I said, "We don't have any engines."

He turns around and says, "Uh-huh!" He was there, that whole vehicle was behind him, it was just the perfect in his mind. He knew those engines were back there somewhere. That's what this thing is for, just suspend the disbelief, here he is. It worked for everybody. If you really got to fly it, we always knew if we'd come down and their armpits were all sweaty, we had a good lesson.

WRIGHT: That they really felt it?

HUGHES: Yes, they were there.

WRIGHT: I was going back through my notes about a couple of things, and since we started just chatting about simulators, I know you had mentioned that the designs of them all were to help provide as much real-time training as they were going to need, and it needed to be as close to real-time, real configuration. I think one time you mentioned that you all had used some type of

tape strips that had some pictures, and different things that you would have to weave. Could you give us some details about some of those that really seem to be odd now because everything is so computer-generated?

HUGHES: Digital, it's going digital, sure.

WRIGHT: You really had to almost hand-knit pieces of information or data so that it would create this whole type of simulation that they needed.

HUGHES: Just to go back, let's go to Apollo in general. Remember, when I got there, the first piece of the first gear is arriving. It turns out that this company called Farrand Optical [Company] put together the visual system. They got the contract to do both the LM [Lunar Module] and the Command Module visual. It was a mix of TV/video, film, and remember I talked about the star balls, that was the thing that had the steel balls mounted on a sphere.

In the case of the film, they found somebody that had a really good globe of the Earth, it's about five or six feet in diameter, big one. We didn't own it, but they went to it and they exposed photos of it. They turned the Earth, and this big camera that they had made up—it was almost like an early IMAX—it was a big, 5-foot-inch-wide film base, we had to go special and get a contract from Kodak to give them the film and make it ready.

Actually, they used something that was working on a reconnaissance airplane at the time. That is, they would shoot this film as the airplane flew across enemy territory. They never told me what airplane, so I figured it had to be SR-71 [Blackbird]. It was one of those things where nobody wanted to talk, so it was from the U-2 and then that same camera I knew for a little later.

What it is, is that it would expose linearly. There was a mirror that reflected onto the film so that looking out the window, there would be a porthole looking out the airplane, and then it would expose the film in strips. It was so good you didn't see, they stayed right there.

For the airplane flying over, or for now our road turning underneath it, it became the whole Earth. It was about 5 inches wide, which, at our altitudes, was at 250 miles wide. We were only at about 150 miles, so we would never see the edge of the film; we would just be flying down the middle of it. Today, in digital, if you change your orbit, the film would change a little bit. The place you'd see would be different later, but this thing, you just flew down the middle of this film. It was 16 orbits worth of film, so when you put it in the Apollo Mission Effects Projector it would fly along like you'd go through a whole orbit. It was 90 minutes, and then the film would just morph in.

When they went around the globe and went around the globe, they moved it just like the orbits were tracking, like you were tilted, the orbit angle is tilted. In fact, there's a funny story about that because Pleddie [M.] Baker, this good buddy of mine, we all work in visual, and when we were trying to accept the simulator from Link, we had to let it run 12 hours. It meant you had to put it in run. Later, we had a thing called "fast time," or "step ahead," where you could jump ahead, but it didn't work right now. It meant you had to crank the sucker up and run 12 hours because this big film, there was actually only enough room in one cassette to have eight orbits, and then you'd have to switch to the other cassette, to continue on for the other eight orbits, to get through a whole day.

Then, you could go back to the first one, and so on, if you were doing your flight around the Earth. The only time we used this is Apollo 7, Apollo 9, it's the only time we stayed in orbit. We had to stay awake and let this thing run 12 hours—it started at, noon, it probably never got

going at noon—it was 2:00 or 3:00 in the morning when it was going to switch to the other cassette. We had to be able to say yes, that it worked, check off an acceptance because it's like one of these DD250s, or whatever the hell it is, the government's going to pay for what it does. It was some form we had to fill out. We're sitting there and I'm on the console, we took turns, we just wanted to make sure it didn't die, just it didn't keep running long enough. I said, "Okay, Pleddie, it's about 20 minutes, you're going to be ready."

He had fallen asleep by now. In the simulator, the way it worked, you laid on your back so that the three crewmen are this way, and that allowed you to stand up in the lower equipment bay where you did the navigation, looking out the sextant telescope. That's a perfect place, it's 3:00 in the morning, what are you going to do? He was still alert as possible, so I said, "Pleddie, we're coming down in 20 minutes."

He goes, "(mumbling.)" He was giving me the answers, totally asleep, sitting there with his eyes opens.

I had to grab him, I said, "I am not doing this again tomorrow night—stay awake." Then, I said, "I'm coming up, too." We sat there and watched the damn thing and then we went home, just this cassette change happened.

This Rube Goldberg thing was wonderful, and I've got pictures, I can show you some of this. That was called a "Mission Effects Projector," and the mission effects were that you'd see the Earth go by. The film as such, as it goes by, you could turn up so you could see the Earth, so you had to see the horizon, and later, you'd see just stars. Those plain stars were great, but if you had the horizon, then you had an occulter that blocked up the stars; otherwise, you'd see the stars through the Earth. All these things had to go on to make it all work right.

Like I say, we've got a couple of these, and people in Binghamton are trying to get them and put them on display, like as a permanent museum display, because it's such a marvelous device. To get it run again would be awesome, but I just wanted one of the star balls, and put it in my living room. They're just great. It used to be one system around here, somewhere. If it is, sometime we'll just take you and show you. I know the Smithsonian [Institution, Washington, DC] has about five star balls up there, and some have disappeared. I really don't know where they've gone.

All of this input is combined, different angles with beam-splitters. Beam-splitters, it's a half-silvered mirror so we could combine this imagery together, so the optics from the TV camera that shows where the LM is, and then you'd have the stars, and then you'd have this MEP, this Mission Effects Projector, showing the planet. We'd show a moon, if it's off in the distance, or we'll show the planet you're closest to; it's a big thing, with material going by.

Then, vice versa, when you get to the Moon, all the same has happened. They found a good-size Moon, it was funny, because the front side of the Moon was really good and the back side was almost ridiculously smooth, because all we had is that one picture taken by the Russians, so we didn't know anything about the back. They just made up stuff and put it on the back. It's like that piece of paper I signed, that was some kind of a safety report we have to do once a year. I know nobody's ever going to read that sucker, but we just spent the time to do it, and then I had to sign off and say, "This is what we did," which it is, but nobody's going to look at it.

WRIGHT: How much did you change the planning and the training as we moved through Apollo 11 and 12, and of course, 13 was a different episode, and then you had 14, and then, of course, the science missions with the [Lunar] Rover began.

HUGHES: It changed every time. [Apollo] 11 to 12, we talked about that, Pete [Charles Conrad] and those guys were really good, and they were ready to go. They were prepared to land on the Moon. None of us thought 11 would make it, I mean, just statistically, something had to go wrong. That was why when we were in the [Mission] Control Center and they did land, I remember Bob [Robert L.] Pearson and I were sitting there, he was the LM guy and I was Command Module in this position, in the Flight Director SSR [Staff Support Room].

He said, "Son of a bitch."

I said, "Goddamn." Shook hands, and then we went back to work because at T+1 minute, you had another change to abort out of there, and then there was another one at T+10, and finally after T+10, they had one that said, "We're going to stay for X hours. " I think it was 6. It was only after they stayed that we kicked back and said, "We really did this." There's so many things that go wrong, so [Apollo] 12 was geared up to be the crew that landed. When Neil [A. Armstrong] and the guys landed, they got just really relaxed for 12. That was really easy, and for 13, too, because both of those crews were so well-trained. They were really eager to land on the Moon, to be the first ones, so they were ready to go.

From July, it was November for 12, and April for 13, and then we're just bringing them along because we're going to land on the Moon right away, as soon as possible. When the landing occurred, it just got really smooth and easy, and they were way up in the learning curve. They were just ready to go. The simulator was peaked out; it was ready to go, too. When we

came back out of 11, the things that we had to fix were things we've talked about already, procedural changes, but there was nothing wrong with the LM computer.

As soon as you turned off the damn rendezvous radar, it was just happy as a clam. Every job like that—there was no alarms, it came down and landed. They also came down, and we realized that they had real serious problems with the quality of the photos we were making our decisions on. So then, we started feeding back from the Apollo 10, the 8x10 pictures the guy in the CSM had taken. Now, they were going back and said, "This is the landing site, this is the best we've got with really good cameras in orbit." They were feeding back in, so our landing site reconnaissance was really good. We didn't miss a lick after that.

We landed just where they wanted to land, the only one on 12, the point they would like to land near that Surveyor [3 unmanned lunar lander], which is right on the southwestern edge of this crater, because of the nature, when he came in and pitched over and saw it, it was easier for him to fly across that crater and land on the other side. Because he was unsure how soft the edge of that crater was going to be, it was easier to just fly past it, and then they just hiked about 100 yards around the other side.

When you did these landings, there were changes, going on.

There were changes coming down for the spacecraft, just changes were coming all the time, so there was always these packages of updates to be inserted in the simulator. The flight software got better and better, then every time we knew about a problem, that we knew about, they fixed it. MIT [Massachusetts Institute of Technology, Cambridge] was doing great. Luminosity, I think, became the LM software systems, and then Colossus was the one where—they were always C's or L's—and some of the names are great. I was going to go back and bring in my notebooks of those times because I've got them all, meetings and stuff like that. The

people were really, really working good, and our instructors got better because they knew everything they needed to know.

After 12, then, I didn't go to Houston anymore. That was the first time I was there. I saw 13 launch, and I mentioned the fact I had this friend with all the high school student girls, and it was two weeks before that that they asked me to go to Houston. That was the beginning—Skylab raised its ugly head here because they said, "Well, we'd like you to help us." They were going to build a planning system, an astronaut planning system; it's like a flight planning system.

I said, "That's all right. I like doing this [in the simulators], but I'll come down and visit, but no."

After 13, then they said, "How about you go temporary detached duty, TDY? You can work at Houston three weeks and go back home for a week, so you don't have to sell your house."

I said, "Okay, that's good." I did. So this is now 1970, and through that year, I literally—I had this house, but it was a good thing I didn't have a dog or a cat, they'd have all starved to death because I was gone all the time. It was great; I had kids in the neighborhood mow the lawn, and all the standard chores. What happened is I came down and I worked for, let's see, have you talked to John [W.] O'Neill? Have you gone through his stuff? He was a Branch Chief in this group, and Tommy [W.] Holloway was the Section Head that I worked for. There were two sections there—he was the one with the Flight Planning guys, FAOs [Flight Activity Officers], in the Control Center.

I was working for another guy named John [B.] Cotter. John's gone now, I believe. He was an interesting fellow. He came out of General Dynamics [Corporation]—he worked on the B-58; he was an airplane guy. B-58 was a thermonuclear bomber, where it would fight its way

into Russia and drop its bombs, and then died because you couldn't get back. The bombs were so powerful that for the crews that they had one nice idea. They had this procedure where you'd come in at supersonic speeds and then you would climb up, going as fast as you can, climb up, throw the bomb out, and then you'd go back the way you came in, so the bomb would still go high for a while before it starts falling down, and give you just some—it was a widow-maker, for sure. If you're throwing bombs that way, it doesn't make a damn dent in the whole world.

Fortunately, we didn't have to test all those procedures. They dropped a lot of test bombs out in the desert, so they knew that the maneuver wouldn't work, they would fire the sucker off, going really fast up in the air, and then keep on pulling the nose up and flip over and head back. It's a great airplane. It's the first one, there's so many first things, that's the first airplane for the Caution and Warning System, they had a voice that says—and it was a female voice. The guys would always perk up at something like that. It would say things like, "You have a fire in your left engine." It was crazy.

WRIGHT: "She's talking to me."

HUGHES: Yes, exactly, so whoever that woman is at Garmin, the one that does all that stuff, it's her prehistory person that did all that. It's always nice, better than the irritating alarm that you got with the master alarm in the Orbiter or the Apollo vehicles.

WRIGHT: Yes, it's a good try.

HUGHES: I came down to Houston and met all these new people, and Apollo's going on, so I have one foot there and now I'm doing something new, so I come down and it was really great. It's after the second trip, I knew that this was a good deal because they were going to pay me $25 a day. That was the per diem to come down here. After a week of staying in a hotel, I went down on NASA [Road] 1 and got an apartment, because I could stretch my per diem dollars. I just kept it for a month at a time, and that was great living. I was right on the lake there, in Seabrook [Texas].

That turned out to be a big deal for a lot of reasons, just met really great people, but along the way, in this new job, they were starting out, Apollo flight planning is going on. It's totally a manual process; you literally had to write in procedures that you were to do. People had to type in little squares of what you had to perform today. Of course, it's changing all the time, everything's going on. The vision in the new job I had was that we could find a way to do this on computers so that you'd get it done faster and better.

There was a bigger project that they had, it's called a Mission Ops [Operations] Planning System, which became MOPS, of course, in the acronym world. The thing I was working on is the Activities Scheduling Program, this is a subset of it because MOPS would also have procedures in it. The ASP, the Activities Scheduling Program, the idea was that you invented little schedulable entities, so the crew would do, like it says, "post-sleep" or "pre-sleep." Every one of those things would have precursors and successors, so you couldn't do a successor until you had scheduled "pre-sleep." Like "sleep" had to have "pre-sleep," and then before "pre-sleep" would be probably "eat meal." It's easy you think that now, but this was really new stuff.

The short story of this is it never really worked very well. We worked for two years, we worked for that year through when we started flying in '73 on Skylab, and we used that all the

way through. It got better and better, but you could produce whole pages of flight planning material, and now, you had pre-arranged what would be in that block. So, then that block would appear on the screen, it'd say this, and here's three guys—you've seen the flight plans and now you know the way they look. But, here's three crew guys and all these little things they have to do. If you wanted to shuffle them, move something before something else, you didn't have to have somebody sitting there with a typewriter who would retype the whole page. The ASP just pulled it all together. It never worked as well as we wanted it to, through the whole Skylab program but that ASP kept on going and by the time in '78 when we were ready to start doing Shuttle flight plans, it had really grown to be a really useful thing, and now, it's the pinnacle of what you can do. It's so flexible in what you can do.

Along the line, it infected your life and mine because one of our programmers—McDonnell Douglas was one of the contractors—and he took the software, the way it was at the time, and went off and started his own company. American Airlines started using it, scheduling their [flights], and it was SABRE [Semi-automated Business Research Environment]. You remember that name, it was one of their selling points, "Fly on American Airlines because we have SABRE Reservation Systems." All the things then, you had to call and talk to somebody, but they would be able to, using SABRE, put you on an airplane. They could see what seats you were going on, that you became a scheduling entity, and that system put you on that airplane. The airplane itself is an entity, where it's going to be and what days it will fly and so on. That [software] went off into the world, into the wild, we always say, being used by everybody. That changed the way you're living today.

Now, you can sit in your own house and do your own scheduling, but the kernel back in there is the old ASP, that it was done. I don't know that anybody's doing a better job. That kind

of software became just part of the way things get done. Somebody might have come along and done some other things; I just am not close enough to know how they're doing it different. It's just a linear thing, always cross-connected between every item and everything else on that schedule. At the time, what we were stuck with was not the idea; it was that the computers weren't good enough to do the heavy lifting you had to do to do all this checking and comparing. It was just too damn slow. The displays were not good either, so you didn't get the resolution you needed to get these little tiny words in the little tiny boxes.

Even by the time we ended [Skylab], we actually had better display and the hardware had improved that much, so you could see stuff. It was going on, and then we'd actually print that page, and then you hand it to the crew, and they would take it with them in orbit. As we flew—and we'll go back and talk about Skylab—every night, every evening, crew would go to sleep, we'd be doing the flight plan for tomorrow. Based on everything that happened today, what you planned to do tomorrow. Put it all together, and then third shift, we'd actually put that plan into the ASP and then create an uplink, and we'd send it up on a teleprinter on board. The format was little boxes for each guy. They'd wake up and there might be 30 feet of teleprinter paper floating out of this thing.

We did [Apollo] 13, got them home, we went through all through the fall, and 14 occurred in January. The biggest problem we had for Apollo 14 at that time is that the crew was out of shape. This is [Alan B.] Shepard and Ed [Edgar D.] Mitchell, and they didn't do anything physically. Al was smoking until the day he flew, had no wind at all. Mitchell was another one of these guys, I can't say he's a couch potato because what he was doing is always communicating with nature or something, but he figured he was going to just transport over to

the Moon mentally, without having to worry about it. It was a physical problem, and everybody knew that this was a problem.

All the stuff we did I've told you about, we'd go out in back and we'd land on the Moon, then you'd go over to the other simulator and get out, and get in the mock-up, and come down. He'd get out, he'd be out of breath coming up and down the ladder of the LM in 1-G [gravity]. Then, they'd step outside and sit down and get on the Rover, and that was okay because then you'd drive around. But 14 didn't have a Rover, they had a [modular equipment transporter, MET], so now they'd only go around the parking lot. They couldn't have the stamina to go as far as that flight plan said they would go.

This thing was star-crossed from the beginning because when they landed exactly where they should have in *Fra Mauro*, then they were supposed to hike up to see [Cone] crater. They quit about 50 feet away from where they could have seen into the crater, but they ran out of juice. They just didn't have the stamina to do it. It was like a [two-wheeled] golf cart, you had to pull this thing. I'm sure that it was a pain to do this because it's loose-packed soil. It's like doing it on beach sand, but if either one of them had just got in shape, I'm sure we'd have successfully gotten through to see into that crater.

[Apollo] 12, we'd looked in the crater, we'd skirted around the crater, we got in the crater, we did everything we wanted to do. Also, the automatic system worked, the landing took him right to where he was supposed to go. There was considerable concern as far as him able—he took it over at about 200 feet and landed. The instructors worked and worked and worked on that. Remember, this [Shepard] is the guy we had to fail everything except pulse mode, is what I'm saying, failed hand-controller. He got through that. He and I were never really great friends, actually, after that.

WRIGHT: You made a lasting impression?

HUGHES: I didn't care who the hell you are, I'm trying to keep you alive, you damn fool. He was a great guy. He was actually a fun guy, he always had that gotcha, he always had some kind of a thing going with somebody. Yet, he didn't want things to happen to himself. During that time period, I was working with some guys, this is before [Building] 4 South was built, so the front of the building looked down a parking lot and it was right there, it was for the astronauts between [Buildings] 3 and 4. He came in one day, slammed into his parking [space], so you know, just high-speed turn, stop. Al's always got to be cool, so then the window rolled down, and he'd reach up with his hand and put some stuff up on the roof of the car, like books and coffee, stuff like that. When he would climb out, he would be cool, close the door, and then grab the stuff and walk in the building. He did it a lot, and this was his thing, so we'd watch. One day, a gust of wind came up and threw everything all over the parking lot, and that was like the best thing. People were talking about that for days! They enjoyed seeing watch Al scramble all over the parking lot picking up pieces of paper.

WRIGHT: Comic relief?

HUGHES: Exactly, it was like, "Oh, Al, that was a good move." None of them were willing to say that to his face. [Apollo] 14 came and went. On the 14 software, now I'm still working on Skylab, and so I've still got these two-tracks I'm playing with.

WRIGHT: You had two jobs.

HUGHES: Yes. I went up to MIT for a lesson that would talk about the software, what it's going to be for 15, 16, 17. This is about a week before they flew 14. Of course, it's January in Boston, so it was colder than whatever. I got sick. I got a cold, flu, whatever. I was miserable, and I was sitting there one night, and feeling pretty damn bad—you never should get sick on a trip, you know how it is, just a terrible thing to do—I'm sitting there and I've got all these keys because I've got a house in Florida and I've got my car at the airport, and then I had an apartment in Houston and I've got a car at the airport—because it was a short trip, I didn't turn the rental car in—and then I've got this hotel here, with a key, and a rent-a-car outside. All these keys, I'm saying, for what the hell? I was always leaving something behind, but this is how my life was at that point. I'm already sick, and I said, "All right, I surrender, I'll move to Houston. I got to do something with my life, here it's kind of out of control."

I got back to Florida. I didn't even go back to Houston, I was feeling so bad. I went back to Florida, I called somebody and turned in the damn car. I said, "Go get your car, it's here, I'll send you the key in the mail." Cut that thing off. My apartment was fine, and I stayed down there about a week and recovered, got in the sunlight, forget that winter temperatures, and I was good. Then, I headed back to Houston again. Then, I went in and talked to [Donald K. "Deke"] Slayton and Warren North. I said, "All right, I'll go."

They both said, "Okay, we'll set up something, we'll do it."

Within four weeks, I was a Houstonian. I lived in Houston. I just kept on doing what I was doing—they just made me full-time down here. There was no going back. I put the house on the market and sold it, it went quickly. Poof, it was gone. That part was nice, but it meant

that I started decoupling from the Apollo thing because now it's getting full-time, so 15, 16, and 17, I knew the guys and worked with them closely, and I kept close in touch with what was going on in Florida, but I didn't have the same one foot in it all the time.

Now, I'm following along with Pete and all the guys I just worked with, now, he's the first crew for Skylab, so we're starting to not train, but plan and meet about how the hell Skylab is going to be. Because I'm in Houston now, I'm with the simulator designers for the Skylab Simulator. The Skylab Simulator was a very, very interesting device.

Let's finish Apollo, though, just to go through these things. [Apollo] 15, I still had a lot going on. I had spent a lot of time with Dave [David R. Scott] when he flew earlier, on [Apollo] 9, and so, now he's the commander, so he really wanted me—literally, he requested me to be part of this training process. I would come to Florida, once in a while. Now it was opposite, I was a Houston guy and I would come to Florida to sit on some sessions for like a week at a time. It was about to make sure that his new guys were ready to fly. This is [Scott, Alfred M. Worden, and James B. Irwin].

Al and I, we were close anyway because he was a backup crew on some of the other flights, so I knew him. Jim Irwin was not as close, but we got there. We worked on the navigation elements to make sure they were ready to fly. By now, the simulator is doing really well and the instructors down there that were remaining behind were great, so I never had much to do with that. It was just great to see how well they were performing it.

That's a problem, though, 15 was the one where the life scientists decided to change the diet, and they sent them all off with not enough potassium in their food. What meant that they were okay on the way to the Moon, and Worden was okay because he never got sweated up at all, but Dave and Jim, when they landed, they had a Rover with them, so they planned to do three

EVAs [extravehicular activities]. After the first one—they worked hard and they got sweaty and everything like that—they sweated out all the electrolytes, so by the time they got up and did the second one, the second day, Irwin, who died of a heart condition anyway, they were throwing PVCs. These are Premature Ventricular Contractions, so it's like an incipient heart attack. They're watching on the ground and this is not good, this is really bad.

They had to throttle down the third EVA, where it was supposed to be another trek on the Rover, and go into Hadley Rille. They had to throttle it back, and I think Jim, they made him only stand up and take a panorama—they depressed that LM, but they just opened the upper hatch, the one which would go to the Command Module, and he just did the 360 panorama with the cameras. That one went off pretty well, and then when 16 came along, now this is Charlie [Charles M.] Duke, John [W. Young], and [Thomas K.] Mattingly, who's now recovered from his measles on 13 that never occurred.

Again, that was a good crew, and they were very relaxed. Now, you go to the Moon, it was like everybody knows how to do this, it's not a problem. They had a great time getting ready to go, it was very relaxed, they were already knowledgeable because they'd been backup crews already or the prime crews. John, this is his *n*th flight, you know, he's got two Geminis and this is second Apollo, so it just worked out very, very well. They landed well, the lighting was good, they had great EVAs, they went out and performed really well. This is the flight they would race around in the Rover—they wanted to do the performance tests of the Rover, and that was really, really well done. They drove somewhere away from the LM, then Charlie would get off and take pictures and videos, and then John would race it round and just put it at top speeds in front of Charlie.

I always look at those videos though thinking that anybody who didn't believe we went to the Moon should look at those. If you looked at those pictures, there's no way on Earth you could do that because it's dirty, it's dusty, but when the dust would fly [from the Rover], it would fall flat. It didn't hang in the air. It would just fly in a parabola and just crush down, and then when you stop, the dirt that was in the treads, it'd just fall down. There was no dust hanging in the air or anything like that. I tried to talk about [it with] somebody, one of these crazies, like that, and then I just gave up on it and said, "They don't believe, they're not going to believe, doesn't matter what kind of logic I am using."

This is the flight where the crew had the orange soliloquy, where they put so much potassium in the food, so that everything tasted like you're licking the bottom of aluminum pot. Too much potassium chloride. Then, of course, they got into the thing where when they got back in the LM and then they stripped down, it's like little kids in snowsuits. Did you ever have your kids when you're cold, and you have a onesie, kind of like a snowsuit thing, and you strip out a part of them [the top half] and shove down. Generally, if they're cold, you just stuff some hot chocolate into [them] or something like that. They just have [the suit] down around their legs because they're cold. Ultimately, you get out of it, but you just feed something warm to them and they feel better.

The 16 crew was starving, as they come back in from the first EVA. So [they] signed off for the night from Earth. They're standing side by side in the LM, they were not ready to put up the sleep bags, but they're standing there, so they shove the suit down around them, down below their waist. Unfortunately, the push-to-talk on the comm [communication] system made connection—so the comm cap that they're still wearing is hot. Now, they don't know that they're transmitting back to the Earth, and that's when these two salty dogs are talking, they

think, among themselves, and about—it was just farts. The potassium chloride in the food gave them incredible gas, they could barely stand themselves, let alone each other—and the cabin is only this big. Going on, like that, so John goes on, he says, "I'm never having another f------ orange in my whole life." He just goes on and on, and it's great. You have to find it in the transcripts. He says, "I don't care what the Florida industry says." He just goes on and on. It is great.

Meanwhile, I can't remember who was the CapCom [Capsule Communicator], but they're all breaking in, it's like, "John, John," and nothing would stop them from talking because, of course, they're just unwinding. They finally sent an abort alarm to them, they turned on the abort light on the console. Then he finally says, "Yes, Houston, what?"

Capcom says, "Make sure you switch off push-to-talk." That ended the long public - private conversation.

WRIGHT: "Let's do one more thing."

HUGHES: "Just one more switch throw tonight before you go to sleep." That's how they couched it. The air-to-ground is going everywhere in the world, so it was great. That was 16, and that's not the only thing I remember, but the hardware's working good, the Saturns were working good, confidence is great. Along in there, somewhere between this time, we ordered 10 more Saturn Vs. This is also the time, in '71, where Congress said, "That's it," OMB [Office of Management and Budget] somehow, Vietnam [War] is getting bigger and bigger and everything. So, when [President Richard M.] Nixon came in '68, I always hated him the rest of the time because he didn't let [President Lyndon B.] Johnson at least go out on the aircraft carrier to see

them come back, because Johnson is who was instrumental in the space program. But Johnson had this great meeting with them later, so that worked out. OMB said, "No more after 17." So, that left three Saturn Vs left over, and then they canceled the order for building any more. That contract actually never occurred.

WRIGHT: You mentioned you were working on Skylab, but this was also about the time the announcement was made that the Shuttle Program had been approved by the President.

HUGHES: Right. He put it together at that time, I think it was '73 or something like that when he said, "We'll do this Shuttle." That's why the design kind of froze way back in the '70s, that's why we have such—not terrible computers, but they were very early, design-wise. The whole Shuttle computer is 128k.

WRIGHT: Yes, so there was a lot going on.

HUGHES: Just right there, everywhere, it's going on everywhere.

WRIGHT: During that whole time-span.

HUGHES: At that moment, I didn't have any hands at all on Shuttle because I was just buried in Skylab. I became an FAO, when we flew it, Flight Activities Officer in the Control Center, but getting this MOPS/ASP thing running, and then we started training the crew. I'm going to stop for a minute, but there was a big mock-up, and it is the one that's over at Space Center Houston,

that used to be in Building 5. All of the pieces, we should take a walk around there sometime. But the Skylab simulator wasn't put together, it was broken in pieces so that you could have different people training in different parts of it at the same time. Instead of have one big thing, you'd separate them by 10 feet, and have another piece of it. There was an MDA, this is the [Multiple] Docking Adaptor that you docked the Command Module to it. Then there was an airlock piece, then there was the workshop itself.

That helped us schedule a lot because there's these three crews, plus a backup crew, all this sort of thing was going on, support crews. At that time, it's the first time that I met a lot of new people because that's when the [U.S. Air Force] MOL people came in, the Manned Orbital Laboratory. That's [Richard H.] Truly, [Robert L.] Crippen, a bunch of them, [C. Gordon] Fullerton, they were joining us for the first time. They're all military—Navy or Air Force, whatever—all had been assigned to fly on the Manned Orbital Laboratory. Suddenly, then, there was Crippen and Truly and the people working on Skylab, too, with us.

Then, we began to form up, well, who's going to be in the Control Center, and it's a whole different thing because now we were going to look at a long-term flight, where 10 days was a big thing for Apollo, but now, we're 28 days since the first one for a first flight. It's going to be 4 weeks, 8 weeks, 12 weeks, so it was going to be 28, 56, 84 days in the [space station]. That was a big deal, so what is the schedule of crews? We put together there would be four teams for the first flight, we would go through this whole thing. The second flight, there was going to be still four teams, and work through the second, but the longer one, by then, flight controllers and flight crew trainers got drafted in to make a fifth team that would work the 84 days.

We had more ideas how we worked so we had different ways that people would shift over. They chose almost the worst thing they could. Every time you got back to work, you worked on a different earlier shift, as opposed to a later shift, which gave them more rest-up, which should have survived, but that was the [reason], I think, a lot of divorces came out of that schedule too, because we just did not think through, or we didn't have anything knowledge to base on..

We should have gone asking people, like FAA [Federal Aviation Administration] and people that did shift work, "How do you do all this stuff?" We manhandled that through, but the simulator, there was a Skylab Simulator being put together by Stan [Stanley] Faber's guys over there in Bldg. 5. The simulator guys that have been working still all the time in Apollo, and in this case, how to train the Skylab crews.

Skylab had four major segments in the program. There was medical experiments, there was ground resources experiments, they called it Earth Resources Experiment Package, EREP, there's a solar telescope that had six different instruments in there, and then there was another set of experiments called "corollary." Corollary was all the cats and dogs, they didn't fit in one of these other three big categories.

WRIGHT: I think I'll adopt that word.

HUGHES: Yes, corollary stuff, it's a great word. Just sounds, like, really smart; it means "everything else." The corollary experiments were really interesting stuff, did everything, but, like, in the medical ones, first of all, everything we did in there—all the food you ate and all the

waste, we measured how much you ate and then we kept all the waste. The urine was put in bags—next one we'd do before we leave Skylab, let's meet at Space Center Houston, okay?

WRIGHT: Okay.

HUGHES: It's easier to take you in and show you what's going on.

WRIGHT: Sounds good, sounds great.

HUGHES: That simulated lab, when you used it, it was a mock-up, and then integrated into that was an electronic simulator that did the Earth resources. For the Earth resources, it was the first time we did a lot of training. You'd look out at the Earth and see a ground target coming at you and you would track it. There were four different cameras that would have different filters on them, so you looked at whatever's going by on a schedule. This was all a big schedule deal because when you did that, we would have ground truth data. That is, somebody would be in that area, on the ground, to see what the weather looks like, what the crops look like, and then there would be an airplane, one of our airplanes would be flying over the top of it at the same time, so they're getting it from the ground, from the airplane just as we're taking it from space, going by.

We did this again and again and again. We had two or three EREP targets a day. In fact, sometimes on one orbit, we would do five or six going across the United States, where people were coordinated to be there. Just to get that scheduled was a big deal, to get everybody ready to go. It had to be the orbit allowed us to see the stuff, we had hundreds of possible places, and

here's where this one track, ground track today, it's going to be the right lighting, it's going to be everything, and we'd say, "Okay, this is what we're doing."

The people who cared about that were really good at making sure it was ready to go, then they'd coordinate all the people on the ground. Different universities along the way would put their people in the field. It was marvelous when it was planned, and of course, then all the [plan] would go to hell because suddenly a thunderstorm came on the place, and all this stuff that the real world happens. "Life happens while you're planning to do something else." It went on like that so well, though. Pete, Paul [J.] Weitz, and Joe [Joseph P.] Kerwin, so they were the three first ones who went up. I was on the team with Don [Donald R.] Puddy, one of the four teams, and it's Chuck [Charles R.] Lewis, Puddy, Milt [Milton L.] Windler, and Neil B. Hutchinson were the four teams.

[Two of] the CapComs were Crippen, who was on my team, and Truly, on another team. We sat down and I had nothing to do, I was the FAO, but I wanted to be there, in the first launch of the first package, with the workshop. Man, it roars off the pad great, it's another Saturn V going, but of course, it looks like a bullet because it's got the workshop inside of it.

About 4 minutes in, all of a sudden, people are saying—I could hear the talk from the electrical people. It had come apart. What happened is that the heat shield was ripped off very early, at Max-Q. Along the way, on the third stage, on the workshop, McDonnell Douglas had built a second skin around the outside of it, and the idea was that when you get to orbit, this third stage was never meant to be lived in, and of course, it was supposed to be used and gone into the ocean. When you got to orbit, the second skin, it was made like this [demonstrates], and so then it would clock out to get 3 inches bigger, so there was 3 inches and you have a 6 inches total size

diameter. But when it clocked out, then it provided a second skin so that if micrometeorites hit it, they would vaporize on that first level, and they'd just be a puff of gas on the inner wall.

Well, at Max Q, there's always a lot of things that happened, maximum dynamic pressure. When that happened, it ripped that skin away, got underneath there. They didn't test the stress enough to make sure it could get through Max Q. So at Max-Q it ripped it away, it tore off one of the solar wings off the workshop and jammed the other one. It was down where it shouldn't have been extended at all at this stage of the flight, but it survived and got to orbit. Now, they're in orbit, looking at it. There's another solar array on part of the telescope, and that clocked over at 90 degrees, so that's how it worked. So, the workshop is here and then this solar telescope is pointing this way.

The solar arrays on the ATM opened up, but there's no electricity coming from the one down in the workshop. Soon, they realized it was gone, one of the two wings is gone and the other one, they were only getting like 3 volts out of it, or something like that, these very small amounts when it was getting certain attitudes. We did launch the crew May [25th]. During that time [10 days], we redid the entire SL-2, the first manned flight. That's where they carried up an umbrella [parasol sunshade]. It's easier to talk to if we're in that mock-up, so we can do that next week, if you've got the time.

WRIGHT: Yes, we'll do it.

HUGHES: The crew, because the solar array's gone but because that second heat shield, it means the Sun was shining directly on the walls of the spacecraft, so it was about 130 degrees inside, Fahrenheit. When they finally went up and docked to it, they went into the workshop and they

carried along this thing which was essentially an umbrella. The workshop had two airlocks, one on the Sun side and one by the anti-Sun side. Those were made for a lot of experiments where it's supposed to plug into those airlocks. The plan was that they'd carry this [sunshade] down, this simple thing they carried down, attach to the Sun side airlock, and then opened up the outside of the airlock and shoved this umbrella out so that it popped open. Once it was open, they pulled it back in tight and tied it down, so it would create shade on the Sun side of the workshop.

When you flew, you always flew with one side pointing at the Sun because that's where the solar telescopes were going to be pointing. The MDA, where the Command Module was docked, where the electricity's up here coming from the ATM solar array. It was cool up there. All the air conditioning was working, but they didn't even turn it on down in the workshop because it's 130 degrees, with all that heat, the air conditioning didn't do anything. The nice thing about it is there's no convection in zero gravity, so if something's hot, it just stays hot and stays there. There's no hot air rise because that's a gravity situation, it means cold air sinks because it weighs more. The way this worked, anyway, they worked in just briefs, socks and tennis shoes, and work gloves, and they'd go down for about 2 minutes at a time, one at a time, to work, then pop back up, and another person would go down. The three of them worked on this for about 20, 30 minutes at this stage of the repair procedure until they got it all installed and set up.

They had to unpack it, carry it down from the Command Module—it was launched under the seats in the Command Module, a 6 foot long, 1 foot square box that had this [sunshade] in it. They carried up so much stuff that was just invented in two weeks. It's one of our classic NASA awesome weeks; it was amazing. The crew installed and got it going and it worked—that is, as

soon as they got it expanded, the temperature in the workshop started coming down because now, you have a chance to overcome the heat from the sun The only problem was when they tied it in, it's rectangular, and it wasn't exact squared, it was cocked off a little bit, so there's still some hot spots, like in top and bottom, where the Sun was still hitting it all the time.

On the second flight, then they carried a different [cover], it was a bigger canvas, beta cloth, they call it, they did it in an EVA, they went outside. Now, it's much more relaxed and you were able to put up this big thing like clotheslines, and you pulled it up over everything, covered everything, and from then on, the vehicle was fine. You still had a little bit less electricity than you were planning to have, but Pete and Paul went outside and did an EVA down to the area. Pete was actually on the array and clipped the wire, the debris that was holding the one remaining solar array. When it came loose, it came up, and it flung Pete straight out the end of his tether. He went the whole end of his tether and bounced back, and he said, "Holy shit!" Then bounced back—they went out to see him because they knew something exactly happened, and Paul was double the size of Pete, so they wanted to have the smaller one, in case he got the ride like he did get. They were able to manage the lines, and Paul was already pulling him back toward the vehicle as he was going out. They did a hell of a job.

WRIGHT: Part of the flight activities, I'm thinking that you had so many of the days pretty much lined out. Then, the first thing that happened is that the whole schedule basically—

HUGHES: Gone to hell. We had to re-plan everything. When we got through, we knew the things we had to do, there was a priority on everything, and so, now this is day one, and nothing happened. First three days, nothing happened, in the sense like that. Then, we started beginning

to do science, we get something going, but they had to get sleep, they were tired, just working in those temperatures was terrible. Fortunately, they had no problem with the gravity, the adaptation. They were just really great; all three of them were good, no sickness. They settled down, but when they finished, they got about 80 percent of what they had planned to do on that flight, which was pretty good. They worked like dogs. They worked really, really hard, but we had to do that. We had to re-plan every day.

We already knew it was bad, and you didn't know how bad it was going to be until you got there, so we just knew that we had to re-plan, and we knew the first five days were shot, and it turned out to be almost exactly that, before they even started to do any science. When they got through the repairs and they settled down, and it meant it was really great, you'd sleep, for the first time, you had a place to sleep. There were three little tiny cubbyholes, about the size of a phone booth. It's funny; I was talking to some kids lately about a phone booth and they didn't know what the hell that was. This little space that you had was just that size, and you slept on the wall with a sleeping bag.

I always talk about that, you have them on the wall because that way, you're not going to float around and get in anybody else's way. That's interesting by itself because one of the guys was a little bit claustrophobic about being in that small space, so at night, he would go out and they would take two lanyards and they would tie his clothes to the wall, so he would sleep out in the middle of the whole workshop, just floating, and you'd just have a line going to each wall, and they just go to sleep not touching anything. They got through that, then we were planning our butts off to make this thing work.

Even as bad as it was, the ASP thing had saved us because if we had to type all this stuff out, it would have been a nightmare. If it had not been working as well as it was, we'd have

been working with handwritten stuff, and then you'd have to read it up to them. Now, it would come into the computer transfer to the teleprinter, so it would talk to the teleprinter, and so we could send all these messages that were typed up like that. I'll have to show you some teleprinter messages sometimes. It's another interesting thing.

It went on and on and on for the 28 days, and then it was time to come home. They packed up, left the vehicle, really good shape, and exited. They make a perfect reentry back in, landed, aircraft picked them up, and it was good. There was three weeks or so between that flight and the next flight, and we got really ready for that flight because now we know the vehicle's going to be good, we know exactly when we're going to do the EVA and put out the other solar sail, and so on, and the crew was really ready to go. This is Al [Alan L.] Bean, Owen [K.] Garriott, and [Jack R.] Lousma. Old Jack, hell of a guy.

They got up there after launch and they got sick. I've never seen a crew where everybody on the crew got sick, but they did. This is Al, who'd been to the Moon, he's flown twice before. Part of it was that same thing, where the spacecraft was so small, there was no way to be, except in the seat, where now you had this enormous space. It could have been just when the other two got sick, the smell and everything else might have—anyway, they were wiped out, to the point where for five days, we didn't get anything done. They barely ate anything. They pulled it together finally, and the guys, they just were really bad. Owen and all these guys, they were space-hardened, devils that had done everything to get ready.

We got to go back and talk to simulations where all we did this, but in the real world, now what happened is they caused such chaos in the flight plan. The crew felt bad about it, so they started working extra. What they did is they did everything they were supposed to do on the flight plan, they caught up, they surpassed it, they went almost, like, manic, they went crazy.

Now, it's 56 days—they even begged and pleaded and they extended them three more days, so they were up 59 days. They came back; they did 115 percent of the planned work, even though they got lost the first five days on the flight. They brought up all the extra experiments for them to do.

It was marvelous, but in a way, we kept trying to say, "Slow down, take it easy," but, they'd work on their days off, their day of rest. All three together, and they'd say, "Give us a list of things that we could do if we got any spare time." It's called a shopping list, which we do now on [International] Space Station, too, but it's a different thing because it's very relaxed.

All of the flight planning tricks that you'd use today got invented right there, on that flight. The shopping list where these are things, we got some maintenance [duties] that you would like to do, but get going, and so on. It was great.

Meanwhile, the third [crew], Gerry [Gerald P.] Carr, Bill [William R.] Pogue and Ed [Edward G.] Gibson, were down, now, and they're not getting trained very well, because everybody knowledgeable is in the Control Center, anyone that knows anything about this vehicle. Their training is a little bit less than everybody else, not quite as good. They're kind of pissed about it, and we try to do whatever we can to field, push people in, "Go see how the simulation's doing." But everybody literally, we just sucked everybody into the Control Center to support everything that's going on on orbit.

The second crew finishes off, they leave and go home, everything's good, and then you get to the third crew, you're ready to go. Gerry's a Marine, a Colonel at the time, so he launches up, and we start feeding him the flight plan. They're falling behind, they're trying to catch up, but they're just working terribly hard, but they just can't do all the planned activities. Finally, one day, he calls down and says, "Houston, this is Skylab." He says, "We're going to take the

rest of the day off. We're not going to do any more work today. We're tired, we're behind schedules, and I want to talk to Chris [Christopher C.] Kraft."

WRIGHT: Uh-oh.

HUGHES: It's our first mutiny in space. Everybody finally had to stop and think, what's going on? The short of it is that we caused this problem because when Al Bean and his guys went manic, we had scaled everything, all those prerequisites on everything we did and how much time it took to do everything, they did it faster. We had modified the flight planning tool so that it accommodated what was going on because they said, "I can get that down to 30 minutes; I don't need an hour," and so on.

Now, these guys come up with a little bit less training than they should have had, and we started loading them up as though it was the Al Bean crew. We had to stop and say, "We apologize; we're going to go back and schedule the way Pete was scheduled, the original thing." Everything got more leisurely the rest of the flight. The big mutiny in space was caused by us in the flight planning world. Everybody got used to it, and said, "These guys just drive you crazy." You're looking around for something to give them to do, the second crew. These poor guys came up to get bowled over by all these jobs to do with less time to do them. As soon as they slowed down, went back to the original [plan], we had to just type everything back the way it should have been. What do you expect, this is an hour job, not a 30 minute job, and so on.

WRIGHT: Tell us about what was going on with you, and how the Skylab—

HUGHES: When it got going like this, then in that context of all that stuff, I'm in the middle of this, I'm one of the FAOs. I'm also the guy that helped to put together the ASP, so I have a second group of people behind me that are actually doing changes to the scheduling program. We went through this, going back all the way for about six months before launch, we started doing integrated sims [simulations]. An integrated sim, this would have the Control Center involved, and we had part of the simulator, but some of it, there was no telemetry because we had the crew actually inside the mock-up.

Inside that thing, there was no telemetry that would go, so we would just do it by verbal [command], "Now the crew is doing the XYZ experiment," and then we'd talk them through that. We actually had one of my guys who would say what the crew is doing just so the CapCom and people would know, because there was no telemetry coming out. It's not like with the electronic simulator. The simulator only did solar experiments or Earth resources kinds of things. They didn't do corollary experiments; those did not generate telemetry anyway. This was a decision they made long ago, that it was too damn difficult to do this kind of simulation.

The medical experiments, we wired them up and we did that kind of monitoring, and we'd go through this other data coming down to the MCC. We actually had some sims with the MCC while we were flying another crew. But there was not much of that, the system was too taxed to do the real flight anyway. That's when I told you about that we wired them up and the flight surgeon came on, he said, "How did you get this tape?" We had somebody from our group put on a [monitor] and we recorded his heart, and then we played it as though it was one of the astronauts. Then we'd pretend he's got something wrong with him, and prescribe some medicine. The doctor comes back to our Sim Sup [supervisor] on the console and he said, "Where did you get the tape?"

I said, "We just suited up one of our guys and did it."

He said, "Let me talk to him." The guy was almost having a heart attack, a real thing. The MD on the console diagnosed this guy, he saw the signs of what his heart did and they immediately went to the hospital. That was pre-stent, I mean they had serious problems. He survived a few more years because of that incident but he heart did him in finally.

WRIGHT: You did him a favor and didn't know it. My gosh, saved his life.

HUGHES: Yes, exactly, just mentioned. Only for about five years. He actually had problems later and he died. He had a serious problem, we just happened to choose him because he's the one that knew all the systems. He said, "Just record me." He instrumented up and he recorded all the data and sent it over there. It was amazing, really something.

WRIGHT: It is.

HUGHES: Along the way, then, you can see all the interesting coincidences. Now, I'm like a hybrid animal—I'm still working the simulator, and then yet we're putting the flight plan, so it becomes one thing after a while. That is, everything is how to simulate it and then how to plan it, and that makes it how to simulate it. It goes back and forth all the time. Some of these people that I'm working with, here, the people that are making the simulator play and then all of these folks, the software guys working at McDonnell or whatever, are trying to program this tool we're using. Along that way, in '71, I also got married, so I was wiped out a couple of years in there, with all this stuff going on. I don't know how we survived it, but we did.

WRIGHT: Your days were full.

HUGHES: Yes, exactly. It was pretty interesting. When I started living in Houston, this is January of '70, then I went and sold the house in Florida, and I bought a house and moved in—I was in Camino South, over here—and lived there 20 years, so that was a good home, a lot of good times. Along the way, I was a simulator guy only, then I became a ground controller, a Flight Activities Officer, and then, at the end of that, and I don't want to get too far and get mixed up, then they asked me to go back because ASTP [Apollo-Soyuz Test Project] appeared on the scene. We were doing the flight planning for that, which meant you were working with Russians for the first time, and that's its own kind of unique experience. Then, they said, "Everybody has gone to do Shuttle. Will you go be a GNC, a Guidance, Navigation and Controller guy in the Control Center because there's nobody else?"

WRIGHT: Builds your confidence, doesn't it?

HUGHES: Yes, exactly, I hadn't smeared any Shuttle stuff on me yet because I'd worked that problem earlier. That flight was 10, 9 days, whatever it was, and it was the most boring flight. I loved boring flights, it was just great. It all just launched, went smoothly, and we landed it. We'll get to that in a minute.

This time period, every day spelled Skylab, it was just Skylab, Skylab, Skylab. When Apollo 17 came, I had almost nothing to do on 17. Of course, I knew the crew well and everything, but I was consumed with this other program. Some of those guys then flopped over

and became part of the system, immediately started work with them that way. The Skylab simulator itself, the design of the simulator was done so well but so different than Apollo—it's very, very different—it was some of the best software kind of things we did, in terms of how to make it like the spacecraft is actually working. This is an IBM computer that runs the ATM, the Apollo Telescope Module.

WRIGHT: This is really your simulator, in the sense that you really had your hands on it at the beginning and prior to, either they were already there or you saw changes, but this one, you had an opportunity to really—.

HUGHES: Yes, early on. This one, I had a lot to do with it, yes. The guys who put it together, though, one thing you said, and I'll fix it there, it says "Singer" because it was not—it was Link, all that time. About this time is when Singer bought the company, and there was something called General Precision was in even before that. That name, you might not have ever heard, but that, who owned Link—I met Ed Link [company founder] down one time in Florida, and he was diverted from that whole thing. He had a submarine; he was doing deep sea diving, it was like a hobby, but he had his own Alvin-style machine at Fort Pierce in Florida. Then, the Link name started disappearing into these other companies, until it became Raytheon, like it is today.

WRIGHT: Was there a CAE [Electronics, CAE-Link] in there somewhere, too?

HUGHES: There was a CAE, yes. Even now Link has actually got two entities: one is Raytheon, and another one is [L-3 Communications]. There's another name like that that's up in Binghamton, New York, still.

WRIGHT: Yes, that's a history all by itself.

HUGHES: It is, it really is.

WRIGHT: Talk, if you can, maybe just the last few minutes, about the environment here at JSC. You've got a major program closing down, you've got a program that's up and running, you've got now the probability that we're going to be working with Russians, when all these years you had not thought about working for Russians or with Russians. Then, of course, in the background somewhere, people are starting to design the Shuttle. Is it an interesting time among the people that are working here, or is it an unsettled time?

HUGHES: It's always been unsettled. That's probably what I love around here, is that there's never a day that you go and do the same thing ever. At that time period, when I came down, I was the new guy in town. I knew a lot of people, but I wasn't a Houstonian, and so, '70 was great and I was rich, in the sense that I was a GS-11 [General Schedule pay system] by then, or something like that, but they're giving me $25 extra, which was like, whoa! My idea of that is that made a lot of friends. I actually had a party—there's a place down in Seabrook, what the hell is it called? What is the place where you go where the girls are all in the short outfits?

WRIGHT: Currently? Hooters?

HUGHES: Yes, Hooters, there you go. There was a place in that building, I think it's in a different building, but physically in that corner. I went down one night because it was near where I lived, where my apartment was, and I said, "What would it cost if I just bought all the beer or all the wine from everybody?" He gave me a price and it was very doable, and so I just put out a piece of paper that said, "Come 'round to this place after work and I'm having a party."

Everybody's like, "How could you do that?" Nobody ever had a party like that. We're doing it. I had a great time. Guys and girls came, and I just literally put out this Xerox copy invitation. It was the first time that Xerox was around enough that you could do that kind of thing, because it used to be a very controlled product. Or it was the blue line mimeographs. I had all these people coming in, astronauts and everybody, and we had a great time. It was nothing, and it cost me $200 or something, it was just incredibly cheap, relatively, at the time. It just cost me a couple of kegs of beer and I just put them in there and I said, "Drink up," that's it.

Of course, I'd be afraid to do that these days, with the going home and get in a wreck, but that was then. A lot of people got to know me, and that was great for just knowing what's going on. I didn't do it for that intent, but the effect was that way. I was not just known by all the GNC flight software people, but a whole lot of other folks as well.

I got to know all the people down here that worked for Slayton in that time, and FOD, Flight Ops Directorate, where all the flight controllers were. What it did for me is allow me to just call people all the time and say, "How does this work? What will happen if this happened? If we fail that, what's going to happen?" You're trying to make the simulator better, and the design is such that it's an interesting thing to build a simulator. This thing looks like the ATM,

Apollo Telescope Mount, computer system, but how does it fail? What's it going to look like if it dies, or if some part of it goes wrong?

They'd say, "Well, I never thought about that." And yet they had to think about it at some point, and so we'd have procedures to review together. It was a driving function to make the simulator better, and at the same time, we created a lot of people who would just come together all the time and say, "What goes on?" This became malfunction procedures; there was a book that became malfunction procedures. Some really good people worked hard on that stuff to make that work, so it's almost like an evolution going on.

From where we were on Apollo, where there's somebody walking in the door and they said, "What do you want to do, Gus [Virgil I. Grissom]?" Now it's coming together to say, "These are all the books that we're going to carry, and so here's the regular, normal ops procedures, and here's malfunctions procedures." A guy named Ben [E.] Fulbright, Gene Gentry and Lenny Riche and some other people, they worked on the format of these things. It's almost like a flow diagram, about how these things would work.

Once they were working, then you made them better. You'd use them and see them and then it didn't quite work right and you'd fix it. When they launched on Skylab, they had all these procedures that were so much better than anything we flew on Apollo, that it was just incredible. We used some of that same stuff—now we backed down and did it on Apollo, so for ASTP, we had those kinds of procedures. Fortunately, we didn't use one damn one.

It was wonderful, that the vehicle worked so well, but NASA, we've got this ability to wait until a vehicle works perfectly, and then have Congress shut it down.

The Shuttle was just like a dream, the Apollo, we flew that whole flight, nothing wrong with that vehicle. We could have flown 15 more of them if you were building them, and could

have been building. I'm sure we'd have been to Mars by '80 if they had just turned us loose, "Let's go do it." We might not have been ready to carry a lot of rocks back or something, but we'd have got there and we'd have done some interesting things. Now, I don't know that this country will ever be the one that gets to Mars. It's going to be somebody else because we just can't get our act together. It's something about the Americans, they're kind of Pearl Harbor [attack] mentality; we think we're just going to wait until the last minute and then we'll work hard and catch up. I think we lost that, the wherewithal to do that.

WRIGHT: Technology, that drive, because you guys were moving all the time, making things happen.

HUGHES: Yes, and it's nicer when it's new because you couldn't have somebody saying, "Oh, nobody would do that," because they didn't know how to do it, so they just stood out of the way and let us do it. Now, since we've tried doing things, it's like, here's this whole group of people where we've got capsules, three or four companies doing capsules, another three or four to do the wing vehicles. I'd go with the wing one all the time—I like SpaceX and I like the way the company works, but capsules, to me, I don't like parachutes. I wouldn't jump out of an airplane unless it was burning, you know what I mean? Coming down after three years being to Mars, I'd hate to see the parachutes come out. If anything else, I'd go into orbit and have another vehicle take me home. Slow down and stay in orbit, and I'd get a ride home like an old gentleman.

WRIGHT: That's right. "Driver, please."

HUGHES: Exactly. Have some young buck that's going up and down all the time and is good at it. It's like if you go to the doctor, you want not somebody that's new at this business; I want somebody who does three or four of these operations a week.

WRIGHT: That's it, yes. Proficient.

HUGHES: Exactly, exactly.

WRIGHT: This might be a good place to stop and we can pick up and talk about working with the Russians, and then how you moved into Shuttle, and we'll squeeze the Skylab in between there.

HUGHES: Let's do that.

[End of interview]