

**NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT**

WILLIAM B. LENOIR
INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is November 18th, 2004. This oral history is being conducted with Dr. William B. Lenoir for the NASA Johnson Space Center Oral History Project in Staunton, Virginia. The interviewer is Rebecca Wright.

Thank you again for letting me come into your home and visit with you this morning. I would like to start with you sharing with us some information about how you learned that NASA was opening up the second class of scientist-astronauts, and why did you decide to apply.

LENOIR: It's an interesting story. Let me back up a bit from there. I went from high school to MIT [Massachusetts Institute of Technology, Cambridge, Massachusetts] as a freshman in the fall of 1957; subsequently got a bachelor's degree, a master's degree, and a Ph.D. in electrical engineering and joined the EE [Electrical Engineering] faculty as an assistant professor. After ten years of being at MIT continuously, my intent was to be a university professor and continue my research and continue my teaching. My research had been in the remote sensing of the Earth's atmosphere from satellites, which in 1964, when I was doing it, was all theory; none of it was fact yet. My intent, as I said, was to continue with that career, but after ten straight years at MIT, it was obvious that it was time to get some broadening and go spend a couple of years somewhere else, and my intent then was to come back to MIT.

So I looked at what the opportunities were, and the Earth Resources Institute at the University of Michigan [Ann Arbor, Michigan] was one; the Goddard Institute of Space Studies

[New York, New York] was another; and there were several other universities that were after me to come join their department. I was communicating with them, filling things out, and one day, thumbing through *Science* magazine, back at the back there was a little bitty coupon that said NASA was looking for applicants for science-astronaut; “Send in your name and address, and we’ll send you some more information.” [When] I thought about it, and I said, “Gee, you know, my research deals with this sort of thing. Let me see what this is all about.” Honest truth is, before that instant I had never thought about it. Was not a close follower of the space program. People are disappointed to hear I didn’t grow up wanting to be an astronaut. I had given it no thought.

It was like magic, though, that one little probably one-inch-by-two-inch coupon turned into a ream of paper that came back, “Here, fill out these forms.” I joke about what I call the “have you ever had,” the medical history. It was pages and pages of three columns, both sides, of “have you ever had” this, that, or the other. I think I took the first six or seven seriously, giving them a lot of thought, and then I quickly went into the “if I’ve never heard of it, I’ve probably never had it” mode, and filled it all out. But that’s how I thought about it. That’s how I got the information back, and I filled all those forms out, and I mailed them back.

I’ve forgotten how many people applied; this was in the group that came on board in 196[7]. I’ve got a vague recollection it was ten thousand, but it might have been more and it might have been less, I don’t know. But their process was they took all of the applications, along with why you were applying, all of your references, your résumé, etc., and they sent them all over to the National Academy of Sciences, who sent back a list of those that they thought were very well qualified scientifically, and I think that was a list of seventy people.

Then they took the seventy of us—I think it was ten at a time—to San Antonio [Texas] to the Air Force’s [Brook’s] School of Aerospace Medicine for a physical, a six-day physical that was the darnedest thing I’ve ever been through. In retrospect, I realize now it was about a three-day physical, and they stole another three days’ worth of baseline data from us that had nothing to do with selection. But in those days you could get away with that, and they did. It was interesting. I was fairly naïve about the whole process. I made no attempt to game it, to learn about it. To me it was just one of several possibilities, and I went into it fairly naïve.

I remember at one point where, after a series of X-rays of everything, the surgeon came in—neurosurgeon, I later found out—and asked was I unconscious when I broke my face. And I said, “You’ve got me confused with somebody else.”

He said, “You’re Bill Lenoir?”

I said, “Yeah.”

He says, “Well, were you unconscious when you broke your face?”

I said, “I never broke my face.” And then he told me about on the left side of my face in three spots where it had been broken. I thought back, and I said, “Oh yeah. I was playing intramural hockey as a graduate student, and I took a check and I hit the ice real hard with my face right there [gestures],” and I told him, “You know how in comic strips how you see the black with the stars in it? That’s what I saw immediately, but I got up and skated off and actually finished playing the game.” I wasn’t unconscious. I went to the infirmary the next day, because it was obvious that my eye had no white; it was all red, and my face was black. They said I had a concussion; “Go home and sleep it off.”

So I went home; I slept it off. Two days later I was playing a hockey game. I never gave it another thought.

He said, “You’re very lucky, because usually they don’t heal that well.” I later found out I was also very lucky because I didn’t realize had I said, “Yes, I was momentarily unconscious,” I would have been immediately eliminated, because I knew nothing about if you were going to be a pilot, you could never have been unconscious like that.

Anyway, so they did that, and they took a bunch of X-rays and tests of my kidneys, because I had had a kidney injury when I was in college, playing intramural football; no problems there. They put me in an altitude chamber—these were all extra tests—and ran me up to 43,000 feet with a rapid decompression to make sure that this face thing hadn’t constricted any passages, and so all that worked out fine. I thought it was all fun and didn’t think much about it. On the debriefing, they told me I had a hernia that was minor, but it was there, and they pointed out I had a black mole on my back they didn’t like the looks of, and so on.

So [I] went on home, and the next step was, everybody that took the physical was invited to Houston [Texas] in the same group for interviews, three days’ worth of interviews. In our group of ten at San Antonio I met—I wish I remembered his name—Morefield, I think, something like that; was an M.D. at Mass[achusetts] General Hospital in Boston, and others were from around the country. So I got to know him.

When I went back home, one of my classmates was at the Harvard School of Medicine [Cambridge, Massachusetts] and doing quite well, so I called him up. I said, “Hey, Jerry, here’s what they said. What do I do?”

He said, “Let me get back to you.” He did, and he says, “Here’s what I recommend. You want to go over to MGH [Massachusetts General Hospital] and have it fixed.” He says, “I could get you the Chief of Surgery to do it, if you would like, but to be honest, I’d recommend the Chief Resident.” He says, “The Chief of Surgery is probably the best guy there, but you’re

hardly going to get any attention of his. The Chief Resident is an excellent doctor, excellent, topnotch, just getting started; has virtually no private patients, so you can get all of his attention.”

I said, “Sounds good.” So I went over and had the operation and talked to him and told him, “While you’re at it, take the mole off my back.” So he did.

An interesting sidelight of that was that when I went in, the way they did things then—I don’t know anymore, because I hardly ever am sick, and I don’t think I’ve been in a hospital since—they gave you the sedative, the succinyl choline, the curare that relaxes your muscles. It makes it so you can’t move, and then they knock you out with the sodium pentathol. Well, they got me totally relaxed, and then they gave me the sodium pentathol and wheeled me in. The problem was, they didn’t give me quite enough, and so I wasn’t out when they started.

Afterwards I was telling the surgeon this, and he obviously wasn’t believing me, and I repeated a couple of the jokes they told, and his immediate comment was, “I’ll send the anesthesiologist right in.” But I had the illusion that I was trying to communicate, and I couldn’t. I had the illusion I could move my right big toe, and so in my mind I’m wagging hell out of my big toe, but nobody’s noticing, and I don’t know how—it felt like it hurt, but it probably hurt as much because I knew what they were doing as anything else. But anyway, so we got that fixed.

Then I think I’m out of the hospital like a day or two, and it’s time to go to Houston for the interviews. I’ve just had the stitches out; I can hardly move; it hurts. So I flew down, and you did three things there, probably four. There’s probably record checking and all that stuff, but you had an interview with the selection board that was chaired by “Deke” [Donald K.] Slayton. You had a medical debriefing of your San Antonio experience. And then you had a backseat ride in a T-38. Again, I was naïve. Had no idea, didn’t try to game anything, didn’t give it any thought.

It turns out that the intent of the backseat ride was to see how you did and if you had any problems with that. It was fairly random as to how you were scheduled. They had no idea I had been in the hospital or had anything fixed, and so the first thing up for me was the T-38 ride. Thank God, as newcomers, they already had the parachutes in the airplane, because I'm not sure I could have carried mine out. I walked around with the test pilot, and he showed me some things, and then I climbed up the ladder, doing my very best to look casual and not at all in pain. Got strapped in, and the crew chief was leaning over, helping me, and I strapped it in real tight, just like he said, and that wasn't hard, because that felt really good, strapping everything down tight.

Then we went out, and we had an hour-and-twenty-minute flight, pulled a whole bunch of Gs, flew upside down, and I had a great time; I loved it. I realized afterwards that when the pilot reported back on me, he must have had some good things to say, because I was just looking, and when we were upside down doing a loop or something out over the Gulf [of Mexico], I noticed there was a regatta going on, and I called it to his attention that, "Hey, they're racing down there, and so-and-so's ahead. Looks like they're rounding that turn," just holding up a casual conversation. All that finished, and I loved it. That was great.

Then the next thing I had was the interview, and Deke Slayton chaired it. Chuck [Charles A.] Berry from the medical world was on it. Alan [B.] Shepard [Jr.] was on it, and Owen [K.] Garriott, who was on the previous science-astronaut class, whom I didn't know, and I knew nothing of any of them. If you had asked me, I probably didn't even know we would have been the second group; I don't know. And probably one other I don't remember, but we were going down the list, and Alan Shepard was summarizing. He was the Chief of the Astronaut Office. Deke was the Director of Flight Crew Operations at the time. But Alan was going down,

summarizing the case, and he was telling me, “Let’s see, and from the physical it says you’ve got a hernia.”

And I said, “Not anymore. I had it fixed.”

And he says, “Oh, when?”

I said, “Five days ago.”

He says, “Oh, wow. Maybe you shouldn’t do the T-38 ride then.”

I said, “Too late. I did it this morning.”

He says, “Oh, you should have told us.”

I said, “Well, I didn’t want to tell you. I wanted to do it.” In retrospect, I realize, boy, I’m really playing to this fighter-pilot mentality without even having a clue.

He said, “And there’s a mole on your back.”

I said, “No, I had them rip it off while they were there.”

The other thing they didn’t tell me—I didn’t find out probably for ten years—was in that report from Brooks [Air Force Base], there was a summary from the psychiatrist, and we did a bunch of that, definitively recommending that I not be selected because I was dishonest and couldn’t be trusted. What was behind it was that I was asked a question, if I knew my best friend was cheating on his income taxes, would I turn him in. I said no, and that was the end of the conversation, we went on to something else, but it was based on that. Had I known that was in there, I’d have been terrified. Had I known it was in there, knowing what I know now, I’d have thought it was great, because you’d be hard-pressed to get a better reference to a fighter pilot than a shrink saying, “Don’t take this guy.”

Then we went through the interview, and we talked about some things, and Alan said at one point they hadn’t decided about the airplane, that the T-38 flying was either going to be

required or optional. And I said honestly, “Well, in my case, then, it’s the same, because if it’s optional, I’m going to do it, and if it’s required, I’m going to do it, so I don’t have anything to think about; there it goes.”

We went on, and then the medical interview, and then went on home. There’s probably more stories around that that were interesting.

Then at one point in the early summer I’m sitting in my office at MIT, and I get a phone call and it’s Alan Shepard. Having sat on subsequent boards, I realize I should have known immediately, it’s Alan Shepard; it’s good news. Other people call the ones that don’t make it. But I didn’t know, and he told me I was selected, and I said, “I accept,” and so on. I went down and I told my boss, Alan [H.] Barrett, who’s a professor of physics at MIT, and we immediately went out and had lunch with a beer or two.

I went home and I told my wife, my first wife, and she said that was great, and then she asked a very practical question. Since I said we were going to move to Houston, she said, “How much does it pay?”

I said, “You know, I don’t have a clue. It never occurred to me to ask. I’ve accepted a job. I assume they pay.”

Then we moved. So that’s the “making a short story long” answer of how did I find out about it. I set out to do a two-year sabbatical away from MIT somewhere and wound up with an astronaut career, and learned a lot along the way about myself that that was much better fit than academia would have been, although academia would have worked.

WRIGHT: Tell me about arriving to Houston and what you found and how your training started to prepare you to become an astronaut.

LENOIR: We moved sometime in the summer of '67. I'd like to think it was August; could have been as early as July; I don't think it was as late as September, but it was still summer. Of course, Houston summer runs till about November, anyway. But I was born and brought up in Miami [Florida] so I was used to hot, humid weather, not to be confused with liking it.

We were new, and it was still in the pre-Apollo times. As a matter of fact, the Apollo fire happened in the middle of my application process, and it's interesting, in retrospect, that it made no difference whatsoever. I never even thought about it as being a factor in whether I applied or not. So, very much heroes. People want to know astronauts; they're heroes in the Houston area. The area around NASA Johnson Space Center—it was called the Manned Space[craft] Center then, MSC—was fairly new; several new subdivisions. First thing we did was we spent three weeks in a motel right across from NASA; I forgot what it's called now; it was a Ramada then, I think. We bought a house in El Lago [Texas], first house that we bought, and people helped us out along the way.

One of the stories I like to tell was I got to know Paul [J.] Weitz pretty good. He was in the pilot class right ahead of me, and he was talking about when he came down. Same story, staying in a motel. In those days motels didn't always have TVs, and his didn't, so he went out to buy a TV one Saturday. Went up to the shopping area that had—it's the Foley's shopping center, I think of, that had only Foley's in those days. There was nothing else there, but somewhere on an intersection right by the interstate there, there was a little TV shack. He went in there and he bought a TV, and he was getting ready to leave, and a Texas downpour comes, and there's water collecting under the underpass.

So, Paul, being fairly smart, decided not to go out in the rain, and so he's chatting with the owner, who asked him, "Where are you from?"

He says, "I'm from Whidbey Island [Washington]. That's up near Seattle [Washington]."

And the owner says, "Oh, Seattle." He says, "It rains a lot there, doesn't it?"

Paul looks out the door and looks back at him, and he says, "You kidding me? It's rained more here in the last hour than it rains in Seattle in a month." But that was typical of the kinds of things that we ran into. And like I said, people went out of their way to help us.

I remember our first pilots' meeting, all pilot meeting, where the astronauts met every Monday. The first one we went to, we all went in, and Deke was there, ostensibly to welcome us. I'll never forget Deke's comments—and if you've talked to others from my group, you've probably heard the same thing—[what] he said, "Well, we didn't need you, we really don't want you, but welcome aboard." He was literally that blunt, and that was the wonderful thing about Deke. A nicer guy never walked the face of the Earth. He never lied to you. I mean, he always told it to you right up front.

So there we were. We immediately christened ourselves XS-11 since there was eleven of us, and we were all going to go off to flying school. Only one of us was a private pilot, and that was Story Musgrave. The other ten of us weren't pilots at all. Story wasn't jet-qualified, so we all had to go. Don [Donald L.] Holmquest was still doing his medical residency, so he was going to do it later. That left ten of us.

Because of the Vietnam War buildup, the Air Force didn't want to do it the way they had done it with the previous class, everybody at one Air Force base, and so we went in twos to five different Air Force bases, and the choices were Williams Air Force Base in Phoenix [Arizona];

Vance Air Force Base in Enid [Oklahoma]; Reese [Air Force Base] was in Lubbock [Texas]; Randolph [Air Force Base] in San Antonio; and Laughlin [Air Force Base] in Del Rio [Texas]. San Antonio and Phoenix were the ones that everybody wanted, and we got together and decided what's your first, second, and third choice, and we went and said, "Oh, gee, everybody wants Phoenix and San Antonio."

We got together and decided, "Okay, Bill [William E.] Thornton ought to get Randolph in San Antonio, because he just came from there and he owns a house there, so that makes sense, and the rest of us, we'll figure out how to deal with it." Phil [Philip K.] Chapman and I played a hand of draw poker, best hand wins first choice. Phil won; he went to San Antonio.

I lost and went to Del Rio, Laughlin [Air Force Base], which was very fortuitous. It was a great place to learn to fly. None of the distractions of San Antonio. Great bunch of people. Tony [Anthony W.] England and I went there, and we were each put in a different whatever they were called, squads, class, or whatever, but we were the class of 69-06, and there were two halves to the class. They did that so that it wasn't quite so unwieldy, and that way one class flew in the morning, did class in the afternoon, and the other class did it the other way around, and then after six weeks you swapped back and forth. So we were in different classes and didn't run into one another.

Because of the notoriety, we had a meeting with the wing commander, a full colonel who was the ranking Air Force person on base, and being military, of course, they had to do everything military-wise. We're not military; how do they treat us? Well, we are civil servants. What's our GS [General Schedule] rating; they look it up, and so they told us that Tony England was the equivalent of, I think, a captain, and I was the equivalent of a lieutenant colonel. In that

regard, I was the third-ranking guy on the base. The colonel was telling me, “This could be a little bit embarrassing.”

I said, “I don’t know why. I’m just here to learn how to fly. I’m not going to do anything stupid. Treat me the same as any other student pilot. I’m probably not going to be real anxious to do all the Mickey Mouse, but I won’t embarrass you. Just treat me like a student pilot and ignore me.” And by and large, they did.

What I found in flying school was that I wondered how I ever lived without this. I took easily to it. I wound up finishing first in the class. At graduation they gave out four awards, and I got three of the four. The one I didn’t get was best officer, but I remember just beforehand when Colonel Goade, the wing commander, called Tony and I in to see how it went, and he told us that I was going to get the best flying award, the best academics award, and also the Commander’s Cup, which was the big silver thing for everything.

And I said, “You know, Colonel, that probably doesn’t make a lot of sense. To be honest with you, none of that’s going to mean anything to me in my career. The Air Force invented that so you can encourage your students to take another step up, to reach out, and so on. Why don’t you just say that Tony and I are anomalous here, and we’re ineligible, and give them to the next guys.” He thought about it, but said no, they were going to do it this way. So I got those, and to this day, I still think there were a couple of Air Force second lieutenants, or first lieutenants by that point, that should have gotten an award that didn’t.

But I loved flying, and came back and checked out with the NASA T-38s and started flying them around, and had a lot of fun doing that.

WRIGHT: What was some of the other training you had? You also went through jungle training and desert training. Do you remember much about those?

LENOIR: Yes, just after we came back from flying school—oh, let me back up a minute. When we first got to Houston, we had six months to kill, because the Air Force wasn't ready to take us, and so we had a big bullpen kind of office. We were all ten of us in there, and we got introduction to this, that, and the other, and we kept our research going on the side.

I remember at one point we had a party for our group at my house, and Brian [T.] O'Leary, who was from somewhere, I don't remember, was talking to me right in front of the fireplace. I had a foot up on the hearth. He was renting an apartment over in Nassau Bay, and he was asking me about the house, and I told him. He said they were renting, and he wanted to rent until after flying school to make sure that he graduated, and it just stopped me cold, and I just looked at him, and I says, "You know, Brian, the thought of not making it through just never occurred to me." There's probably a lot of future look there, because I went through very well, and O'Leary discovered he didn't like flying and resigned right after his first solo, and so there was probably something there.

But just after we got back from flying school, then they sent us off to various survival schools, the idea being that if you were in an Apollo capsule and had to make an emergency letdown, you could be anywhere in the world, and it might not be accessible for several days to the rescue crew, so you had to survive. And the idea for us was that we were brought on board for what was then called the Apollo Applications Program, which was a lengthy post-Apollo program of Space Station-like activities. It subsequently got a lot smaller and became Skylab, but that's what that was all about.

So the first thing we did was we went up to, of all places, the area outside of Spokane, Washington, for desert survival. I don't think of that being a desert, but it is. It's a desert; they grow some potatoes up there. We spent some time there, and like most survival schools, you spend a couple of days in class being lectured as to what you do, this, that, and the other, and demonstrations of this, that, and the other, and then you go out in the environment and survive.

One of our interesting stories was, as we were driving to the desert for the survival on an old converted school bus, the sergeant that was taking us out there, who was in charge, was up front, and as we neared it and went through a gate where we're going to get off the bus and go on to four-wheel-drive pickup trucks to take us in, there's a couple of picnic tables and a bunch of people, and I guess he knew the region.

What happened was the local farmers had heard that there were astronauts coming, and so they'd set up a picnic and a bar, the whole nine yards, and the sergeant takes one look at that and says, "Oh, gosh. I wish they hadn't gone to all this trouble, because these guys are not going to go out there and drink alcohol, with what we've just told them about going into the desert."

Of course, to a man, we got off the bus and went right to the bar and started drinking. I was talking to one of the farmers, and he said, "Hey, anything we can do for you?"

And we had big, heavy parkas and stuff, because it was going to get cold at night, and I said, "Gee, no." I says, "Well, wait a minute. You got a case of beer?"

And he says, "Yeah."

I says, "Here. Wrap it in this," and I put it in the back of one of the pickup trucks and got on the pickup truck. There were three of us; actually, there were five of us, and we were going out to two different sites.

They dropped the first three off somewhere, and then Story Musgrave and I were going to be the next two, and the sergeant that's in the back with us said, "You're up here around the corner."

I says, "Where?"

And he turns around to point, and I threw the beer off the truck. So we got set up there, and I went back and I got the beer and applied the number one lesson that we learned, and that was I got the highest rise I could find, got on the north side of it, dug down till I got to cool sand, cool, damp sand, and put the beer in there. We drove them crazy. They would come through every now and then to check. We're sitting there drinking beer.

"Where did you get the beer?"

"Oh, I don't know."

And at one point, we decided, "You know, this is too much Mickey Mouse," and so we just got up from the campsite that they had set us into, and we wandered off into the desert, and again drove them crazy. We could hear them. They're trying to find us; they couldn't find us. So we just survived on our own. They chewed us out, probably, a little when we were done, and then we got done there.

Then our next survival school was Panama, jungle, where, same story, you spend a couple days being briefed. The equivalent of the farmer's thing was the Governor General of the Canal Zone hosted a dinner for us on his boat as we cruised up and down the Panama Canal. The very first day, we walk in and sit down, and the sergeant that starts briefing us starts off by saying, "Which one's Lenoir?"

I said, "Me."

He looks and he says, “I heard of you.” It turns out survival school instructors apparently are a tight-knit group. So that was all that was said.

We learned about stuff, like what’s one of the things I learned in the jungle, and that is that when I was in Miami as a kid, I had eaten rattlesnake. That’s pretty good. In the jungle training, what I learned is eating boa constrictor is a little bit like trying to eat rubber bands. So we learned all that stuff, and then we go off and we get in a helicopter, and we’re hovering about ten, fifteen feet over the Chagras River, and we have to jump out—splash—and then we’re supposed to swim over to a little area where we congregate, and they do the final briefing, and then we break up into three different groups.

What they didn’t tell us, that we all figured out very quickly, was that after we had done all that—and a couple of the guys were not too wild about the water, and so it was troublesome to them. We tried to take care of them as part of the group. I was brought up in Miami; you know, I probably swam before I walked. But what I wasn’t used to was after we got out of the water, you have to stop and get the leeches off of you, because there’s leeches all over you.

So then we went, and they said that the game was that we were going to do the same Air Force survival, and the game is, you are supposed to survive. You had been given a map, which we learned didn’t fare very well once you got it wet, and you’re supposed to get to a place downriver within two days, three days, whatever it was, and you meet on a dock. You’re all wearing these floppy hats, and you’re supposed to avoid and evade the locals, the local Indians, like you would if you came down in Vietnam, something like that. And you need to know that they’re paid a dollar a hat for getting your hat, and so your objective is to show up with your hats.

We were assigned three different routes. They said, “Now, in the real world, you’d go down the river, but we don’t want you to do that. This group, you’re going to go down here. This other group, you’re going to go up a little. And the third group,”—that’s Story and me—“you’re going to be the furthest away from the river.”

So we’re talking to them and I’m thinking about that, and I say, “You know, there’s mountains and stuff around here. The further away you get from the river, the more you’re going to go up and down. With the drainage things, and up and down, up and down, that doesn’t make a lot of sense. These Indians probably aren’t dumb. They’re staked out. They know exactly where we’re going to come.”

So just as he said, “Okay, now head out,” the heavens opened up, and it rained.

So we walked out; we rounded a corner, and I pulled Story into the bushes, and we sat there for a while, and I said, “Let’s let everybody settle down and get away,” and then we swam across the river to the other side. And I said, “They know exactly where we’re going to be over there. Let’s see if they can find us over here.”

So we went over there, and some of the things that happened was, one night in our camp, apparently a couple of big wild pigs came rooting through. Boy, they raised hell. Another night, I’m lying in my homemade sleeping bag, which was made out of a parachute, same as our tent, when I felt across my feet a spider that must have been this big around [demonstrates] walked up and over one foot and up and over the other foot and kept going. We had toucan soup one night when we got a toucan and ate him. Had iguana; great stuff.

And a little bit early, we got down across the river from the pier where we’re supposed to meet them, and nobody’s there yet, and we didn’t want to sit out in the open there, so I walked

up a little further and run across a guy fishing. And I'm talking with him, and he's telling me that he's the vice president of a local country club, which is just downriver a little bit.

And I said, "Oh, okay," and then it hit me. I says, "You got any beer in your country club?"

He says, "Yeah," and I told him the story of Spokane. He says, "Come with me." We went up there, and he got us a couple of six-packs of beer.

So we swam back across the river, and we were the first people there. We were the only two that arrived with our hats, and when the sergeant and his group come on a boat down the river, there we are sitting on the pier, dangling our feet, drinking beer, waiting for them, and, boy, did that make our reputation. That was something else.

Then we also did a sea survival; actually, two different ones, one at Homestead Air Force Base in Florida, which was not very far from my home. As a matter of fact, the big B-52 hangars in Homestead Air Force Base I helped build. I used to be an ironworker when I was in high school, and so that was kind of like going home. We did all kinds of water stuff, get towed behind a boat on a parachute up to about five hundred feet, release, and then parachute down; and swim underwater and go down—all kinds of water stuff, which to me was kind of like Disneyland. "Hey, this is fun. This isn't work."

Then we had a different kind of survival at Pensacola Naval Air Station [Pensacola, Florida], which dealt with if your airplane goes in the water, how do you get out of it, and things like that. The memorable part of that was the "Dilbert Dunker," where you're in like a seat, and you're strapped in, and you've got your mask and helmet on, and this goes down a set of rails into a deep pool. It goes down about, I don't know, ten, fifteen feet and then flips upside down, and then at that point you're supposed to unstrap and get out. A couple of the guys that weren't

really comfortable in the water were really spooked by that. I went first, because I didn't mind the water, and to me, it wasn't bad. You went down there, and you got upside down, and you stopped, and you thought about it, and "Oh, look at this," and you unstrapped, and you came up and said, "See, guys? It works."

So those were our survival schools, which were a lot of fun. We kept trying to tell them that, "You know, there are times in the year when there's winter, and we could be coming down anywhere. Shouldn't you send us to survival school at Aspen [Colorado] or Vail [Colorado] or something like that?" We could never sell that one.

WRIGHT: Didn't do that one? It's a good idea. Once you completed training, what were some of the first duties that you were assigned?

LENOIR: The first thing that I was assigned, I'm not sure whether there was a temporary one or not, but the first long-term thing I was assigned, to follow the design of the airlock module for Skylab, which was then still called the Apollo Applications Program, along with Bruce McCandless [II], who was the older astronaut that was doing that. Most of the rest of my group, I think maybe all of it, was assigned to be support crew for Apollo, which meant that they weren't in a flight profile, but they supported. They did the odds and ends from an astronaut perspective, and then they talked to them during a mission as CapComs [Capsule Communicators]. I think because of my engineering background; most of the rest were either doctors or scientists, real scientists. I was an engineer, but I was assigned to engineering duty of watching and overseeing, from an operations perspective, the design of the airlock module.

Then a short while later, the multiple docking adapter got added to that list, and at some point, it might have been a year later, the workshop module, built by Douglas [Aircraft Company] out on the West Coast, was added, which then wound [up] completing all of the Skylab modules, except for the command module that was going to be a part of it.

So that was my job, so I got off the track from the rest of the guys and spent a lot of time flying to St. Louis [Missouri], which is where the airlock module was built. Got a lot of experience flying the T-38s in and out of St. Louis, and subsequently in and out of Denver [Colorado] at Martin [Marietta Corporation], who was doing the multiple docking adapter.

One of the stories I tell about Denver was on one of my trips there—these were back in the days when a little bit more—I don't know whether it was legitimate or not, but a little bit more was done entertaining astronauts. I think there was both the desire and it was okay, and I'm sure somehow it was allowed as a business expense. But they took a couple of us skiing. I had learned to ski in New England in college and had only skied in New England. And I'm going up on the chairlift at Winter Park [Colorado] with one of the local engineers who is just as apologetic as anything, apologizing over the terrible conditions this day. He says, "You know, the ice, everything is just terrible. You should be here on a good day." I think he's kidding me. I'm looking around, and all I see is powder. He's calling it ice. What he means by ice is there's a real light crust on top, and I tell him after our first trip down, that he just doesn't understand ice. Ice is thick stuff that's an inch thick and it's blue. It's the reason you've got the sharp metal edges on your skis, and that's New England. But that was my introduction to skiing in the Rockies, which is the best place in the world to ski, as far as I'm concerned.

But those were my assignments, was to do the engineering oversight, from an operations point of view, of those three subsequently Skylab modules. At some point in the middle of it, the

program changed from what used to be called the wet workshop to the dry workshop. The idea with the wet workshop was that it would be launched on a Saturn I, and the Saturn IV-B upper stage would be used, and after it was used, you would set up shop inside the hydrogen tank, which would be your workshop. The dry workshop decided to use the extra Saturn V that was left over when the Apollo Program got shortened, and launch that S-IV-B empty, so you could outfit it and didn't have to haul all that stuff in. And about that same time frame, the name got changed from Apollo Applications to Skylab.

So that's how I got into the Skylab business; how I, other than as an observer, had very little to do with the Apollo Program. I felt comfortable about it, because Skylab was the reason our class was there, and I figured that ultimately we're going to fly in this thing, whereas the guys that are supporting Apollo are never going to go to the Moon, and so this was more fun, and it just seemed more fun to be out in front doing some engineering work than it did to be kind of on a third- or fourth-tier crew helping others get their job done. Although they had a lot of fun and did a lot of good work, especially supporting the lunar science.

WRIGHT: You were named as a science pilot backup for Skylab 3 and 4. Tell me about that announcement and your thoughts and then what your duties were in those positions.

LENOIR: There were three different Skylab crews, and interesting, if you go back, you can get confused in history, because NASA at first called the first launch Skylab 1. That was the dry launch of the workshop, and as I recall, that was the Arabic numeral one. Skylab 2 was the launch of Pete [Charles] Conrad [Jr.] and his crew for twenty-eight days. Skylab 3, [Arabic] numeral 3, was the launch of Al [Alan L.] Bean and his crew for fifty-six days, and then Skylab

4, [Arabic] numeral, launched Gerry [Gerald P.] Carr and his crew for fifty-six days with the understanding that it was likely to be extended maybe as much as eighty-four. Subsequently they've gone back and renumbered the manned crews, one, two, and three, with Roman numerals, and so you can get confused.

But the assignment, I was still naïve and had no idea how it all worked. Deke Slayton came down off the mountain and made an announcement and then crawled back up on the mountain, and to me it made sense, because I'd been working Skylab, which seemed to say that, hey, I was right about that was the better place to be than Apollo. There were only two from my group; that was myself and Story Musgrave. The first crew that was announced was Pete Conrad, Joe [Joseph P.] Kerwin, and Paul Weitz. Joe was a Navy flight surgeon; he was a doctor; and it was felt important, because nobody had ever been up that long before, and you needed to have a doctor. Story was his backup, so if anything happened, he still had a licensed M.D. on board.

The third crew was Al Bean, Owen Garriott, and Jack [R.] Lousma, and I backed up Owen Garriott. The fourth crew, or third, depending on how you want to look at it, was Gerry Carr, Ed [Edward G.] Gibson, and Bill [William R.] Pogue, and I backed up Ed Gibson, and so we only had two backup crews, even though there were three. The first crew, because it was different with the M.D., had one crew, and then Vance [D.] Brand, Don [L.] Lind, and myself backed up the other two. It made sense.

It was a bit of a problem, because shortly after the announcement of those crews, Deke announced that the other nine of us were going to be released; you know, fired, RIF'ed [Reduction in Force], or whatever, because, frankly, with the programs being cut back, Apollo ending, Skylab being down to three missions, there was no need for them. So Story and I got to

stay, and the other nine guys had to go. Never really understood what happened there, other than, obviously, there were some politics. Somebody who was connected and some congressman or senators or somebody complained, and that firing never went to fruition, but basically they had two extra years of hiatus than I had, because—well, actually, it's more than that because of the training—and so I got deeply involved.

Basically, in those days the premise was that the backup crew is as ready to fly as the prime crew as you can possibly make them. Obviously, if you get into a bind and there's a priority problem, the prime crew gets priority. But we didn't have any of those, so we were basically as ready to go as the prime crew; in theory, right up to the end, the problem being that as you get close, you can't substitute just a crew member, because then you break up the crew camaraderie. If you're six months before flight, well, sure, you can develop it again. Before the missions, I couldn't get either Owen or Ed to take up my offer of an all-expense-paid ski trip, figuring maybe they can break a leg or something, but they didn't bite, and so we did all the training that they did. It was interesting; it was a lot of fun.

It was different than Apollo, because you weren't training for a short mission, where basically every minute of every day has something in the flight plan. We were training for a longer mission, where it was admitted that we don't exactly know what we're going to be doing in weeks two and three and subsequent, and how it will work out. So we had to train with that in mind and learn how to deal with that, and then also we were in a much bigger spacecraft that you just couldn't build a simulator around, and so we had a makeshift simulator around the walls of a room, that had the control panels that weren't in their right geometric configuration at all, because you just couldn't get there from here. It worked out well.

WRIGHT: Did your training change at all from the first manned Skylab mission before Gerry Carr's group went? Was anything handed down from Pete Conrad's crew that changed your training?

LENOIR: Yes and no. As you probably recall, the first unmanned launch didn't go as planned. Part of the meteoroid shield deployed prematurely and was immediately ripped off by the airstream. Actually, both of the solar arrays deployed early. One of them got stuck with some of the metal that was from the meteoroid shield, and it didn't fully deploy. The other one did deploy, and it got ripped off, and so here's this sick bird with no power up there, and no Sun shield, and so that was the thing. Originally Pete was supposed to launch the next day, and that was put off for five days. Everything went in five-day cycles, because the orbit that it was in precessed around once in five days, and so things were in five-day cycles that way.

So they waited five days, and I don't remember whether they launched in five days or in ten, to be honest, but in the meantime, there was a whole bunch of different teams put together to deal with all kinds of things. The first was, how can we get it cooler in there, how can we shield the Sun. There were three different schemes. One of them was to use a scientific airlock that went out the Sun side and basically deployed a big umbrella. I wound up working on that. There was another one that once they got up there, they would put a big shield over it, and to be honest, I've forgotten what the third one was. I worked on what was called the parasol, as the crewman doing it, working on that engineering team, and my job, obviously, was to make sure that it was doable by the crew. Pete and his crew were very busy doing their stuff, and so they basically had no insight into all the different things going on.

Subsequently it was decided that the parasol would be the prime thing, the first thing that we would do, and in helping with the design and making sure it was doable, I had also worked to build the flight procedures; how do you do it. They had never seen the hardware, had never done it. I had done it a bunch of times in the simulator and on the 1-G trainer, and then I went to the Cape [Canaveral, Florida] and briefed them on it, took them pictures. Actually, in my pod I actually took the flight hardware, which there wasn't time to obey all the right rules for how you're supposed to do stuff, and how do you get it there. I was going to the Cape in a T-38. I could put a pod on it and take the flight hardware, and I did. And so a crew from the launch center met my airplane, and they put it in bonded storage right away and took it out and loaded it, and I went into the crew quarters and briefed Pete and Joe and Paul on it and how it all worked, and answered their questions, and that was my support in that time frame.

One of the big lessons—and it didn't all come from Pete—was in learning how to deal with longer-term space flight and crew adaptation. It was a well-kept secret that about half of the crews got sick, or whatever you want to call it, in Apollo. Not even the astronauts always knew what happened; that was considered a medical, private thing. When Pete and his crew went up, there were no expectations of them, because their workshop is broke. It's not even clear they can salvage it, so anything they do is great, and they'll be heroes. They got the parasol up and that worked, and started to get cooler in there. They did some EVAs [Extravehicular Activities] and pulled the other solar array loose, which got a lot more power, because up to that point the only other power was on the arrays that were on the multiple docking adapter. So now they got half of the lab's power going, and then they did some experiments as well, which included the medical experiments, which is why Joe was there. But they were a raving success because they saved the machine.

When “Beano” and his guys came up, the mentality tends to be continuous on the ground, and so Pete and his guys saved the machine. You know, they didn’t do a hell of a lot other than that that we had originally intended, and so again there’s not a lot of expectations and a lot of pressure on Beano and Owen and Jack. And they got up there, and in retrospect, they started nice and slow, and they got into it. They stayed ahead of the ground as they developed, and right up to the very end, the entire ground team could not keep them busy. Didn’t matter how much you sent them, they did it, and they pioneered some things, like whatever it was called, the work bin, where, “Okay, here. Just send us up the list of things you’d like to get done at some point, and if we can fit it in, we could.” And at the end of every day, they were done; the bin was empty.

Unfortunately, that same mentality on the ground carried over for Gerry, and Gerry and Ed and Bill were expected to hit the deck running and be just like Bean. They weren’t given the time that Beano and his guys were to get slowly up to speed, to get over any discomforts that they had. Bill Pogue got sick. There’s the infamous story where, unfortunately, on the recording of the intercom [intercommunication system], he and Gerry are conniving how they’re going to throw it all away, because one of the Skylab experiments dealt with the metabolic take-up of astronauts, and for three weeks before the mission, all during the mission, and for I forgot how long after the mission, you were restricted to the Skylab diet. Everything that you took in was measured, and they knew what was in it, and everything that came out of you was saved for later analysis. So by the rules, this bag of puke is supposed to be brought home, but they didn’t want anybody to know that Bill had been sick, and so they apparently threw it into the trash airlock, which went then into what was the oxygen tank, and it was gone forever. But unfortunately, they

talked about it over the intercom, which they had forgotten was recorded, and so Alan Shepard had to formally reprimand them.

They never did get on top, because the ground kept waiting for them to be just like Bean. I recommended that we give them a few days off, because I was part of the support crew on both of those, taking my tour as a CapCom as well as supporting some of the other things that you're going to ask about later. I recommended we give them a couple of days off, and every time I recommended it, it was agreed, but before we could execute it, it got, "Yes, but we need this, that, and the other," and pretty soon it's all full again.

So they never got on top of it, but that was one of the things that Pete brought back was that you need some time to get adapted. He brought back some very practical information about the EVAs and the need to be restrained, commented on some of the screws that had backed out, and in zero-G, screws tend to back out, but torquing them down doesn't always lock them in. So there was a bunch of engineering things, but from a crew perspective, it mostly dealt with how do you work for the longer term and how do you grow with it.

WRIGHT: Skylab was a twenty-four-hour operation. How did that affect your ability to do your job? Were you on call the entire time the crews were up?

LENOIR: Actually, all three of the missions had three people on board at a time, and they were all on the same shift, and their shift was sunk to Houston mostly for the convenience of Houston, so that their nominal workday was eight to five or six, although an astronaut's workday is a lot longer than that, and they would sleep at night.

Then on the ground there were three different teams in work at any time. There were actually five, but they took different times. There was the execute, there was the planning, and then there was the late-night shift, so stuff was going on all around the clock.

During Skylab [3], Beano's flight, I was also still training as a backup for the next mission, so I supported that as a CapCom, talking to Bean and the guys, helped be an interface for the solar science community in talking with primarily Owen about the solar science, and then also talking to Owen and Jack about the pictures of the Earth they were taking as part of the Visual Observations Program.

At the same time I was in full-time training to be a backup for the next mission. During the last mission, of course, I was no longer training, and so I was more or less full-time supporting that. Then I took up all three of those things again. CapCom; I spent a lot more time working with the solar scientists to make sure that we could get what they learned into it so that it wasn't always predestined.

One of the things we learned on the very first Skylab mission was, there were two X-ray experiments, one of whom came into it with an anti-manned bias and built everything automated. Another came in, and he had listened to some astronauts who said, "Hey, we can intervene," and he had automation, but everything could be intervened. You know, it's kind of like a camera now that's automated only, or you can get in and change the settings. What we found when we got up there was the Sun was a different animal than we thought in X-rays. It was a lot hotter. The guy that had everything automated didn't get nearly the data he could have, because he had guessed wrong. The other guy was able to make all the changes and have the crew redo things and do some things manually, and so there was a lot of interacting with them of what have we

learned, what do we want to do differently, what do I need to tell the crew so that they really understand what you're thinking.

Then during that mission we also pioneered actually having one of the scientists—they had a term that they called a czar, and I forgot; I think it was for a week. I think there were six PIs [Principal Investigators], and they had to work as a group, and they sometimes had competing requirements. They got together and decided that they weren't going to ask NASA to adjudicate their differences; they would do it themselves. They had what they called a czar. One of them was final say for a week, then another, then another, and so they took turns, but that was the final say, and he was the boss.

So the ground team had grown up distrusting the scientists and not allowing them to talk directly to the astronauts, and we set it up so that I think it was once a week, but I forget, where the czar would come online and talk to the crew for a pass or two, and this was back in the time frame before the TDRS, Tracking [and] Data Relay Satellites, where you'd have anywhere from five to ten [to] twelve-minute passes as you went over specific ground sites, so you could talk for that long, and then you can't communicate. So we set that up, and then on the Visual Observations Program, I would brief Ed, and Bill Pogue on the last mission, on what it was we were trying to do, what we thought they were going to come over. None of this was an official program, but we would send them up a list of sites and when they were going to come over, "If you got a chance, get this kind of a picture. Tell us what you see about this, that, and the other."

There were a variety of different things that we were looking for to take advantage of the viewpoint from space and the fact that there's a human there. It's one of the things that we had learned what—I've forgotten who called it; I think it was Gerry Carr—"the picket fence effect." You know, if you stand outside a solid fence that the pickets don't quite touch, what do you see?

You see a fence. If you're driving by it in a car, what do you see? Well, you see right through it, because your eye and your brain integrate the picture looking through those little slots, and eventually you get to see everything. If you take a picture of the Earth, you see a hazy Earth. If you go over it with eyeballs that are continually looking at it, you see much more clearly, because it's like the picket fence effect; you're looking through it better.

And so we were trying to take advantage of that. We were trying to study the oceans. We were looking for some geological features, and we had three different scientists that were working with me on it. Bob [Robert E.] Stevenson was at the Naval Research Institute; actually, it's Scripps [Institution of Oceanography] in La Jolla [California]. He was looking at it from a Navy perspective, studying the oceans.

One of the interesting things that he had seen earlier was what looked like what he called a backwards eddy. You get eddies where, you know, you flush a toilet and things go around, and it looked like there were a couple cases where there some going the wrong way, and he wanted to know more about those, because they had some interesting implications to the Navy, in that if that was true, then you were going to have a zone where sonar didn't penetrate; i.e., a submarine could hide. So we set up a big program to find those, and we had trained on that.

Then two geologists, Lee [Leon T.] Silver, who is played up real highly in all the Apollo stuff, and Bill [William R.] Muehlberger at the University of Texas [Austin, Texas]. Lee Silver was at Caltech [California Institute of Technology, Pasadena, California]. And they worked with me, picking out geological things to look at. So that was that program, and that was pretty much where I did it.

Now, on the last Skylab mission, it was eighty-four days long. I went into it without really thinking ahead, and I got myself in a bind where I had a critical job, or so I felt, and there

was me. I didn't have a backup. I worked eighty-four straight days, sometimes twenty-four, thirty-six hours straight, just because that's the way it jammed up, and I loved every minute of it. I felt like I was doing something worthwhile and, you know, I was part of it. Then, unfortunately, that program ended, and there it was.

WRIGHT: What were your thoughts at that time, knowing you were working in a program that was ending? Did you have curiosity?

LENOIR: To be honest, I didn't think much about the ending. I tend to get engrossed in what's going on and not think too deeply into the next step. I didn't develop those abilities until later, and so right up to the very last day I was trying to get in as much as we could on Earth observations and to squeeze in the last solar work. There was going to be plenty of time to think about it later, because there obviously wasn't a whole hell of a lot to do.

One of the things you had asked was about the potential of a rescue on the middle mission, and my role on that was to get out of the way. Basically the idea was that there was a backup command module, so that we needed three, and we had four. One of them, the other one that was never used—it might have been used for the Apollo-Soyuz [Test Project], I don't know. Otherwise it's in some Smithsonian [Institution, Washington, DC] somewhere.

It had three couches, and underneath the couches there was some deck where you could get. In order to make room and have the weight and center mass and everything right for returning three crewmen, it was decided that a crew of two would go up and do that. The center guy, which was me, would not go, and his couch would not go, and so whenever there was training for rescue, Vance and Don did that, and I went off and did something else, so that was

real easy to support; it's just kind of get out of the way. Luckily, that never happened, although as crewmen, I'm sure both Vance and Don had mixed feelings about that. You don't want anything to go wrong, but you sure do want to fly.

WRIGHT: When you were at MIT, you said that one of your areas was remote sensing. Did you feel like some of the theories and some of the areas that you had thought about, you were able to apply to your Skylab experience?

LENOIR: In a general sense, yes. Specifically, no. At MIT I was in the Radio Astronomy Group, and I was doing radio astronomy just like everybody else. The only thing is that my subject was a lot closer than theirs. I was doing theory around radio astronomy of the Earth from orbit, whereas they were doing radio astronomy of Venus, stars, and other things, and so I was looking to how do you look back in radio spectrum at the Earth and infer what the temperature is as a function of height, way up, and if you have a map of what that is over the Earth, then you can really make much better predictions. It took, I think, fifteen years before the ability of the hardware to be built caught up with what that was. But the idea of sensing the Earth, in general, was what drove that whole Visual Observations Program, and I felt like I was very much in the middle of it.

I had maintained my connections to MIT. I had resigned as principal investigator on two things that were going to fly on Apollo Applications, and became a co-investigator; let somebody else pick up the principal role, since I didn't have the time. But I was a co-investigator on a whole handful of remote-sensing programs, some on manned spacecraft and many on Nimbuses and things.

WRIGHT: Another thing that you mentioned was that the investigators worked out their issues and had this czar that took turns. Were there issues that had to be worked out between what the PIs wanted and what the ground crews wanted and what your Skylab crews wanted to do?

LENOIR: Not very often. Occasionally there was a disconnect between what the PIs wanted to do and what the ground team wanted to do. Some of the things required reorienting the spacecraft. The solar experiments were lucky, because since the spacecraft had solar cells, it was oriented to always point to the Sun, and so obviously we pointed the solar telescopes in the same direction, so the Sun was always out there. The Earth experiments, if you weren't going to have a person look out the window, but you were going to take high-quality stuff out a very high-quality window, well, then you had to reorient the spacelab [Skylab] so it pointed toward the Earth.

Then there was the discrepancy between not just the orientation, but crew time. One guy can only do one thing. He can either do solar science; he can do Earth science; he can do some medical experiments, or he can do housekeeping things as mundane as eat dinner or clean up, because with only three people, everything that happens up there, happens by one of those guys. There's nobody that's going to come in after you and clean the restroom or any of that, and so it just takes a lot of time. So usually it was around crew time.

I'd say the teams worked together very well, especially the Flight Directors. There was Don [Donald R.] Puddy and Neil [B.] Hutchinson, Chuck [Charles R.] Lewis, Milt [Milton L.] Windler, and Phil [Philip C.] Shaffer, and when Chuck Lewis got sick with some gut problems for a while, Gene [Eugene F.] Kranz came in and subbed for him for a while. But those guys, in

their heart, wanted it all to work, also, and the only reason it was up there was for doing these experiments, so they bent over backwards to try to make it work, and it was a good team. The key thing usually was getting whoever thought they had a disagreement together, so they could talk to each other and understand what each other's needs were, and why what you wanted to do was really going to mess me up, why what I was going to do was going to mess you up, and if I could understand yours, then maybe I can think a little bit about mine. "Well, if I do it differently, then you can do it." It almost always came to a decent outcome.

We discovered that letting the PIs actually talk to the crew worked out just fine, that it wasn't a problem. It took a while on the first mission. That's one of the things that Pete learned that the ground hadn't learned that, "Hey guys, I can either do the work you want me to do, or I can talk to you; but I can't do both. So every time we get a ground contact, don't call me and make me talk to you, because I've got to stop what I'm doing and talk to you." It took a while, but eventually they caught on. What really helped was when Beano and his guys got so far ahead, was that the attitude in the control center was, "Hell, let him run. They're doing better than we are."

WRIGHT: How did you transition from your Skylab duties when they, of course, went away because the program went away, to your duties to be part of this NASA Satellite Power Team?

LENOIR: The first thing I did was coming out of there, there was a NASA summer study at Snowmass [Colorado], which is right next to Vail. It was summer, so you don't have to get suspicious; it was summer. I told them they had the wrong time of the year. Being an Earth observer, I went and I gave a talk, and I think it was a two-week summer study, and I had a

couple things that I was presenting. I took my family—my wife, my son, my daughter, and my dog—and we drove out, rented a place in Snowmass for a month, and so I worked for two weeks, which was really nice, not bad work, and then stayed for another two weeks, just us.

My dog was a white German Shepherd, and at one point he got into a skunk and learned what skunks were. I saw it happen. He saw it, he ran up to it and grabbed it and gave it one shake, and then he threw it down and then he yelped, and then he went running around the blacktop trying to scrape his nose. Everybody said tomato juice is what you use. Well, that dog was pink when we were done.

WRIGHT: But was the smell gone?

LENOIR: Yes, mostly. As I've learned with another dog after that—but whenever they get damp, the smell comes back for months.

And then I gave what was called—I called it a dog-and-pony show. Everybody wants to always hear from the astronauts, and so for the local community I talked for a couple hours on Skylab and showed some slides and stuff, and I had referred to it at home as dog-and-pony show, and somehow my daughter picked that up as its official title, and she wanted to go see the ponies. No, it doesn't work like that.

But that was kind of in the interim right after Skylab, and then I thought I was going to do just like everybody else, which was sit around the office without much to do, get back more deeply into my research. At that time I was still officially an assistant professor of electrical engineering at MIT, on leave. It wasn't till a couple of years after that I got a phone call from the head of the department wondering if I was ever going to come back, and I said, "Gee, I don't

know.” And he told me something I hadn’t realized, and that was, did I realize that I used up a slot; that the department only has so many slots, and by being on leave, I’m filling one of them. And that afternoon, I resigned. I said, “Hey, that’s not fair. You need more people,” and so I resigned. I hadn’t realized I had done that to them.

So I anticipated getting more deeply back into the research, because I’d gotten out of it pretty much, when Jack [Harrison H.] Schmitt called, Jack, who had been one of the last on the Moon, and then had gone to NASA Headquarters [Washington, DC] to be Assistant Administrator for Energy Programs. This was in the time frame of that first big Arab thing with the oil, and everything’s expensive, and we’ve got to do this, that, and the other. In my group, Joe [Joseph P.] Allen had gone to Headquarters as Assistant Administrator for Legislative Affairs, a job he was really good at. Joe was really good with people and could work politics in a way that I couldn’t. I don’t even think it right. I’m just an engineer, basically.

Jack called me and said that there was a bunch of people that were talking about satellite power, getting a satellite up, big satellite with solar cells, turning it into electricity, turning that into microwave energy, beaming it down to the Earth, receiving it, detecting it, and then turning it into AC power and putting it out on the grid, and he was putting a team together to look at it. Would I lead the team for him? I said, “I don’t know. Let me come talk to you.” Another excuse to fly to Washington. It was the flight, not Washington.

So I flew up, and I talked to him about it, and I agreed to do that, and I put a team together that had—golly, I’ve forgotten names now. Somebody from Lewis [Research Center, Cleveland, Ohio], who were into the solar cell stuff and some of the microwave; a guy from Marshall [Space Flight Center, Huntsville, Alabama]; Hugh [Hubert P.] Davis from JSC. What was his name? Somebody from [NASA] Ames [Research Center, Moffett Field, California].

Gosh, I'm terrible with names. He was crippled. Because they worked on some of the power sides of it, also. I don't think I had anybody from the Cape.

WRIGHT: Anybody from Goddard [Space Flight Center, Greenbelt, Maryland]?

LENOIR: No, I don't think so. Basically, the whole concept was there's a satellite with solar cells. Okay, so I need somebody in the solar cell side. Then there's the detection of that and turning it into microwave energy and beaming it down and then receiving that, so I need somebody on the microwave end of it. Then there's the receiving and turning it into regular power; well, any engineer can deal with that. Then there's, hey, look at all this megatons of stuff that has to go up; that's Houston and Marshall.

We met for two years, and we looked at that, and it was really interesting. I started it fairly naïve, with no idea how to proceed, and kind of figured it out as we went along. We involved Boeing [Airplane Company], who were doing some systems studies on their own; Raytheon [Company], who were doing systems studies; Spectrolab [Inc.], who made solar cells, were part of the Raytheon team doing studies. What was his name at Rockwell [International Corporation]; was a forward thinker. He'd done some pontificating on it, and we talked with him.

Then we met and we just hammered some stuff out and looked at it from a perspective that said if the end result is we want to put power on the grid for people to use in their home, then the key measure is cents per kilowatt-hour, and it's real easy today to find out what's competitive. We can look at various projections as to where it may be going, and do high, medium, low, and all that.

Then the question is, how much would this cost? Well, what would it look like? How would you get it there? And so we put all that together. We identified what we knew. We identified what we didn't know. We did a real rough sketch of programs that would let us learn what we didn't know but needed to know, and then we took some optimistic guesses at what things might cost and projected that it would cost—I've forgotten the numbers—so many cents per kilowatt-hour, which wasn't immediately competitive, but it wasn't out of the question. But we had obviously made some very optimistic assumptions along the way, and we had said that.

We wrote three reports, submitted them. I was called up to testify to the House and the Senate, which was a brand-new thing for me. It was a big deal for NASA, because they wanted the program to go forward, because they didn't have anything. They had Shuttle coming and nothing else, and so they wanted it to go forward, so it mattered to them. Jim [James C.] Fletcher was the Administrator, and George [M.] Low was the Deputy, and when Jack said I was going to brief the Senate, because they wanted to be briefed, immediately Fletcher and Low got in the loop, because they wanted to—so I had to dry-run this thing, and I hate dry runs.

I'm reminded of a friend of mine, the same Jerry Grossman who was my college classmate, who was at Harvard, who advised me medically. He was drafted by the Air Force on the Berry Plan, so that he ducked it initially, but eventually he had to go in. This was around the Vietnam [War] time frame. Jerry was both an engineer and a medic, and he was real big in computer-aided diagnosis, so he did a whole bunch of computer stuff for the Air Force, and in some cases it was leading-edge. At one point he had to brief the Secretary of Defense, and Jerry was one of the least military people you can imagine, and it terrified everybody in his chain of command. "My god, we can't have him talk to them."

"He has to. He's the only one that understands what he's doing."

Everybody from him up had to have a dry run, and he was telling me afterwards—I had dinner with him once when I was in flying school—he was saying that the first thing he would do is, he said, “I don’t really understand why I’m doing this dry run for you, because you have no assurance whatsoever that what I’m about to tell you bears any resemblance to what I’m going to tell the Secretary.” Well, that didn’t make them real confident.

Then he gets up to Washington to brief the Secretary and finds out he needs a certain uniform, dress blues. He doesn’t own a set of dress blues, and so somebody arranges for him to borrow. It’s a little bit big, but he’s doing it, and they’re waiting around in the outer room for the Secretary, having coffee. Jerry excuses himself to go to the bathroom. He goes to the bathroom; he stands to the urinal, and he’s going to the bathroom, and he realizes he doesn’t hear anything. He looks down, and he has peed all over the front of his coat. At that instant somebody comes into the restroom and says, “Come on, the Secretary’s ready.” So he goes to brief him. [Laughs] So I’ve always thought about that when I did all those dry runs, but I never had the guts to do it.

It was really interesting, because at one point they were really adamant as to, “You’re going to brief the Administrator, you’ve got to follow our rules. We need all of your stuff the night before so we can make the right viewgraphs. You can’t do it on other stuff.” So I sent them up, and I got them back the very next morning; a couple of them are wrong, and so I didn’t say anything, I just substituted my own home-done one that didn’t have the right overhead or anything, but it was right, and I briefed them.

The interesting thing was, that I learned then, it’s very difficult to brief both Jim Fletcher and George Low, if you do it the way I did it, because I sent my charts up the night before. I start talking. Jim’s the lead guy; he’s looking at it right now for the first time, and he’s hearing me talk. George has read everything the night before, and he’s got six detailed questions he

wants to ask. Trying to deal with both of them was really interesting. But I really respected George. He's one of my heroes.

We got all done, and George had some questions, and he pointed out some things that weren't quite the way it ought to be, and maybe if we did this or that. He was also paying attention to keeping it right, doing it with integrity, but seeing it this way instead of that way. Why don't I go home and think about that, and let's talk about it again in the morning.

So I came back the next morning, and Fletcher wasn't there. Low was, and I went through the stuff very quickly with him, and one of the proudest moments was when I was all done—he hadn't said much when we went through. When I was all done, he just looked at me and he says, "Outstanding." And that was all he said.

Then I was off to brief the Senate, which was interesting, and the House. That was the first time I had ever done that. And that was the upshot of that, and to this day, I think what we said—and I probably somewhere in some crate somewhere I have a copy of those reports—was still true. Most of it is still unknown, and it's probably not very practical, certainly not with today's cost of launch, and we had to assume that we could get the price down, way, way down. I always thought about it, as an ex-radio astronomer, that you look up at the night sky, and it's wonderful here. You know, if you had a whole bunch of these things around the equator, you'll look up at the night sky and you're going to see these, and they're going to block stuff, and I'm not sure we really want to do things like that.

But anyway, that was an excellent mix of engineering and management for me, in an unofficial way, where I was in charge and had to figure it out as I went, without the slightest idea of how to get there from here when I started, and it went out pretty well and got well received.

WRIGHT: Sounds like it. Before we move into the areas of how you impacted the Shuttle and that era, let's take a break and change out some tapes and just stop for a few minutes.

[Tape change]

WRIGHT: I'd like to start this tape by asking you how your tasks and your assignments were transitioning into the new era of the space agency, which was the Shuttle era. How were you involved, and what were you learning about how you were going to be involved with the Shuttle Program?

LENOIR: Okay. Let me back up a minute in order to tie this together. One of the things that I've been trying to do as I go through here is mention people by name. Unfortunately, sometimes I forget the names of those that I wasn't real close with, but I try to do that because I think, outside of the astronaut corps and some well-known people, Flight Directors, John [W.] Aaron, etc., the people that are the real heart and soul of the program don't ever get any credit for it and hardly anybody knows them by name, and all of them have names and they're real people, and so whenever I cross paths with them, I try to mention them by name.

Way back in 1969 when I got back from flying school, shortly after that in the Astronaut Office on the third floor, back by the coffee, a guy came in and says, "Hi, I'm Dick [Richard H.] Truly," and he stuck his hand out, and sure enough, he had on the yellow badge, and it said "Truly," and I probably said some joke like, "Truly?" We shook hands, and that's when I found out about the MOL, the Manned Orbiting Lab, astronauts coming from the military, and met Dick and all of his cohorts, which included Al [Albert H.] Crews who was too old to have been

an astronaut, but he was out at Aircraft Ops [Operations]. Subsequently, Dick Truly and Bob [Robert L. “Crip”] Crippen became my very best friends to this very day. I wanted to go back and mention that that’s when I first crossed paths with them. I did a lot of work with Dick Truly around the Orbital Workshop. He and I were both the engineering guys on that.

I worked with Bob [Robert F.] Overmyer on the airlock module with me as well, and then subsequently Bob and I flew together. But in this time frame, coming now into the real Shuttle Program out of the Satellite Power Team—and this was in 1986; I did the Power Team from ’84 to ’86—we’re beginning to get a little bit more serious about the Shuttle, and the astronauts are having a bigger role. I was assigned.

If I’m not mistaken, at this point George [W. S.] Abbey was the Director of Flight Crew Operations. We went through a variety of things here after Deke retired. We had Kenny [Kenneth S.] Kleinknecht for a while, and then somebody—I’ve forgotten whom. Somewhere along the line, George came up, and they invented this god-awful thing of George and Gene being parallel and Cliff [Clifford E.] Charlesworth being over them, and George and Gene never did get along.

But anyway, so I was assigned; I think I was assigned. I was the type that if I wasn’t assigned, then I assigned myself something. I don’t want to sit around here and wait for somebody to call and not be doing anything. Where can I add value? And I know of at least one of those where I wasn’t doing anything, and I asked Crip, I said, “Hey, where can I add value?”

He says, “Hey, I’ve been working on these CRT [Cathode-Ray Tube] displays. Why don’t you give me a hand here.”

But one of the things I got into then was the Spacelab, and I don’t know whether that was ever an official assignment, but I took it on, and my mentality said it makes a lot of sense for me

to do a little bit of stuff around Spacelab, because I have just come off from Skylab, and I have a lot of experience, short of being on the crew myself, but none of them are available right now, and so it makes a lot of sense. So Joe Kerwin and Paul Weitz were also follow-on. It turns out that Ed Gibson, who had flown eighty-four days on the last Skylab mission, had retired, and he was under contract to ERNO [Entwicklungs Ring Nord Organization, Space Division of Eum, VFW-Fokker-Mannheim] in Bremen, Germany, for working on the Spacelab Program.

So I worked with that and tried to envision operations there and how some of the discrepancies between the way they were doing it their way and we were doing it our way in the Shuttle, which ones could we live with and which ones couldn't we live with. I remember getting embattled in something around a computer, and I can't even tell you I remember what the issue was, but I was dead set that we were right and they were wrong, and of course, they didn't want to listen, so they wanted to do it their way.

We went over to a preliminary design review that was real interesting. It was, I think, two or three weeks. We started in Nordvik, Holland. We rented a car and got around there, and then we drove from there to Bremen, and then we drove back, and then we went back to Bremen and back to Nordvik and home from there. But in one of the Bremen things, the German computer software designers were fighting us because they didn't want to do it our way, and at one point they got to, sitting there at the table, just talking back and forth very quickly in German. [Imitates] Back and forth, back and forth, back and forth, as though we weren't even there, and when they finished, I said, "Excuse me, I need to go to the bathroom."

And so one of the guys on our team, Gunter Sabionski, came too, and I said, "Gunter, what did they say?" He's excellent in German, so he told me everything that they had said, and I

said, “Okay, we can’t live with that,” and so we went back. We wound up prevailing, and to this day I think it was the right thing to do.

So I saw that through the preliminary design review, and then did a first rough-up of how would you activate it in an engineering sense, you know, how you use it depends on what it is, and—let me get the order right. Then I think is when I helped Crip around some displays, and I’ve sort of picked up the SM, the system management, set of software, to dig into that. Found a couple things I didn’t think were right; wrote some change requests; defended them to Glynn [S.] Lunney and convinced Glynn we needed to do those, and then those got in.

Then I think it was in 1978—might have been ’7[7], but ’78, when George asked me to follow the remote manipulator arm in Canada. Don Lind had been following it, and Don is a—basically, he’s a scientist; he’s a physicist. He’s not an engineer; he’s not a practical operations person, which is what I’m all about. So when I started that, that was quickly my conclusion, was that, “Nice idea here, but this isn’t the way to implement it.”

I think the Canadians, by and large, liked me. There was a couple of areas where we crossed paths, and one where I just couldn’t get them to agree with me, and I wound up ramming it down their throat, and it was the way they implemented their eight-ball, which was different than the way the Shuttle did its. I told them the way they did it is absolutely right for a crane-type operation. My problem was that if we had eight-balls that were different; it was yaw, pitch, roll versus pitch, yaw, roll, if you know what that means. That was a training problem, and it was also a potential safety problem where in the heat of the moment, a crewman might think wrong; think the other one and do something wrong. They’ve just both got to be right, and there’s no way in hell we’re going to change the Shuttle. Therefore you’ve got to be pitch, yaw, roll. They didn’t agree. We wound up going all the way up to whoever it was, Lunney or

Charlesworth or somebody, and they went our way. So it got rammed down their throat. They did it. They resented it for a while, but I think, by and large, they appreciated the new approach, where we were looking at, from an operations perspective, and I helped them with some of their engineering things.

“How do we certify this thing? Let’s don’t just certify it as a piece of hardware, but let’s certify it as a complete system that’s got the human operator inside, so we’ve built the procedures and everything.”

The first trip I made up there, I went with Lou [Louis V.] Ramon, who was in the Flight Crew Support Division, dark, bearded person, Middle East descent, which I have to pay attention to in order to even think it, because I don’t notice things like that. One of the stories I tell was, I’m very active in MIT alumni activities, and when I was President of the South Texas Alumni Association for MIT, we had a meeting and one of the new graduates was there, a fellow named Sam Denard, and we talked and got into a whole bunch of stuff, and later I was talking to somebody about Sam, and he was saying, “Yeah,” and he said something about him being black. And I said, “Black? We’re not thinking of the same guy. Sam’s not black.” Well, turns out Sam’s black as the ace of spaces, and I hadn’t noticed. So normally I don’t notice things like that.

But anyway, so Lou was with me. We had to make a connection in Chicago [Illinois] to Toronto [Canada], and this was way, way back when. Well, Lou, even at that, set off all kinds of alarms in their mind, and we’d almost be strip-searched; and he always would. After the first time I went through with him, I said, “Hey, we’re going through one at a time. I’m going to pretend like I don’t even know you.” And I decided, “This is dumb. We’ll lose a lot of time connecting in Chicago; can’t get there from here. We’re going to take T-38s.” And so I came

back to Aircraft Ops and says, “How do I work this? Don’t have a clue.” So I got them to help me some.

I worked it with the U.S. State Department and the Canadian equivalent of the State Department, and finally got an agreement through where we could, on official government business, fly T-38s into Toronto, Montreal [Canada], or Ottawa [Canada], all three places where they had some space things. What I tried to sell was, “Hey, we’re government employees on official government business. We’re flying airplanes that don’t have long ranges. Especially in the wintertime, I want the guys returning—especially since it’s going to be me a lot of the times—to be able to focus on where’s the weather the best, not where is Customs. So what if we just waive Customs, and we’ll promise you that we’ll shoot anybody that breaks the law?” Canada went along; the U.S. couldn’t.

So still, the very first hop down, you have to clear Customs, and people have pointed out that—you know, when you fly in and out of Toronto, you clear U.S. Customs there. My answer is, “Yes, *you* do, but the airplane you fly in clears when it lands.” And so I was told yes, I could clear, but I’d still have to do Customs for the airplane when it first landed. But we got the deal going. We go in and out of Canada like we didn’t exist; they don’t care. But we still have to do Customs, and so we made a note of where the bases were, where you could get Customs, and which ones were fast, and which ones weren’t.

Sometimes we’d bring back beer, and I was always honest. You can bring back the equivalent of a six-pack, or wine or booze or whatever, and I always told them what I had. A couple of times there would be two or three six-packs of beer in the pod; gets it nice and cold. And I’d tell them which was over and supposed to—nobody ever made me pay duties. They said, “Yeah, that’s fine. Go ahead.”

But anyway, that was one of my big contributions, was getting the ability to use the airplanes so that I didn't have to go the commercial route.

One of the times when I did do a commercial flight, though, I was making a connection in Atlanta [Georgia] on the way home, and I sat, I think it was, with Lou Ramon, I'm not sure. In Atlanta we had several hours to kill in the bar, and on the little cocktail napkins in a ballpoint pen roughed out the first set of flight procedures for the RMS [Remote Manipulator System]. Drew the little pictures of how the talkbacks would change and everything. When I got back from that trip, I handed them to the procedures guy for the RMS and says, "Here's the first cut. Why don't you pull these up and let's see what it looks like." Somehow those have gotten lost to posterity. I wish those napkins still existed.

But we did tests up there. We learned some things; learned how it works, how it doesn't work. We certified it for its use in their simulation environment and looked at the flight hardware, and in the process, in 1978 we had the Thirty-Five New Guys come on board. John [M.] Fabian, Sally [K.] Ride, and Norm [Norman E.] Thagard were assigned to me, and so I got them involved in some of the RMS activities in Toronto. They were really good guys, and it's interesting that when their group first flew the STS-7 with Crip, those were the three on their group that flew on that flight, and so I always felt pretty good about, "Well, it can't be too bad to have worked for me."

But the RMS came along. It was a really good machine, and it has behaved well, and to the best of my knowledge, is still doing quite well and still pretty much under the same procedures as we had back then. I've occasionally gotten a question from a current astronaut; "Lenoir, somebody told me to call you. Maybe you know why it's this way." At one point I was

asked, “You know, there’s a limit to the minimum clearance you need on either side. Why is that?”

I said, “Well, that’s because that’s what it was certified for.”

And, you know, “Well, why that?”

“Because when we were doing it, I thought that was a good number and it would pass, and so we picked it. We made a mental note that it’s probably better, and it probably is, but you’d still have to certify it to that.” There’s a lot of corporate knowledge that’s gotten lost along the way.

That segued into the In-flight Tile Repair Program. Prior to the STS-1, there was the issue of the tile and whether it would stay on and what do you do if it doesn’t. I’m going to run up against one little issue here that’s probably no big deal now, but I treat these whole things seriously. There’s some classified information in here that I’ll skirt around and you can decide whatever you want about it.

So the question was what do we do about it; what can we do about it. There were three concepts. One involved the Manned Maneuvering Unit being built by Martin Marietta; another involved the RMS; and then a third involved a combination of ground sitings and MTV, Maneuverable TV, a Max [Maxime A.] Faget kind of a thing.

Basically, all those were melded into one from a crew perspective, and I was in charge because of the RMS activity. So I transitioned from being purely an RMS guy to now spending a lot of time in Denver on their simulator, doing it with the Manned Maneuvering Unit. We pulled that whole thing together. I kept Crip and John [W.] Young involved. We had procedures. We did things on the zero-G airplane that tested the material, tested your ability to attach, and all of that.

Basically had a program, and that's one of the examples I use of how a program ought never be run. There was a long period of time where the official contract documentation and reality at Martin were 180 degrees out of phase, where the program is contractually cancelled, and we are full steam ahead working on it. The contract is fully up to date, and we're full speed ahead, and we have stopped, and it's always because the contract lagged reality. I've forgotten what it was; it's like thirty-something people were employed full-time by Martin just to keep the paper chasing around; not adding any value to the program. That wound up going away when at some level it was decided we'd accept the risk, and that worked out fine.

At some point around there, the assignment of the first six flight crews to Shuttle was made by George, then that's because the first six were considered the Orbital Flight Test. The ALT, the Approach and Landing Tests, had happened somewhere in that same time frame, and I was only peripherally involved with that because Dick Truly was, and he was a good friend of mine. I used that to scrounge some flying time and some touching near it and things like that.

At that time, and I assume they still do, for flights or anything where there's risk, a crewman is assigned as—*handholding* might not be the right term, but is assigned the spouse of one of the flight astronauts to take care of and, in good times, to make sure that he or she understands what's going on and how it's going, and in bad times, is there to help get through the issues. Dick's wife, Cody, was not the easiest person for some people to get along with, but we were good friends, and so whenever Dick flew, I was the person that would work with Cody. And we'd joke about it and have a good time.

So I managed to go out and see some of the ALT things while I was doing these other things. But once the crews were announced, the first six, as I said, were considered Orbital Flight Test, with the premise being that it's operational after that. Then, obviously, things

change as you go. The first four were two men in *Columbia* with ejection seats up front. The fifth flight was also on *Columbia*, but it was the first four-man crew. The ejection seats were still in, but they were disabled. Then the sixth flight was the first flight of *Challenger*; four men with no ejection seats.

The assignment to the fifth crew was Vance Brand, Hank [Henry W.] Hartsfield, Joe Allen, and myself, so Joe and I were the first two from our group to be assigned flight assignments. Subsequently when Fred [W.] Haise retired, before STS-3 where he was to command, Jack Lousma moved up to command, and Gordon [C. Gordon] Fullerton moved from four to three, and Hank Hartsfield moved from five to four, and Bob Overmyer moved from six to five. So our crew, in fact, was Vance, Bob Overmyer, Joe Allen, and myself, and Joe and I were the first mission specialists.

I got into a debate with Vance around the ejection seats. They were going to be disabled; were, in fact, disabled, I think, and were not going to be used, and Vance was comfortable with that. My take was, why the hell should you lose four people if you could only lose two? If I'm one of the two that you're going to lose, I'm going anyway. Why shouldn't two of you get out? But Vance was never comfortable with that, so we flew with hot seats, but there were no procedures or plans to use them.

Then we trained as a crew, and subsequently, parts of our mission were called the first operational flight, because we, in fact, did operational things. We launched two satellites that were paying money for it. Back in those days, the Shuttle was going to be the be-all and end-all launch vehicle for everybody's everything, and a lot of the reason it's the way it is today was for some of the military launch requirements. So our two big things were to launch two satellites and to perform the first spacewalk, and then we had a bunch of other "dogs and cats," as I call

them, and some student experiments; a whole bunch of engineering tests to run, data to take, and so on.

The training was fairly straightforward, and we were clicking down the flights. Crip and John did their thing, with the big unknown there of nothing's ever been done before. Will the tiles stay on? Rockwell had a hell of a time getting them to stay on on the ground. Will they stay on with the rigors of space? And the answer is, fine; that worked.

WRIGHT: Where were you on that first Shuttle flight?

LENOIR: I was just an observer, kind of just like I was on Apollo 11. I was in the viewing room in the control center. Had gotten into some loops based on some classified data that gave us a little bit of insight into what was going on, and I was in that loop only because of the In-flight Tile Repair Program, so that I was supposedly smart about some of that stuff. But there were no issues.

Then Joe [H. Engle] and Dick did their thing, and Jack Lousma and Gordo; of course, they landed at Northrup [Strip], at White Sands [Missile Range, New Mexico]. Nobody's done that since. I guess *Columbia*, when she went recently, still had some of that [gypsum], I'm sure. They never could get that out.

The memorable thing about Ken [Thomas K.] Mattingly [II] and Hank Hartsfield was that they landed on the runway, on the hardtop, at Edwards [Air Force Base, California], and the President [Ronald W. Reagan] met them, and one of Ken's comments was that he didn't like that kind of a thing, because you've been in space, you're a little bit disoriented. You're going to walk down the stairs, and the first thing you're going to do is shake the hands of the President of

the United States, and he was worried that he was going to walk down and just fall flat on his face. Hank's comment to him was, "Well, then there's only one thing you can do."

"Well, what's that, Hank?"

And so he says, "Nice shoes, Mr. President." [Laughs] So we used to joke about that.

Then our turn came, and unlike the others, we launched to the second of our intended time that was picked, I think, like a year ahead. We didn't have any delays; we just, you know, click, click, click, click, click. Boom, off we went.

Help me get started on that, unless—is there anything up before that that I should have talked about but missed?

WRIGHT: We can talk about it while we talk about your flight, because I want to talk about the EVA training that you went through and some of the simulations.

LENOIR: I should go back, because in that same time frame with the RMS, I also became the lead astronaut for EVA, that Rusty [Russell L.] Schweickart had been, and then he retired after Skylab. He was the backup to Pete Conrad. He retired somewhere in that time frame, and then I picked up the lead EVA for the Astronaut Office; I don't know why. I had trained for it in Skylab, for one thing, so I had the training and everything.

One of the stories I like to tell was we had the big water tank back in Building 220 in the back of JSC, and you had to be qualified there, and I remember for a requal [requalification] at some point after a long down period, I was scheduled for the requal there. I've mentioned I was brought up in Miami and I'm very comfortable in water. So I went there, and I was told that—I think it was fifteen feet deep, maybe twenty; I don't remember—okay, everything's down on the

bottom, that you dive in and you go down there and you don your scuba gear down there. Then you do all your exercises and stuff, and then when you're all done, you doff it down there and then you come back up and you come on out.

But before I start, when I jump in, I'm supposed to tread water with my hands out of the water for a half hour. All right, I'm easy to get along with, so I do that, and then we start the whole thing. I go down; I get it. I get the stuff on. I do my stuff. I interact with them, and we're all done, and we're debriefing, and I asked them, "What was that all about?"

He said, "Oh, that's just to get your heart rate up, because we don't want you to come in there real cold. We need to get your heart rate up."

I said, "Oh, I probably should have told you that I came here from having just run ten miles." [Laughs]

And he said, "Yeah, you probably should have."

So I was the lead EVA person, which meant that primarily I worked up the procedures for the emergency cargo bay door closure. That was the only emergency EVA we had was if they didn't close—they've got to close for you to come home—then you go out, and basically you winch them closed and you tie them down. I worked up those procedures and spent a lot of time in a water tank doing that, and so to that extent it was natural for me to do the first EVA, but the real reason was that we wanted to do an EVA as soon as we could so we got all the things done before we needed to do an EVA, and we could do some engineering tests on it. But we weren't comfortable doing it before we had a crew of four, and so logically, the first crew of four, whoever they are, are going to do the EVA, and that happened to be Joe and me.

Of course, as it turned out, we didn't do an EVA. We had two unrelated suit problems that made his suit inoperable and mine questionable. His had a problem in the pump, and there's

a single pump that moves both the oxygen and the water, and the Hall effect switch in his pump circuitry had gotten wet and it wasn't working, so he was clearly no-go. I think, as I recall, the space suits are supposed to hold 4.3 pounds per-square-inch pressure, pure oxygen. Mine was holding 4.1, and it was rock solid, and it was solid there, which is safe. The ground did what was the right thing to do, which was to say, "We don't understand this. We don't have to do this EVA, so let's don't."

Of course, we tried to talk them into it. It was made more difficult by Joe being inop[erable], because now I'm trying to talk them into not only are we going to go EVA with a suit that you don't really understand, but there's only one person going to be out there, so you don't have a buddy system, so clearly that didn't work.

What we did was we put me in the airlock and closed the door and we did a partial decompression, trying to see what was going on with my suit, so I got in near vacuum, although I was never outside, and the suit held lock-tight. Subsequently, post-flight we found out that there was a spacing washer, spacer, in the pressure regulator that had been omitted, and so instead of holding to 4.[3], it was holding to 4.1. It would have been perfectly safe there. Knowing what the problem was, there was no issue; but not knowing, there was, and so that's just the way it worked out.

As an engineer, I can say after the flight that it's a hard thing to admit, but we learned far more from Joe and me not doing that EVA than we would have if everything had gone well. The problem with his Hall effect switch and the circuitry we found early. We could have found it on a mission that we needed an EVA. The quality-control problem around mine, we could have found when we needed to do an EVA, and we probably would have done it, but a lot of people

would have lost a lot of sleep about that. So we learned a lot more, but that wasn't the most comforting way to do it.

Our main thing was launching the two satellites. That was one of my main jobs. The other job was to invent the mission specialist role for the ascent and entry portion of the flight, that clearly two people can get a Shuttle into orbit and back, because they had proven it, and they had done it four times. On the other hand, if you've got another set of eyes and ears and a brain, you'd be stupid not to use it. The seating is such that there's the two forward seats with the commander and the pilot, and then the two seats behind them are skewed a little bit so that the left of the after ones is actually between the commander and the pilot. On the STS-5 configuration, that was the only other seat. There were only three seats on the flight deck, because there wasn't room for the fourth with the ejection seats in there, because they're huge. Subsequent missions, you do have four seats up there.

So Joe and I agreed that I would do that seat on going uphill, and he would do it coming downhill, and so that that way we both got it, and we didn't have to have somebody else tell us how to do it or who was going to do it. I took the lead in inventing the role from the ascent perspective, and a lot of that carried into the descent perspective. Joe was a very excellent scientist and also a very good person for dealing politically with people. Less so was he an engineer, whereas I was, I thought, a very good engineer. Not the world's greatest scientist, although I've got my union card from MIT, and, God knows, I'm the last person you'd send in to deal with something politically. I used to take advantage of that when I was at Headquarters. In our meetings I'd say something outrageous just to make sure the lawyers would be uncomfortable ever having me go testify or go to court, and I'd do it intentionally.

So I did the ascent and basically invented that role, along with Vance and Bob. They're going to do their thing; how can I help? Well, the obvious thing is I've got a checklist, and I read and tell them what to do and look over their shoulder and make sure that it did happen and help them interpret the feedback from that, and in the event of off-nominal caution, warning, or whatever, immediately get out the book and work us through the malfunction procedures and help us get through other things, so that I would try to back them up, which meant that I needed to learn their systems so I knew how they worked.

As an engineer, I always liked to do that. It's like I tell my wife; we go out to buy a toaster, and most people are looking at it for how it works. Well, if you leave me alone for five minutes, I've got it apart, because I'm going to figure out how it breaks and then how do you deal with it.

[Officially I was MS (Mission Specialist)-2, and Joe was MS-1; however, we reversed roles for entry with Joe performing the MS-2 Orbiter duties. MS-2 was MS with Orbiter duties (flight engineer) during ascent and entry. We jokingly called me the MS-2/1 and Joe the MS-1/2.] So we invented and then performed that Flight Engineer role, if you like. We launched two satellites and didn't do an EVA.

The satellite launches went off wonderfully. That was another case of never been done before, hasn't been invented, and so preflight, we had to look at the schematics, work up the procedures, work with the customer for how it goes. I can remember my clients at Satellite Business Systems. Subsequently that was a part of MCI [Inc.], but he [Mike Lyons] was the Vice President of Engineering. It's interesting, when I got to Headquarters, I hired him. So he was the guy I dealt with, and the thing was that in those days—again pre-TDRS—I think we only had communication with the ground something like 15, 20 percent of the time. We never had

communication with the ground crossing the equator. These things were going to get launched crossing the equator. By definition, we are not in communication with the ground, so when I coined the term Orbital Launch Director, that person really was the Launch Director, the final say for whether you launched it out of the Shuttle or not.

We would go through simulations, and I knew, I think, more about the system than the trainers did, and so I spent as much time training them as they spent training me, and I helped Sim Sup [Simulation Supervisor], oh God I went blank for a minute. Chuck [Charles W. Shaw]— Air Force major who was one of the Sim Sups putting in the malfunctions, and I would tell him the things that I thought we needed to look at, and sure enough, we'd see them, and not too surprisingly, I'd be ready.

But one of the things was in the mission rules was the temperature of the solid rocket. This thing that's back there spins. It's spin stabilized; it has a solid rocket, and you point it right with the Shuttle, and then its spin table spins it up, pushes it off on a spring, and half an orbit later, it lights off. Its ignition sequence got initiated when it left, and you can't turn it off, so you want to be gone. But it's got to be pointed right, and one of the mission rules was the temperature of the rocket engine needed to be, I don't know, 55 degrees, plus or minus 5, or it's no-go.

“Mike, how did you get that number?”

“Well, that's what analysis says it's supposed to be.”

Says, “Well, you realize if it's 56 degrees, when launch time comes, I'm not going to launch it,” and we won't get a shot again until day three, cause you're on day one. TELESAT is on day two. Your second chance, and their second chance, also, comes up on day three. Who knows if we'll still be in orbit?

“Let me think about that. Okay, Bill, yeah, we’ve got new numbers. It’s 65.”

“Roger, Mike.” If it’s 66 degrees—we did this, I think, three or four iterations.

Finally in the last iteration, he said, “Bill, launch. It doesn’t matter. If it’s off-scale high, launch.” So I had to pick on those things that they had decided, based on nominal analysis, what it should be, and they then translated that to those are our limits.

I say, “No, what are your real limits? Beyond this, it won’t work right. That’s what it’s supposed to be.” So some of our training was training them how to deal with their own equipment.

We got up there, and everything was perfect, and it went off just fine. Then Joe was the Launch Director on the next day’s one, and so I supported him from the background. Then the EVA was going to be on day three, if we didn’t need to do a backup one of those. On our mission, I think as early as day two, Bob Overmyer wasn’t feeling good, and he admitted it, and, you know, he filled a couple of bags. I never stopped giving Bob credit. We had a bunch of engineering tests to do. Sitting up in the pilot’s seat, taking data, doing this, that, and the other, he never missed a step. He didn’t feel worth a damn. He’d puke his guts out, and he’d get back to work. And he felt crappy for two days.

About a half a day or a day after he started, I felt bad, and talking later to Bill Thornton, Bill was saying that he thought what happened was I had myself so psyched up for the two launches that I didn’t let myself get sick, and that as soon as the second one was gone, I relaxed, and my body said, “Wait a minute. We don’t like this,” and so I got sick is the only way to call it. The real way I describe it is for about a day and a half, I felt like I had a low-grade hangover. Just like Bob, I could do anything, but I really didn’t want to do anything other than “curl up on the couch” and sleep it off, and basically that’s what happened. We postponed the EVA for a

day. I just kind of sacked out in the middeck, and then we gave it a try on the fourth day for the EVA, and that didn't work.

Both Vance and Joe had slow days, but they didn't have days like Bob and I did. Vance had an early slow day or two, where you could just tell, this isn't the same Vance. And Joe kind of ran himself out of gas the last day, because he wasn't sleeping real well, and some combination of that and he was making adaptation, and he needed to get some sleep, because I remember at one point he says, "Hey, Bill, take over." He was doing a student experiment. "Here, finish this for me." He says, "I've just got to get some sleep."

"Okay." And so it was an interesting thing—I'd never seen it before; and maybe I could figure it out. So it worked out fine. But that was interesting, and it was consistent with data all the way back through Apollo that said about half of the crew will exhibit some kind of a transition. You can call it being space sick, space adaptation syndrome, you know, all kinds of names that it's had, and basically, it's just your system's got to get used to it. Your brain's getting data from your eyes as to where things are; it also gets data from your ears, as to which way's up and what's going on; and for a while, in space, those aren't telling it the same thing.

Even today I have days where I realize this is a day where my brain won't listen to my ears, and at least I've figured that out, and I don't close my eyes a lot in the shower when I'm standing on one foot. So you go through that. No big deal once we learned it, and that's what had hit Bill Pogue on Skylab [4], but we hadn't learned as much. I think that that's consistent with what the Russians have learned. I'm not inside of what's going on now, but I can't for a minute believe that's not the same thing that's still happening, because humans are humans.

Anyway, that was pretty much our mission. It was pretty much as planned. We launched, like I said, to the second on November 11th. We landed five days and a couple hours later on the sixteenth, and came home.

WRIGHT: Any thoughts you'd like to share on the launch and the landing? I mean, you waited fifteen, sixteen years to fly.

LENOIR: I tend to be fairly relaxed. I sleep easily; I can sleep anywhere, anytime. In the Skylab training, when Vance and Don and I were doing a command module test at the Cape for—I've forgotten whether it was for Bean's crew or for Gerry's crew. It was a suited test in the command module in a vacuum chamber. The vacuum chamber is pumped down, so the command module is in a vacuum, and the engineers outside are taking a million measurements. And then we're supposed to evacuate the inside of the cabin, and they're making a million measurements. We don't do a damn thing. Well, when you don't do a damn thing, I go to sleep. The flight surgeon called and made Vance wake me up. I used to run a lot before I got a bad hip, and my heart rate was getting into the thirties, which they don't like, and the flight surgeon tried to cancel the test. They talked him out of it, but only if Vance would keep me awake, because then he'd make me move and do things, and my heart rate would stay in the low forties. So I tend to be fairly relaxed.

When we got strapped in on the pad, we were not in space suits. We were not in what they do today; we were just in our blues. We strapped in, and "Ox" [James D. A.] van Hoften strapped me in. A story on Ox was, much later, when I was at Booz Allen [& Hamilton, Inc.] and consulting, Ox worked for Bechtel [Corporation]. As a matter of fact, he was the senior VP

[Vice President] that was in charge of putting in that new Hong Kong [International] Airport [Hong Kong, China], and one of my senior partners [Bruce Pasternack] was in charge of consulting for Bechtel, from Booz Allen, and he met Ox one day at a big senior management meeting, and Bruce went up to him and says, “Hey, maybe you know a partner of mine, Bill Lenoir.”

And Ox looked at him and says, “Know him?” He says, “I strapped him into the Shuttle.”

But Ox strapped me in, and then as soon as he got out and they closed the door, and we’ve got two or three hours to kill, I unstrapped, curled up, and went sound asleep. Vance woke me up a half an hour or so before launch. I strapped back in, talked him through the checklist, and based on previous history, I fully expected we’d get up somewhere close, and we’d wave off; we’ll try it again tomorrow. We counted down, and you could feel the—just like the crews before us said, you can feel the main engines when they come on. You hear them. Actually, at five minutes you feel the hydraulic pumps come on, and then you feel the main engines come on, and just like it’s supposed to, the stack rocks over and then rocks back, and when it gets right there, [indicating vertical], is when the solids go. That’s why the main engines light at seven seconds before; it’s because that’s a seven-second period, and it will keep going. It will do that for a while till it settles out, but you catch it right here, point it straight up. Then you blow the bolts, light the solids, and sure enough, there was this bang, and off we went, and it was a rough ride, is the best way to describe it.

I remember at one point Overmyer said to Vance, because the crews before us hadn’t commented on how rough it was, and Bob said, “This is really rough.” I mean, it would shake your teeth. Bob said, “This is too rough, Vance. I’m afraid we’re going to come apart.”

And on a whim, I just said, “Relax, Bob. No use dying all tensed up.” You know, I’m the scientist and he’s the test pilot, and he was reminding me of that later. And sure enough, in two minutes it all got quiet and peaceful. The solids went away, but they were a really rough ride. Then riding on the mains, the [ride] was like an electric engine [imitates sound], and you don’t feel it. People say, “What about the G-load?” The G-load’s nothing; you pull more Gs than that in an airplane. The Shuttle won’t take more than 3 Gs, and if you fly an airplane the way I fly it, you’re out there intentionally pulling 7 or more Gs a lot. It’s not like Apollo, where on reentry you might pull 10 Gs.

So that’s very nice, and we got up and, boom, main engine cut off right on time, and so now we’re in zero gravity, and we’re coasting toward our first OMS [Orbital Maneuvering System] burn to circularize, and my first reaction was, “Uh-oh, something went wrong. I’m not in zero-G.” I’m firmly in my seat and everything. I took the checklist, and I held it out in front of me and I let it go, and it just stayed there. I says, “Well, it’s okay after all.” I’d strapped in so tight, it just felt like I still had G on me.

Then we got organized and went into our “Okay, let’s secure things. Let’s make sure that we’ve got the pins in the seats, and all that stuff is taken care of, and we don’t do anything dumb, and we get ready for the burn and secure things. Get the doors open after the burn.” Then we moved right into the first sequence for the first satellite deploy, and that was good to get that off successfully. Then we had dinner and went to bed.

There were four of us, and there were official places to sleep, and we told them we didn’t need all that stuff. Bob slept in a real sleeping bag that was designed for that purpose. He did it to test it out for the engineers. Vance didn’t like moving around a whole bunch, so he would tether himself with a little clip or something to a handrail so he’d be right there, and one night he

scared hell out of himself. When you're relaxed in zero-G, your arms are up here [gestures]; they're not down by your side, but they're up here, and I'd learned in all of my EVA training, because one of the reasons I did so well at it was that—a pressurized suit has a certain shape whether you're in it or not. That's the zero-energy shape. Don't try to relax the way you want to be; relax the way the suit wants to be. But Vance was sleeping, and he kind of woke up in the middle of the night, and here's something right out in front of his face, and it scared the hell out of him. It was his own hands.

I got myself in a little zone in the aft part of the flight deck, up over a panel, where there was a side panel end. It was actually the RMS place, where the RMS would have been, but we weren't carrying one, that you could bend it [yourself] just a little bit, and you'd fit right in, and then you relax out. But if you were relaxed, you didn't fit back out the opening. So I just kind of freely bounced around in there, being real careful that I wasn't going to hit any switches or anything, and that's where I slept. Joe was comfortable just wherever he was; he'd just go to sleep. He might wake up in a totally different place, but that didn't bother him. So that's how we slept and did that the first night.

The food was the food. After having been back up on Skylab with that awful mess, the regimentation was worse than the real stuff there, but the food was good, not great, but good; but then just like flying an airplane. You don't fly airplanes for the food; to get somewhere. We weren't there for the food.

I think you or somebody is always asking about spare time. Well, in five days, we didn't have any. I still maintain to this day the main thing that you need for using spare time is a window where you can see the Earth, and you can amuse yourself for months, just looking out at the Earth and watching it go by and seeing different changes and everything. You don't need a

deck of cards or anything like that. But we spent some time looking out. We took a lot of pictures. I still had my old Earth observations mentality and had some specific things that we were going to try to get.

Some of the things that we did way back in Skylab we specifically went after. I remember we went after Lake Chad in sub-Saharan Africa, because we'd documented that pretty good back in Skylab, and then ten years later we look at it, and it's obvious that the water in that area is going down; it's decreasing. So you could see some very interesting ten-year differences there.

But that's pretty much it. We didn't have a lot of spare time, and then it was time to come home.

WRIGHT: How was the landing? Was it what you had prepared for?

LENOIR: Oh yes. We landed on the concrete at Edwards. At least I think—yes, we did. I was in the middeck, and Bill Thornton had talked both Joe and I into doing some tests for him both on ascent, on orbit, and on entry, where he was monitoring how your eye movements go and how you react to that, so he had sensors on. You've probably seen some pictures of both of us looking rather stupid with this thing out in front that's going back and forth, up and down, and we're following it with our eyes, and I was really concentrating to do Bill's thing right, because I had a lot of respect for him as both an engineer and a medical doctor, and thought that he was really on top of a lot of the problems, whereas the medical community, I thought, were out in left field on some of them. So I was concentrating on that.

The only thing I was aware of was it got a lot warmer in the middeck than I had anticipated it would. It really got warm in there, and I could hear them on the intercom, but I wasn't watching anything, and Vance really greased it on. It was one of those—no jokes. “Hey, tower. Are we down?” And then one of our tests was to do a maximum braking test, and so Vance really got on the brakes, you know, smoked the brakes. But we were supposed to, and we landed nice and sharply, and got off and it was over. We walked down the stairs and “machoed” it out of there.

WRIGHT: After that flight, you worked on mission development. Can you share what that task was?

LENOIR: Within the Astronaut Office, at any given time you're divided up into sections. You've got a bunch of people that are assigned to flights or backups that are training. Then you have other people that are taking care of things that astronauts have to get dealing with. Nowadays, or at least in those days, there was two other parts. One dealt with the piloting aspects of it, and then the other dealt with the mission aspects of it. The piloting dealt with getting to and from orbit, and the mission aspect dealt with what did you do when you were in orbit.

So I led a small group of astronauts that followed the various things that we were being asked to do or to deal with in orbit. I was the directorate member of Leonard [S.] Nicholson's Control Board for Mission Development that had the vote for FCOD [Flight Crew Operations Directorate] as to whether that's right, wrong, or indifferent, and I tried to take it seriously and worked real hard at it. I got other opinions, and I think I developed a lot of respect, that unlike some of the people before me, I wasn't just coming in shooting from the hip with no knowledge.

Things were well thought out, and I'd give them answers when they needed answers, and everything worked well.

But it was making sure that as the missions got integrated, they got integrated from the flight crew perspective as well, so that it was a workable thing and that they didn't interfere with one another or involve something that's not the right way to do it. It was fun and interesting and got me a little bit into the NASA management scheme of things.

WRIGHT: In September of 1984 you left the astronaut corps. Can you tell us why you made that decision?

LENOIR: Yes, I had been assigned as the lead mission specialist on the Spacelab D-2 mission, the German mission. Bonnie [J.] Dunbar was another one, and had started taking German at my request. We had some ideas in the Astronaut Office that weren't always popular, and in some cases, in retrospect, weren't always right. But in that time frame, we were concerned about the people that wanted us to be off somewhere else doing a lot of training, long times in your flight, where some of the mission specialists, in particular, needed to be part of the launch crew and couldn't be gone for that long.

So we drew a line in the sand—John Young was the director of the office then; George Abbey was the head of FCOD—that said three weeks was the longest continuous time that it was okay for an astronaut to be away, and in particular what we were thinking of was the Spacelab missions where you would be in Europe, that we just didn't want somebody to have to go over there for six months and then go native on us and come back and not really be an astronaut anymore. That got all the way up to the Control Board, with Glynn Lunney presiding, and I

made the pitch, told them what the answers were from our perspective. And to this day I'll never forget it; John Young and George Abbey were there, sitting behind me, letting me make this whole thing, and Glynn looked at them and said, "What do you guys think about this?"

And George's answer was, "We can deal with it anyway." So Glynn disapproved it, and I decided that, based on principle, that I really believed what I was saying, so I went to George's office and asked him to take me off of the D-2 crew, that I really felt like I had said the right thing, and he ought to take me off that crew, and I'd go on a subsequent crew.

But at the time I knew George well enough to know that—well, there's an old Army term, that I had just shit in my mess kit. So I was forty-four and already aware that if I'm going to have another career, it's not getting easier by waiting, and so I had begun to think about what am I going to do next. In retrospect, I think if I had stayed, I would have flown again. George would have rubbed my nose in it somewhere along the line, but I would have flown again. I didn't want to be like Story and fly seven or eight times and retire there.

Then out of the blue I get a phone call from a headhunter who said he was representing somebody in the consulting business who was looking for an astronaut to run a business, and I said, "Who is it?"

And he said, "Well, I can't tell you until we get any further."

And I says, "Well, then I guess we don't go any further."

He said, "Well, then I can tell you. It's Booz Allen."

And never being one that obeyed rules very well, I asked him who it was, who was the contact, and I called the contact; basically worked directly with him. The headhunter got his money when it was all said and done.

But it was Booz Allen. They were looking for somebody to come up at the principal level and start a space business for them. I interviewed with them twice. They offered me a job, and I accepted it. It was one of those “I take this now, or this isn’t going to stay open,” because they’re not going to be able to stop. And it seemed to fit with where they wanted to go and the capabilities I had, although I didn’t know how to get there.

So I accepted the job, and then I left NASA, and I went into the consulting business. Again, fairly naïve from a business perspective, and first thing I discovered was that there had been a small space business there that they wanted me to take over and build, and it took me a year to finally deal properly with that. The answer wasn’t to build that; the answer was to get rid of that and build the right space business. They were into what they called space commercialization, and they had a couple of contracts with NASA Headquarters, going around talking to companies, GEs [General Electric Company], 3Ms, etc., trying to sell this to Shuttle, that you should be doing research in space, and trying to help facilitate all that.

I told my boss, a senior Vice President named Pete Wood, that, “Pete, I really believe in commercial space. I really believe in it, but not this decade, and we don’t have the patience to wait. That’s not the right place to take this business. The right place to take this business is around what I call space operations. There’s a whole bunch of people that deal with engineering, all kinds of contractors, consultants that are under contract to NASA, all around engineering. Nobody is helping them deal with the operational issues, and that’s what I’m all about.”

He disagreed with me, and we decided, in a friendly way, to take it up to his boss, who was Gary [D.] Mather, who was the president of the technical side of the company at the time. Gary agreed with me; decided that Pete wasn’t going to be behind it enough to really nurture it right, so he reorganized and had me report directly to him.

Several months later, Pete Wood retired and left, and the first thing I did then was I had ten people I had to get rid of, because they were the wrong people. They didn't have the skill basis I needed. A couple of them were not easy to get rid of; some of them were. One of them was a female, who was not very good, to put it bluntly. There was a couple of males that weren't very good, either, but they were easy to fire. Females weren't that easy to fire in 1984. She was one of these "New Agers." She wanted to do her thing and wasn't always kept under control, and so I came up with what I thought was a very innovative way to deal with it, after having talked once with the lawyers and concluded, "God, I can't deal with this." I transferred her to one of my principal colleagues named Joyce [C.] Doria. Joyce tried to make it work, and Joyce fired her. That worked out fine. There weren't any big issues there.

One of the guys I fired, helped him find a different job within Booz Allen, in contracting, and he subsequently several times came back and thanked me. I had two of them thank me for firing them, because they were really in the wrong job and I told them that, and then they went in a different direction and succeeded.

So then I started to rebuild and went out to build a business, with no idea how to do it, but what I discovered was my instincts around business were very good, and that even though I didn't have the school learning, my instincts were pretty good for how to compete, how to build things, how to get there from here. I had my sights set pretty high. At one point Pete Wood, before he left, and I went, just after NASA announced the Space Station Program. Reagan had approved it. Phil [Philip E.] Culbertson at Headquarters was the new Director.

An interesting side on Phil Culbertson was that Phil was the NASA Headquarters person around Earth resources. Back in '74 when I went to the Earth Resources Conference right after Skylab at Snowmass, when that was over, Phil took a hike, camping hike, and he climbed up into

the mountains and camped and hiked and fished for a day, but was going to need a place to stay when he got back the night before he flew out, and we were talking over a beer before he left about this. I says, “Hell, I’ve rented a place that’s got more room than I know what to deal with. Come there.” So he hiked up, and he slept there, down in like a bunkroom with our daughter, who was three or four at the time, so we joke about that.

So I got an appointment with Phil, and we went over and talked to Phil and his guys, and right at the end—we’d spent about an hour or two there—Phil said, “And NASA’s decided to do the SE&I, the System Engineering and Integration, itself in-house.”

I said, “Excuse me?”

He said, “NASA is going to do the SE&I in-house.”

“Oh, okay. Thanks, Phil.”

We went out side and I said, “Pete, that’s the best news I’ve heard.”

“What?”

“That SE&I in-house.”

He says, “Why is that? There’s no work then.”

I said, “That’s going to fail. They can’t possibly do that. But it’s going to take them long enough to admit that they’ve failed before they reach out for help, that we’ve got enough time to get credentials so we become a real player.” And that was the strategy behind my business building. Pete never understood it. He left.

I hired Hal Emigh from Rockwell, who was the head of their Payload Ops Group that I had worked with, as a principal to help me build business. He was a great business builder. We got a bunch of small jobs, real small jobs, a little here, a little there. Admittedly, the only reason we got them was because the prime company wanted the astronaut, and so I was making them

pay for that, but in the prospect, I got a subcontract with TRW [Inc.] on a military contract that was studying space assembly, maintenance, and servicing, because the military was looking at doing a lot of that stuff. It was just a small \$15,000 thing, but I got into the water tank at McDonnell Douglas and did some stuff for them. TRW loved me; the Air Force loved me. And when you wrote up on your quals [qualifications] that Booz Allen had this contract, it didn't say \$15,000; it just said that we had this contract on space assembly, maintenance, and servicing, and our role was—and I touched almost everything. So it wound up looking real good.

We built up a whole bunch of those. They put out a RFP [Request for Proposal] for a Headquarters support contract. We bid as a prime and won, and that was the first real thing that made our business, and then they announced defeat on SE&I, and I had told Pete way back in '84 that what would happen is it would take them a while, but they would finally admit defeat, and there were two things they could do, since they had the four work-package contractors. They could pick one to be the prime contractor, like we had done in Apollo, and the others would be under them. Or they could say none of them could do it, and it would be somebody totally different. The right way to do it is the former; therefore the way they'll do it is the latter. But to be honest, that won't work, either, but that will run five or so years, and then they'll go to the other. And that's exactly how it's played out.

When they announced they were going to get an SE&I contractor, the obvious players were TRW, Lockheed [Aircraft Corporation], were the two big ones, and Grumman [Aerospace Corporation] was the third one, kind of a dark horse. Rockwell, Boeing, Martin, who else—they couldn't compete. So I went out and I marketed TRW and Lockheed, and they were both very interested. I brought something that no others had, which was the space operations aspect, and they were very receptive.

Then I remember I got a call from the guy at TRW. At this time Ed Gibson was working for them. It was Ed's boss, who said that he really wanted us on the team. I said, "Oh, great. That's really good. And we get space operations, right?"

And he says, "Well, there's a problem with that."

I says, "What's that?"

He says, "Well, we're going to team with Lockheed, and they've got that, and they won't give it up."

I said, "Well, then we don't have a deal, because that's who we are, and you'll want us on board, a little here and a little there, and I know how that's going to play out, so I'm not interested in these other things." Ed told me that I was making a big mistake. I mean, TRW and Lockheed are teamed, the two best SE&I places in the country.

Grumman called and said they wanted [us] on the team, and I said, "Well, let's talk." So I went up and I talked to them. By that time they knew that TRW and Lockheed were teaming, and I told them that TRW wanted us on their team also, but I didn't tell them I'd turned them down. So they wanted us, and I said, "I want space ops."

And they said, "Okay, you've got it."

And then I said, "And I have a partner who's really big in the computer world, and so I want the TMIS, the Technical and Management Information System, as well."

And they said, "We can't give you that. Grumman Data Systems is going to do that."

And then I bluffed. I said, "Well, then we don't have a deal," and I went home

The next day I get a phone call, and he says, "Okay, you get them both," because they recognized they needed us in space ops. I had somewhere along the line here made partner at Booz Allen, so my other partner was very thankful that I had gotten him this job.

And so we worked with them to write the proposal. Fred Haise was the lead of it, and Dick [Richard L.] Kline was his deputy, and I had known them both. Dick Kline had been, oddly enough, one of the people way back who was at Grumman, connected to Raytheon, back on the satellite power stuff, so all these guys I had known for a long time.

I sat on the red team, and I sent Bill Brooks up there to lead, and admittedly maybe Grumman had gotten the impression that they were going to see a lot of me, like every day, and I had a business to run. I couldn't be there, and so I sent Bill Brooks up there, and I would keep getting these phone calls. "Lenoir, where are you?" Okay, that didn't work. So I sent "Tucker" [Henry J.] Pierce up. "Lenoir, where are you?" So I brought Tucker back, and I sent Bill [William] Bastedo up there, who was much lower level than them. They were principals, and Bill was an associate that I had just hired away from Sy Rubenstein at Rockwell. And they didn't call; I said, "That worked."

So one of the very first review teams, red teams, I was up there for with Fred, they were presenting their thing, and they're presenting the overview of what the proposal's going to look like, and they're talking about how this is systems engineering and integration and why Grumman is the best job for this, the Grumman-Booz Allen-Ford team, and he finished, and I says, "Excuse me. I'm in the wrong room."

Fred says, "What are you talking about?"

I says, "This isn't SE&I. This is about manned space operations. That's what NASA needs here, is about manned space operations and integrating and operating the Space Station. It's not SE&I. TRW and Lockheed will have us for lunch around SE&I. This is manned operations. It's more important that you build airplanes that land on boats than that you build unmanned spacecraft." And so we built that into our theme. We said that's what this was all

about, and we sold it to NASA. We had a good set of orals, and we won. The biggest single job that Booz Allen had ever won, I had just won, which was in '87, so that was three years in; it was about the right time.

Got that going, and hired Ed Gibson. Ed gave me a call to congratulate me. The way I had built the business was that in building up to that, I would promise myself, and then when we won, I would try to hire somebody that could actually do it, and they wouldn't complain that they didn't get me. They still got me, but not as much as they thought. Certainly here was this thing, where our role was built around me, and I needed to move on and run the bigger business. So Ed called to congratulate me, and I asked him if he was interested in a job. He said yes.

I says, "Get on an airplane, and let's talk about it." So he came over, and I hired him. He moved to Reston [Virginia], and took over lead of that part of the contract. I ran the whole contract, which had both of the pieces, the information system and the ops. Ed ran the ops and one of Steve Gottlieb's guys ran the information systems. Then [I] subsequently hired Bo [Karol J.] Bobko to do the Houston stuff, and I hired Luther Powell in Huntsville to build Huntsville business. That didn't pan out, and Luther left after a while. I guess that's how that fit out.

But we wound up with about a hundred people working on that before too much longer, and that was going great guns. I had a big business, self-sustaining, within Booz Allen, one of the largest businesses. Very profitable, doing very well, with a five-year strategic plan out in front of me that had how we were going to grow the business, anticipating what was going to happen. Remember what I said was one of these days NASA was going to get to the right answer, which was that one of the primes needed to run it, and that we needed to make sure that we didn't get clobbered by that.

Then in '89 I got a phone call from Dick Truly. Parallel with all of this, in '86 *Challenger* blew up, which was an unfortunate thing. I felt that much more than *Columbia*, because except for the two payload specialists, I knew all five of the people on board very, very well. Judy [Judith A.] Resnik and I were very good friends. El [Ellison S.] Onizuka had worked for me for a while. So had Ron [Ronald E.] McNair, for that matter.

Coming out of that, NASA did a whole bunch of reorganizing, because the senior management was all screwed up. Jim [James M.] Beggs was on leave because he was under indictment. There was no Administrator. Bill [William R. Graham], who was from the spook world, was the Deputy. He didn't have a clue what it was all about. Jess [Jesse W.] Moore had been the AA [Associate Administrator] for Space Flight. He had just moved to Johnson as the Center Director. It was just all turmoil.

Reagan brought Jim Fletcher back as Administrator, and Fletcher brought Dick Truly over, who had retired from NASA, gone back to the Navy, and had been the first Commander of Naval Space Command, and he was living in Dahlgren, Virginia—I had visited him a couple of times, he and Cody, there—and had set up Naval Space Command, so he was brought back to be the AA for Space Flight, and his job was to get the Shuttle flying again.

Partly for some money and partly just as a friend, I did a lot of work with Dick, some consulting and then a lot of just discussions over beer with Dick by himself or Dick and Crip, Jay [F.] Honeycutt and some others, around what they were doing to get back into flying. Dick asked me if I would be on a committee. They were putting a committee together that was going to look some stuff over and give them some advice, and he was a little bit afraid of it, and it couldn't have any NASA people on it, but it sure would be nice if he had a friend on it, and so I was on Al [Alton D.] Slay's committee that looked at all the safety aspects and did that.

Then in 1989 just after George [H. W.] Bush was elected, George Senior, Dick called to say that he had been asked to be the new Administrator, and would I be interested in going up to the White House with him to be sworn in. I said sure, and so I came on over and went up, and he was kind of briefing me that the President would be there, probably the Vice President. The President's whatever you call his horse holder, Chief of Staff, John Sununu, would be there, and he'd introduce me, and I didn't tell him anything about that. So when we went in there, and then the President and Sununu came in, Sununu walks into the room and says, "Bill, how are you?" Comes over and shakes my hand, and I hadn't told Dick that I used to play lacrosse with John at MIT. John was from MIT. And so we were reliving some old lacrosse stuff. Neither one of us were very good.

Dick got sworn in, and in the car going back, he told me why he really had asked me. He wanted me to come over and be the Associate Administrator for both Station and Shuttle, and to combine them; at that time they were in two different things. And I told him, "Dick, I can't possibly. I'm just getting to the point now where I'm starting to make some money, and I'm starting to save. You know, I don't have much for retirement. It just doesn't make any sense."

Then he called again, and at some point the President's Office got involved. It's like I tell people, when that level asks you, there's only one question. It's, "Yes, sir. When do I have to start?" So, boom, there I was.

Because of the way it was set up, I came in immediately as the emergency AA for Space Station, and Dick had the authority to make an emergency appointment into the SES, which he did—Senior Executive Service—as the AA for Space Station. [James B.] Odom had left. Jim Odom from Marshall had been the Administrator. Dick clearly wanted the two combined, and I totally agreed with him that it would be like taking the Shuttle Program and trying to put half of

it off over here and half of it off over there, where anytime they disagree, it's got to go to the Administrator for resolution, that didn't make any sense.

At the time, George Abbey, as Deputy AA for Shuttle, was the Acting AA for Shuttle, and the big picture was that Dick needed me to get in as AA for Space Station, because I think two days after my first day, the House was slated to vote it out of existence, and so I immediately went up to the Hill, unpolitical me, and talked to God knows how many people and did what I later have referred to as the annual "It's time to save the Space Station" trip. But we won a narrow vote, and so I did save the Space Station.

The jobs that I agreed with Dick to take on when I took it was, I said, "There's a couple of conditions. One is, I want some objective. I don't want to just come on and do it." There were three of them. One was save the Space Station. The other was to get the Space Shuttle under schedule control, so that we could fly so many times a year; and to get the Space Shuttle under cost control, because cost had not been an issue with him getting it back to flying status, and it just kept going up and up and up and up, and it was out of sight, and it had to get under control.

I said, "Okay, and another condition is that you have to be willing to fire me if it's the right thing to do, either because I've screwed up, or because it's the only way you can keep something from getting to you is hang it on me and throw me overboard." And he said okay. I didn't really believe him, but he said okay. Because I think that's important.

So I came on. We saved the Space Station. We went through the rigmarole of getting into the regular SES, and for reasons that I didn't totally understand, you can't transition from having been an emergency appointment into the real SES from that job, and so we invented another job at the SES level that was an assistant to Dick that I filed my paperwork for, and to

nobody's surprise, he selected me, and so I got into the SES. Came in as an SES-6, which wasn't too surprising, since that was a third of the pay that I was getting before I came. Took a bit of a pay cut. Then he made me the AA for Space Shuttle as well as Space Station, and so at that point I have two hats, and one of my first jobs was to put a staff together and generate the paper that turned that into one hat.

I hired Mike [Michael] Mann away from Tommy [Thomas] Campbell over in the Comptroller's Office, because Mike was an analyst over there who knew more about Code M, Space Flight's budget, than anybody in Code M did. So I said, "I can't live with the Comptroller knowing more about my finances than I do," so I went over and talked to Mike and convinced him to come over. Great guy. So he became kind of my comptroller, if you like, and started building a staff.

I hired Dick [Richard H.] Kohrs to run the Space Station as Level I, and Leonard Nicholson to run the Space Shuttle as Level I, and let them run their own business and would get with them strategically and make sure they were headed the right direction, but I didn't want to get into the nitty-gritty of that. Hired Mike Lyons away from now MCI to head the group that had the unmanned launch vehicles and stuff like that in it, since he'd done a lot of work there, and then Mike [Mann] ran the financial side of the house.

Along about in here, I had to ask George Abbey to go away. Dick had asked me if I would give it a try with George. One of the things that Dick had done when he first came in as AA that I really respected was, unlike recent history and some other natural tendencies on NASA, the first thing he did when he became AA was he assigned some responsibility and fired some people over *Challenger* at the Center Director level, so that Jess Moore was gone, [William R. Lucas] at Marshall, Dick [Richard G.] Smith at the Cape, and put some new people in. He

removed George as being Director of Flight Crew Ops, but brought him up to Headquarters to be a special assistant or something, and ultimately became Deputy.

George is an enigma. George is an extremely smart person, very sharp. Very good team player as long as it's his team and he's in charge. Not a good team player on anybody else's team, and I could never get him to play by my rules, which were, "We'll talk everything out in the open. You must talk. You cannot walk out of here with an opinion you didn't say and then later bring it up. And then once we decide, you support it, or in good conscience, if you decide you can't support it, you quit. But you don't try to undermine it."

Now, Forrest [S.] McCartney at the Cape was another one that I had a lot of problems with, but Forrest bought into that, and I have to say Forrest was absolutely the right integrity. He often didn't agree with me. Often we did things the other way. Never once did he work out of channels around it. George was always working out of channels, so I asked him to go away. I fired him, but I did it in a way that says, "Why don't you find another job within NASA or without." So Dick helped him find a role on Tom [Thomas P.] Stafford's committee that was doing some special study or something, and I asked Tom [Thomas E.] Utsman to come up from the Cape and be the Deputy.

We did a lot of good work, I think. We put a good management team in place. One of the things that used to bother me when I was an astronaut and I would support the various control boards, was I would hear things like, "The board decided this; the board decided that." I've never been in the military, but apparently I have a military bent to me, because my reaction would always be, "The board didn't decide a goddamn thing. The board discussed an issue in front of the chairman, offered some opinions, said what they thought, and the chairman of the

board decided something.” But the chairman of the board is accountable. You can’t hold a board accountable; the chairman is.

So I reinvented the Management Council for Space Flight, and that involved the Center Directors. There were four Centers that report to the AA for Space Flight. That’s the four you would guess; that’s Kennedy [Space Center, Florida], Johnson, Marshall, and Stennis [Space Center, Mississippi]. The four Center Directors, their Deputies, the Director of the Space Shuttle Program, and the Director of the Space Station Program, and me and my Deputy, is the Space Council. I make the decisions. I’m only saying this because just the other day I read something in *Av Week* [*Aviation Week*] about how “The Space Flight Management Council decided such and such,” and I [said to Craig Couvoldt at *Av Week*], “Goddamn it, Craig, that’s not the way it happens.” We would discuss things.

I remember once Jay Honeycutt had been a good friend of mine when he was George’s horse holder, and then he went off to run a part of the Shuttle thing at the Cape, and when [J.] Wayne Littles—he was the Deputy at Marshall—when he went to the Harvard fourteen-week thing, I put Honeycutt over as Acting Deputy at Marshall, as a way of broadening Jay, and he thought that was great. But that allowed him to come to one of these meetings, and he’d been to a whole bunch of meetings, and he had commented to me afterwards, he said it was the damndest, most profitable thing he’d ever been to, that it really did stuff, and it wasn’t like he’d seen before.

We’d talk about strategy. “What are we going to do in two years?” “Aaron Cohen, you’re the Director of JSC. Who are your top three candidates to replace yourself, and what are you doing to grow them so that when the time comes, it’s really hard to make a choice? The next time I’m down there, I want to meet your top twelve people, comers, and I want to meet

some youngsters that are comers. I want to talk about how are we going to develop the next generation, rather than letting it happen. How are we doing things?" Never once in three years did anything that we discuss ever leak, and so that really worked.

At one point I went to Dick Truly and I said, "You're right about the Shuttle and costs. I want to institute not just let's get it under control and cap it where it is, but I want to take cost out, and here's my plan."

And he said, "Hmm, okay. You're sure you can do that safely?"

And I said, "Yeah, and my chief cohort in making this work is going to be Mike Mann. He's the only other person, other than you, that knows what the real issue is here, and I'm going to proclaim a program that we're going to take 3 percent a year out of the Shuttle cost for five years. In fact, the second year I'm going to up the gain to 5 percent, but I think that would give people so much heartache right now that it would be hard to get people on board, so we're going to go for 3."

Leonard almost quit over it. As a matter of fact, probably would have, but I had to tell him that he didn't have an option to not do this. He could stay and do it or leave, but it was going to get done.

I had talked with Mike Mann, because I had done some consulting at Booz in the aerospace industry, and I said, "What's going to happen is everybody's going to fight us tooth and nail, and we're going to beat them up and make them do it. Then they're going to start seeing some early results, and then they're going to get to be a believer. Then our role has to change, because they're going to want to go too fast, and so we're going to push, push, push, and then we've got to get out in front and try to slow them down." And that's exactly what happened.

So we started taking some money out. We had it controlled, and just to make sure nobody was going to be hollering, my instructions to Crip were to take so much money out and demonstrate that he made it safer along the way, so nobody could say, hey, we're going to make it unsafe. Well, it's hard to demonstrate that it's safer, but—and I learned something very quickly, how it doesn't work. You don't take processes and make them simpler and think that that's going to matter, because the contractors all have a list of things, and when things get happening sooner, then just other things happen, but you still spend as much money. You get them where it really matters, and you say, "You don't have as much money this year as you did last year. Let me know how you're going to spend it."

We did that, and it worked, and I'm convinced we did, in fact, make the Shuttle cost less. It was, I think, four billion and going up, and it was about three billion a year, operations, when I left. No, it got to three billion a couple of years after I left as part of that, and it got safer, because we made sure that we paid attention to things like that. And some of it was just in getting back to flying, you did whatever it took. Sometimes you'd do things so many different ways in order to provide redundancy that the danger is that they're going to overlap in a way that is not good, and so by simplifying you actually do make it safer.

My last full year, we flew eight times, which was the first time that we'd ever met the eight. We did six the year before, which was, I believe, the first time we ever flew as many as we said we were going to fly. Because that was one of the other conditions with Dick when I came on. I think at that time we were claiming twenty-four flights a year was what we were going to build up to, and I said, "Dick, you and I both know that's absolutely BS. I won't take the job unless my first trip up to Congress, I can tell them the real number's eight. I don't want to go from twenty-four to twenty to sixteen to twelve to eight. You and I both know the answer

is eight. Let's tell them it's eight. If we need it to surge, we could do ten now and then, but eight's the answer."

So he said, "Okay." So I went up and we took one big step down to eight, which we actually got to the last year.

WRIGHT: Let me get you stopped just a second, because—

[Tape change]

WRIGHT: You were telling me about the challenges of being an AA.

LENOIR: Yes, and in describing it, I'm probably going to keep going back and retracing some steps. It's not as easy to do it chronologically. Being an astronaut is largely at any instant in time fairly unidimensional, in that you're focusing on one thing. Over a career, you touch a lot of different things, but in any instant, you're training or you're following a design or something of that nature.

Being an AA is multidimensional all the time, and at any instant you are constantly working multiplicity of problems, all simultaneously. So if you take a train of thought and run it through, then there's a whole bunch of other things that were happening in those same time frames that you have to go back and talk about. So I've kind of talked at the high level of starting as an AA and then getting into the Shuttle, in taking on both the schedule and the money things and getting that under control and a little bit of that.

A reflection is that that's a very tough job. As a matter of fact, it's in the *Prune Book*, whatever—you know, *The Fifty Toughest Jobs in the World* [*The Prune book: The 60 Toughest Science and Technology Jobs in Washington* by John H. Trattner]. The AA of Space Flight is one of them, or at least it was then. And I believe it, because you touch so many different things. At that time I had 50 percent of the NASA employees reported to me, and 60 percent of the NASA budget I spent. In my three years I spent \$25 billion, and I'd like to think we got our money's worth, but there are days when I'm not so sure.

It's a hard job. I think in one way I'm probably fairly typical, in that I was at it for three years. I think that's a fairly typical time. It's not enough. If you're trying to change anything that touches the culture, in engineering terms, you've touched something that has a three- to five-year time constant, or in physical terms, has a half-life of three to five years, which says that you don't just edict something and it happens. And I've made a lot of money in corporate America doing the same thing. A really good change program takes three to five years to pull it off. You have to not only decide what you're going to do, but you have to know how to do it. Then you have to get the people on board so all the who's are there, too.

That's the hard thing. NASA's got a whole cadre of mid-level civil servants who, rightly or wrongly, feel threatened whenever change comes in, just like any company feels. These people inherently don't like change and will fight it, because they feel threatened by it. It's fairly natural. You have to make them see it. You have to make them feel less threatened by it, and get them on board, and that takes time. Three years isn't long enough, especially if you come in as cold as I did, really not having a clue how the hell to do this job or even what it is.

Basically, I'm an engineer. To spend the majority of my first year up on the Hill talking to congressmen and staffers isn't something that I would have thought I could do. I found out I

was good at it. I was good at it because I didn't lie to them; I told them the truth. If you've heard the name Dick [Richard N.] Malow, he in those days was the Clerk of the House Appropriations Committee that dealt with space. He was a Democrat. The Democrats were in the majority then. He was hated and feared by everybody at NASA. I developed a rapport with Dick by telling him the truth. Hardly anybody realizes it, but my last two years, Dick and I met monthly at the McLean [Virginia] Hilton over a beer. We took turns buying, since neither could buy the other's, and we would talk things. I would tell him some bad stuff coming up. He would tell me the budget hit coming up. I never lied to him about things. He would tell me when he vehemently disagreed, and I would tell him when "That's tough, I'm doing it anyway," and I think we respected each other, and I never had problems with Dick.

Kevin [F.] Kelly, who was the Senate counterpart, who was the Chief Clerk for Barbara [A.] Mikulski in the Senate, was pre-law. He went to law school and got a law degree, but he was technically challenged turning on a light in a room. I could not communicate with Kevin. He got the impression that if I opened my mouth, I was lying, somehow. He and Dick Kohrs got along great. It didn't take a rocket scientist to figure out working the Hill, I'm going to work Dick Malow, and Dick Kohrs is going to go talk to Kevin Kelly. On the other hand, Stephan Kohashi, who was Jake Garn's guy on the Republican side in the Senate, was a very reasonable guy and easy to get along with and technically could understand. Dick Malow's problem was that he thought he was the Chief Engineer of the Space Station, and he was a fairly decent engineer, but still.

There was just so many different dimensions to work, and I came in fairly cold, not really understanding how it all worked. It took me a year or so to figure out how it works. Then it took me another year to figure out how to deal with it, which only left me one year to actually do

anything, which isn't long enough if you're trying to change a culture that you've got to stay with for three or five years. So I started and pushed in a direction far more times than I actually succeeded in pulling something off, and oddly enough, the Shuttle Cost Control Program was something that lived on beyond me, because we did it right. We recognized that people were going to get on board; how to get them on board; how to keep them under control.

In retrospect—personal opinion—later I think they stopped paying attention and they took too much out. They had to put some back in, and they're hovering around, and you have to be aware that you're never right; you're never exact. The best you can do in a management sense—this is Lenoir theory—is to oscillate, or if you sail, tack around the middle line and never get too far away from it.

But from a NASA perspective, if you're dealing with a flight safety issue, you don't ever want to get on that side of the line, so the game is to tack and get up near it, but never cross it. Unlike management, where, okay, well, we had a bad year; we lost some money. You can maybe survive that. Having a bad year and losing some crew is not something that you want to take. So it's a little different, and you have to offset it, but nonetheless, you're never stable. Things always need to be different than they are or different than they're headed. If they're headed in one direction, you need to be working to turn it around and get it headed in the other direction, because you're going to keep doing that.

It took me, like I said, two years to figure all that out, to get my team together. Mike Mann was a very good member of the team. Dick Kohrs. Bob Crippen was the Shuttle. Toward the end I asked Forrest McCartney to leave. To this day I think Forrest would tell you that he doesn't like me at all. He didn't think that was the thing to be done; didn't see why he needed to go. I told him it was absolutely no prejudice. I'd get him another job. He could work for me. I

felt that strongly about him in a favorable way, but my personal opinion was that one of the issues that we had coming out of *Challenger*, was that Center Directors and other key people had been in their tenure for so long it was hard to tell the difference between Dick Smith and Marshall. They became one and the same. Therefore my rule of thumb was five years is all you get, and then NASA ought not be done with you. You've got a lot that NASA can get, but it's time for somebody else to pick up the ball and run with it, maybe tack a little bit, do it a little bit differently. I was having those conversations with Aaron, also, when I left, and I noticed shortly after I left, Aaron also retired. The others I had named. Roy [S.] Estess. I didn't actually name Jack [Thomas J.] Lee; Dick did just before I got there, but I named [J.] Wayne [Littles], his deputy.

So I fired Forrest, in his words. I asked him to move to another job. I actually offered him one up in Headquarters, but he refused it and did retire, and appointed Bob Crippen in his place.

So that was part of that whole thing of okay, now, what's our succession plan here, and how do we plan for it. We got that started, but we never did get far enough with that, and I don't believe it held. Certainly when George Abbey got back into the picture, that's not the thing that George wanted. George wanted to make sure there was nobody to take the place of key people, and that's one of the problems today—personal opinion—is that JSC doesn't have the depth of senior management talent that it should have. The talent is there, but the experience and the growth isn't. So we did that.

The key thing I noticed when I got back, I took on a Space Station problem. I had been the Vice President at Booz Allen who had opened the Reston office to support the Level II Space Station work at Reston. Well, Reston was the wrong answer. Remember my earlier story. Well,

now—a little bit like Jim Fletcher. In Jim's first term, when Skylab was up, there was an opportunity to try to get a Shuttle flight early to reboost the Shuttle, and we used to joke that, well, the easy answer is, "Hell with it. It's not going to reenter on my term." Not your first term, Jim, but it did reenter on your second term. So here was my comment about how this was going to play out, and now suddenly I'm the AA, and I'm already smart enough to know this is the wrong answer.

In summary, Reston was a stupid idea from the beginning, and always was. It was not the right way to do it. We could not get the right level of engineer. The only people that you could coerce to move from Houston or Huntsville to Reston were mid-level engineers that you promised a two-step increase. Hell, those aren't your lead engineers, and so you wind up with your mid-level engineers at Level II supposedly leading the show, with your really chief engineers back at the Centers supposedly being led by people that they rightly ought to be looking down at. So I moved to close Reston.

Learned an awful lot about politics. Luckily, I had learned some of it early. One of my first things was that I told Dick [Truly] that I had a different idea for how to deal with budget problems than he and others did. The typical NASA thing is you ask for x ; you get 90 percent of x . So you take all of your programs and you give them 90 percent of what they asked for. I told him my philosophy was I'll ask for x . If I get 90 percent of x , I'm going to reexamine my programs. I'm going to prioritize them; I'm going to start at the bottom, and I'm going to cancel them until I've killed 10 percent. But everybody else gets funded full. It became real when I went to him one day, and I says, "Dick, orbit maneuvering." Was it orbit maneuvering vehicle or orbit transfer vehicle? I forget; one—OMV [Orbital Maneuvering Vehicle]. "I'm going to terminate the program for the convenience of the government."

“Okay.” And he said, “Why?”

I said, “Well, (a), I don’t have the money; (b), it’s a program I just reviewed a review—I’ve forgot what review it was [requirements review]. Hell, it doesn’t even have a firm set of requirements, and we’re supposedly going to be off cutting hardware. That’s a prescription for disaster. That’s going to cost us billions more than we think. It’s a billion-dollar program. I need the money. It’s not well founded. I’m going to terminate it.”

So, naïvely, I terminated it, and interestingly, you know who the President of that part of TRW was, where that was terminated? A fellow named Dan [Daniel S.] Goldin, who never forgot.

The lashing I never forgot was the next day I was asked to come up to the Hill and talk to Judge [Howell T.] Heflin, the senior Senator from Alabama. This was a contract out of Huntsville. He gave me hell in sort of a nice way, and basically, he didn’t say it quite so crudely, but his message was, “You’re just an engineer, and you don’t understand politics. This is not how you cancel a program. I don’t find out about this in the newspapers. You need to come talk to me, preferably before you’ve done it so I can either be in the loop or feel like I have been in the loop.”

“Yes, sir. This will never happen again.” And it didn’t, but I learned a lot there about how to deal with some future things and how to cancel stuff.

The other thing that I ran into when I first touched the Shuttle, when we made me the AA for Shuttle instead of Abbey Acting, Dick had gotten it back to flying, and I believe he flew four missions; maybe it was only three. The Flight Readiness Review for the next one I was in on, and I went down to chair the Flight Readiness Review. At the time, and I don’t know how it is now, the hierarchy is that the Flight Readiness Review, two weeks before a Shuttle mission, is

chaired by the AA for Space Flight, and he is the accountable government official that approves that flight for performance, and at that point, subject to whatever conditions there are, you empower the Program Director to proceed and execute the mission he just talked to you about, assuming no more changes. I went down there, and I was absolutely appalled at the level of engineering discipline that I saw, that in the time I had been gone, the engineering had just sunk.

I've stayed, over the years, involved at MIT, and even though I'm a EE grad, I've done a lot of work with the Aero[nautics] and Astro[nautics] Department at MIT, including five years ago helping them reinvent themselves, and I've talked with them about a lot of stuff. At the time I was aware of one of their issues that they had, and that was that we're teaching kids how to be engineers, and that includes using the computer-aided design techniques for engineering now that everybody can use. A friend of mine then, who subsequently became the department chair, told me one of his concerns was he didn't think that the graduate engineers really understood what was going on under this stuff. They knew how to do it, and they knew, okay, the answer is this, but they didn't have a good feel for it.

And that's what I saw, was guys who would come down there and they would describe a problem, and they'd tell me, and, "It's okay," and, "We've run the analysis, and it says this."

I'd ask them a question about it, "Does it feel right to you?" and they'd just give me a blank look.

"Feel? What does that mean?"

One of the examples that I have used several times was somewhere on about the second or third flight, we had a military mission, DoD [Department of Defense] missions, as they were called, that was high-inclination daylight. It launched into a 57-degree orbit, which meant that coming out of the Cape, you went pretty much right up the coastline. What that means is that

Air Force C-130s had an easy time staging out of somewhere in North Carolina and New Hampshire somewhere, to stay under it and basically to film the entire ascent. What came back was that the body flap, the back flap on the Shuttle, appeared on the film to be oscillating thirteen degrees. Spec [specification] says three. So there's a problem. Obviously—this was, I think, the third mission [for me as AA], something like that—you don't fly the next mission until you understand it and have approved it for flight. So my question of Rockwell was, "Well, what's your take?"

And the answer is, "Well, we don't think it's real. We think it's an artifact, looking through the plume of the solids."

And so my reaction now was, "Oh, okay. That sounds credible. What's your analysis say?"

"Our what?"

"Your analysis." Hadn't done any. So I said, "Do some."

Next time I talked to them, they still hadn't. Now I would give Bob Minor a real hard time, and I'd try to embarrass him publicly around this, and at one point I said, "You know, Bob, this just isn't that damn hard. If you guys don't do it, I'm going to get co-op student to do it. It's not that hard."

Very shortly I got a call from them; said that they had done the analysis. They'd made all the worst-case assumptions about the solid plume being a lens, etc. The biggest thing you could do is to create a half a degree.

"So what's your conclusion?"

"It's real."

"What, do you have any more?"

“Yeah, and it’s always been real. We’ve always been doing that.”

“Well, Bob, you’ve got a different problem now.”

“What’s that?”

“Well, you’ve either got to fix it so it doesn’t oscillate more than three, or you’ve got to certify it for thirteen, because we ain’t going to fly until you’ve done one or the other.” And apparently they’d gotten out of the habit of doing that stuff, and they’d wave their arms, and you’d just go off and fly. So they certified it for thirteen. Concluded that yes, it’s okay after all. But it was that rigor.

We had some things around launch winds. “What’s really happening on the pad?”

“Well, the limit says this, but it’s 2 knots over that. We’re still go.”

“Why are you still go? Tell me about it. Show me your analysis.” Hell, the people talking didn’t understand what it was you were trying to do. It’s got to do with that twang at the start, that it’s not that the wind’s going to blow you over, it’s that it’s going to affect it in such a way that when the mains light, you go over—you don’t come back. You’re here [gesturing] when the solids light. Well, you’d like that not to be the case.

So I just thought that the engineering was not rigorous, and that’s another failure on my part was, I tried to start it [a fix]. I got a Chief Engineer at Headquarters; hard to get. I got Chet [Chester A.] Vaughan to come up from Houston. Good guy; did good stuff. I put him in a lot of stuff.

We had a problem somewhere early in there with the infamous hydrogen leaks. We were doing a tanking for a mission, and hydrogen was leaking. The sniffer sniffed hydrogen all over the pad. They shut down, secured, and we waved the launch off. Then I was at the Cape for the

launch; went back home. Got a call that they got it all figured out, and they fixed it. They're going to do a practice tanking; tell me about it tomorrow.

“How did it go?”

“Still leak.”

Second time, pretty much the same thing; still leak. I picked up the phone, and I called Bob Swinghammer at Huntsville, and I says, “Bob, get your butt on an airplane, go down to the Cape, and lead them through it. Help them figure it out, because they're just shotgunning this thing.”

At that point, there probably weren't six engineers in all of NASA that I had a lot of respect for. That doesn't mean I hated the rest, that just meant I either didn't think they were very good, or I didn't know them, in most cases. But Bob was one who'd been around since I was an astronaut who I really respected. Chet Vaughan, Henry [O.] Pohl. Max [Faget], of course, was gone by then.

So I sent Bob down there, and he did it rigorously, got out the fishbone idea, the fault tree, whatever you want to call it. Walked them through it. They're in a meeting, and they're identifying all the things that, if something happened on this branch, what would it look like? Does that look like what we're seeing?

Then at one point, they got to one, and said, “Yeah, that would look like it.” At that point, a junior Rockwell engineer in the back row raised his hand and said, “You know, just before all this started, we replaced a seal on that joint.”

“Well, maybe we ought to go look at that.” So they took it apart, and sure enough, it was a stainless mesh seal. Part of it had folded back over. Click, click; now we're off and flying again.

But it was that lack of engineering rigor that to this day still exists, and that was one of the key things that I learned, which I didn't like, but again, three years, taking a couple of years to come to your conclusions, wasn't enough time to solve it. I would do it a lot differently today.

WRIGHT: Was there talk of bringing in more international partners with the Space Station while you were still there, specifically the Russians?

LENOIR: I inherited the team that was ESA [European Space Agency], Japan and Canada, and while I was there, I signed the agreement with Italy. Some people don't know that Italy has two roles; part of ESA and a separate one that built whatever we wound up calling the mini-modules that they built. There was a mini pressurized logistics module.

WRIGHT: I think Leonardo. Maybe that was it.

LENOIR: It's gotten more important as we've gone downstream. But I negotiated and signed that agreement with them. What happened was one of their Ministers, Bertusi [phonetic] or something like that, came to me and said that the government wanted to beef up that industry, and they had a half a billion or a billion dollars to spend; could I use it?

“Can I use it? Let me get back to you. What if we built one of these. It ought to be about that much.” And so we put it together and signed it.

Brazil came after me. There was a couple of times when our international group came to me and said that we were under pressure from the State Department to include the Russians, and my answer was always fairly adamant, said that “I don't have enough time to deal with that. I

think I know how that was going to go, and that's going to cost me money. I don't have any money. If they want us to pursue it, tell them to send money." And it went away, and so they didn't get on board when I was there. As soon as I left, they came on board. Now that it's fully integrated, it's clearly the right answer. We're behaving about right. The first five or so years, it was a disaster, I think, but now it's gotten to where it's a good answer, so it probably was worth the five or six years of hell getting there.

WRIGHT: When you first took this job with Dick Truly, you told him that it would be for a specific time. How did you know when you reached that time?

LENOIR: I told him there was a couple of things that were going to matter, was I wanted some objectives, and clearly fulfilling them would be enough reason that I could leave. I'd promise him three years. I would also promise him that I'd consider up to two more, and that because of where I was living and what I was doing and the pay cut I was taking, I was going to be living on a negative cash balance. I was willing to spend my savings for my country, so to speak, but I was really hesitant to go into debt. Therefore, when I went broke was another reason to leave.

Well, it turns out I met the goals, three years came up, I went broke, and Dick Truly got fired, all pretty much at the same time. So I had begun to think it was time to go back, what am I doing to do?

I guess it was actually January when I got the call from Dick saying that he had been fired. I had worked with Dick as a part of the U.S. Space Council from the NASA perspective, where we worked with the Air Force. When we were working one-on-one with the Air Force, that was a great arrangement and things went well.

When we got into the Space Council, I never liked that. That was always political. It was all about politics and not about space. Mark [J.] Albrecht was the lead staffer. Dan [James D.] Quayle was the Vice President in charge of it all, and it's all about politics, and I never liked that. As a matter of fact, I have smelled March Albrecht's hand in this earlier incident that I was talking about in Quayle's book. We were never political. I mean, Dick was—I don't even know if he considers himself Republican. I consider myself an Independent. I'm really apolitical. But we were working for what was best for NASA. We don't think that was opposed to or contradictory of what was best for the country. It might not have always been what was best for the Vice President, and we'd be first to tell you we didn't give a damn. And that probably didn't help us.

But Dick got fired, and I told him, gee, I'd been thinking of going, anyway, and I suggested that as a show of support and that we weren't just going to take this sitting down, I would immediately announce my resignation, which I did and then found out that that wasn't the smartest thing I ever did. If I had hung on for a couple of months, it would have made a difference in retirement and stuff like that. But I said, "Hey, come on. We've got to do what's right. I don't like the way this has panned out. You brought me here. I'm leaving." So I announced before he left, and if I'm not mistaken. No, he left before I left by a little bit, and Dan Goldin came on, and that seemed anomalous to me.

I've never been a big Dan Goldin fan. At one point before I left, he came over and talked to me for a couple of hours, and I told him what I'd learned; I told him about inertia and culture and time constant and how much inertia there was in the NASA Headquarters, how hard it was to change direction, etc. He thanked me profusely and said it had been a most interesting

discussion. He wanted to come back and talk some more, and I said, “Absolutely. Anytime.” And he never called back. And I left and never looked back.

I went back to Booz Allen and went into a totally different area. That was in '92. I didn't touch space again until '97. Learned that I can do financial consulting, I can do international consulting in Latin America, and then eventually came back to aviation and space.

So that's how that all played out, and when I look back on it, I tend to look back more on the Headquarters as a job that was clearly undone and in work when I left, and unfortunately, most of it didn't go to completion, and there's a lot that needs to be done there that unfortunately probably won't get done.

If we want to get somewhere—the thinking and the mentality that got us to the Moon in Apollo doesn't exist anymore. The humans that did it don't exist anymore, by and large. But the talent that's available is the same thing. It's there. It could happen, but the setup will not let it happen. Can you imagine today—do you remember Apollo 12, got struck by lightning going uphill? They got into orbit basically with all the circuit breakers popped and dead in the water. They tried a few things. John Aaron did his famous “SCE [Signal-Conditioning Equipment] to Aux[iliary],” etc., and it all worked. They did a quick checkout, and within a few orbs [orbits], they lit off for the Moon. Can you imagine the NASA today doing that?

So anyway, I think back on that, and I think the biggest accomplishment at Headquarters that I think I'm the proudest of, it's probably got to do with getting the Space Shuttle under cost and schedule control and on firm, solid engineering footing and management footing. It hasn't always stayed there since, but it was on pretty solid turf at that time. Then as an astronaut, it's hard not to think of having invented the mission specialist role. That's something that has left a lasting footprint, that's still done pretty much like we invented it, and really mattered, as opposed

to doing something that is very enjoyable and very much fun, but doesn't leave a real lasting footprint.

WRIGHT: I've been reviewing my notes and seeing if there was any other areas, and I don't really have any. Do you have any other thoughts, or do you want to take a moment and—

LENOIR: I'm afraid to look at my notes here, for fear that I'll—

WRIGHT: —see what else you want to reflect on?

LENOIR: —go on for another several hours. Let me just take a quick look here. Probably not. There's all kinds of war stories. You know, the old pilots' adage, "They get better every time we tell them." That, and the other one was, "The first liar doesn't have a chance." They're two of the sayings.

But there's a whole bunch of people. We've mentioned Don Puddy, that I wish we could capture what's in his brain before that's gone, and others. One of the challenges that the Shuttle has even today, even as old and seemingly obsolescent as it is in a lot of people's minds, is that there's a lot of corporate knowledge that is gone. We do things such and such a way. Why? Well, we've lost track of why. In some cases it really matters; there's a lurking danger that this is circumventing. In other cases, it was fairly arbitrary and we picked that because we had to pick something. And not knowing the difference can be a little bit scary if you're trying to expand things.

WRIGHT: I have a loosely related question to that. I did have a note of that earlier that I was going to ask you. All of the things that you learned during your training with Skylab and working with that, were you able to apply that when you were looking at Station as a manager? Did any of that come back to help you?

LENOIR: We did some. I did some work most recently on a review committee for Booz Allen, who did some cost work for Bill [William H.] Gerstenmaier, when the Space Station all went to hell around the budget, and that was one of my conclusions, was that all of those Skylab lessons learned, 99 percent of them are going to have to get relearned, because in a way it's like bringing up kids. You bring up kids, and you learn something by experience. It sure would be nice to tell your kids, so your kid didn't have to go through that turmoil, but it doesn't work that way.

There's a lot of that in the management of the space program, too, is they just can't listen and deal with—let's don't plan it out to the minute. For God's sakes, let's give them a list and let them figure it out. Let's give them some time up front. Let's understand adaptation to space. Let's understand how to work with the PIs. There's a whole bunch of things that are Skylab lessons learned, and somewhere there's books that literally are titled *Skylab Lessons Learned*, that have gotten away from us.

The thing I think that bothers me most is that when we developed Shuttle, that happened largely in the seventies, and you remember that Mercury, Gemini, and Apollo was a sixties program, that when [John F.] Kennedy said we're going to go to the Moon and back, no American had ever been in space. Talk about guts. The experience that developed Mercury and then Gemini and then Apollo, all to support the Apollo goals—because those first two steps were needed to learn so we could get there—that experience and those people were the very senior

people that led us into the Shuttle. Like I said, that was in the seventies. We're now in what I call the Os, which is thirty years later. None of the people that developed Apollo are still around and available in a meaningful way. Virtually none of the people that developed the Shuttle are around and available in a meaningful way.

Whenever we do whatever it is that we're going to do next, it's going to be with a blank sheet of paper, starting all over again, and it's going to be important to budget it, both time and money, understanding that there's a whole bunch of lessons that are going to have to get relearned, and that the way we're talking about it now in some of the going-to-Mars studies just strike me as not very well informed and not working the real issues.

We'll continue the NASA thing. We don't have enough money, so we'll do a system study, and we'll outline what it is we're going to do. For God's sakes, why don't we identify the technologies that aren't good enough yet, put money into them, and maybe one of these days they'll be far enough along. If we had the money that we've spent on studies over the years, had instead developed it in technology, we'd be another generation into a couple of things.

But I worry about that, and that's partly the agency has ossified. The people with experience are gone, and the people that are there now just aren't the same. And it's not that they couldn't be, it's they're not the same because they didn't have the same set of experiences. They didn't deal with the Apollo 12. They didn't launch STS-1 for the first time, hoping like hell that the tiles stayed on. Those people just aren't going to be around.

WRIGHT: It will be a very interesting time the next few years to watch and see what happens.

LENOIR: Yes, and there's not enough money, anyway, and so it looks to me like we're going to do—I'm a pessimist—we're going to do the same thing we did under [George W.] Bush's dad, and that is we're going to announce a program to Mars. I mean, we put one together. Dick set up a whole program around it when I was there. I told him I didn't want anything to do with it, because there wasn't any money in it, and the same thing's true here. We're going to kill a couple of trees, write a couple of books, and do nothing. We're going to talk more about the Shuttle being obsolete, and we're going to edict it gone by a day when there won't be any other way to get there, so of course, it will keep flying. We're not doing anything different. One of these days, we will.

WRIGHT: I guess till then we'll look forward to that day.

LENOIR: Okay.

WRIGHT: Thank you again for all the time you gave me this morning.

LENOIR: Well, it's been interesting. It has been interesting and fun, and it will be interesting to see how it turns out and whether it looks like it makes any sense and has any degree of coherence whatsoever.

WRIGHT: I think you'll be pleasantly surprised.

[End of interview]