

# ORAL HISTORY TRANSCRIPT

RICHARD H. KOHRS  
INTERVIEWED BY CAROL BUTLER  
KIRKLAND, WASHINGTON – 20 JANUARY 1999

BUTLER: Today is January 20, 1999. This is an oral history with Richard Kohrs in the Kistler Aerospace Corporation offices in Kirkland, Washington. The interview is being conducted by Carol Butler, assisted by Summer Chick Bergen, for the Johnson Space Center Oral History Project.

Thank you for joining us today and taking time to talk with us.

KOHRs: Fine. It will be a pleasure.

BUTLER: Thank you. To begin with, let's start back when you first became involved with aerospace. What sparked your interest in going into aviation?

KOHRs: I started back in 1953, working at McDonnell Aircraft [Corporation] in St. Louis [Missouri]. I graduated from Washington University in St. Louis. My three summers in college, I worked in a summer job. When I got out of college in '56, I went back to McDonnell, primarily working on airplanes—the Phantom. After about four years of that, they moved me into an advanced design group, which worked on proposals. McDonnell had the Mercury Program, had the Gemini Program. We were bidding on the Apollo Program, and we worked on that proposal.

McDonnell lost, and North American won, which then became Rockwell, now became Boeing. Then the Manned Spacecraft Center [Houston, Texas], as it was called then, was looking to build up, and they got a lot of their employees from the losing contractors. If you go back to people like Aaron Cohen, etc., you'll find that they were at General Dynamics

and had worked on the Apollo proposal. A number of us at McDonnell had worked on the proposal. When those companies lost, people who were really interested in going into the space program took the opportunity to join NASA, because NASA had a big recruiting program going to staff the Johnson Space Center, which was then called the Manned Spacecraft Center.

So that's what I wanted to do. I wanted to get into aerospace and out of the aircraft side of the house, so it was a great opportunity. They were hiring. There were some niches. My background had been what we called system engineering and integration, which I was working on the proposal, so I went down into the Apollo Program Office, into their—I think they called it system engineering back then. One of the guys I worked with at McDonnell, Bob [Robert] Battey, we had worked together at McDonnell, he went before I did to Houston, and he kind of recruited me to come down in January of '63.

So I worked in the Apollo office for ten years, till '73, primarily in system engineering. Primarily what I...did, they had something called a Spacecraft Operational Data Book, which was the document that the program office provided to the mission operations people, that reflected all of the capabilities of the subsystems—propulsion system, environmental control. So I started doing that and worked my way up after a couple of years to what they called a section chief, then a branch chief, up through the Apollo Program. Then I got into what they called weight and performance, providing the weight and performance of the vehicle, which was critical to all space programs, keeping the weight down to meet the performance.

So I spent—I can't even remember the dates, but probably, before we flew, '67, '68, concentrating on that. We had a bunch of weight-reduction programs with the lunar module contractor, which was Grumman, North American then of the command module. This was after the fire. Worked on that...almost daily, around the clock, to get the weight and things defined, primarily working—at that time George [W. S.] Abbey was George [M.] Low's

configuration and control chairman, I guess, secretary to the configuration and control chairman. Worked that.

Apollo Program, we went through Apollo 11 through 17. At that time the Shuttle Program was starting up. It was overlapping. The proposals were overlapping. So when this Apollo Program was over—I have a hard time remembering all this. When the Apollo Program was over, they reorganized the Johnson Space Center. Some of the people went over into Skylab because it was just starting to fly. Other of us went into the Shuttle Program. I wound up in the system engineering in the Shuttle Program. At that time, Bob [Robert F.] Thompson was program manager and Owen [G.] Morris was head of system engineering, and I was branch chief under Owen. Here again, I primarily worked systems integration, weight and performance. We built a Shuttle operational data book just like...for Apollo, and then I had a branch, I guess, maybe a division.

Then about—let's see. '79. You probably have this in your history, but a number of the key people in management had retired and then rehired as rehired annuitants, because they were in the Senior Executive Service. There was a deal there for a while that says—I was not in the Senior Executive Service—..."If you retire, we'll hire you back to be a rehired annuitant, and you make the same amount of money, but you've got your retirement already." And they paid you the difference between your retirement and what you were making. So that went on, and I think even Dr. [Christopher C.] Kraft, my boss Owen Morris, was in that, Bob Thompson was in it.

We got through the first—was up to the first Shuttle flight, about 1980, my boss Owen Morris retired and then I moved into his job, which was head of system engineering for the Shuttle Program in the program office under Bob Thompson, to start with. Then we did the first flight. Then Glynn [S.] Lunney moved in. He had just finished up on the ASTP [Apollo-Soyuz Test Project] Program with the Russians, which had been another post-Apollo thing we did with the Russians. Then we did Skylab. Then I was working for Glynn

Lunney. Then I became Glynn Lunney's deputy. Then he left to go to Rockwell, and Arnie [Arnold D.] Aldrich became the manager and I became Arnie Aldrich's deputy. Got through that into the *Challenger* [STS 51-L] accident.

Then we reorganized. Aldrich moved to Washington [D.C] to run the Shuttle Program and they split the two deputies. I was the deputy in Houston for the program, and then Bob [Robert L.] Crippen was the deputy in Kennedy [Space Center, Florida] for operations, so we did that through about four flights. We got back to flying.

Then in '89, when we had about a six-month lull there between flights, [Admiral Richard H.] Truly became administrator, or it was announced he was going to become administrator. Brought in Bill [William B.] Lenoir, who was a retired astronaut who had gone to Booz-Allen, and Truly brought him back to run both the station and the Shuttle in Washington. So Admiral Truly asked me to come to Washington, initially to run the Shuttle Program.

I can talk about this later, but when I made my trip to Washington, they decided that they wanted me to work on the Space Station Program. So I naturally agreed, and in '89 I moved to Washington and became the director of the Space Station *Freedom* Program. Then did that until '93. Dan [Daniel S.] Goldin came in as administrator, Bill [William J.] Clinton came in as President, and, to me, they changed the direction of the Space Station Program to have more involvement with international partners, primarily the Russians. So, a new organization was developed and that was a good time for me to leave. So I left in November of '93.

Took off for a year, maybe, did some consulting work, went to work for a company called ANSER [Analytical Services], which John [M.] Fabian, ex-astronaut, was CEO. It's about a 500-person company in Arlington, Virginia. Primarily I had an office that dealt with the Russian interface. We did a little bit of work for Arnold Nicogossian out of Code U in Washington. Involved with that. Since we have a bunch of ex-NASA people out here, Dr.

Cohen was an advisor. They asked me to come out here [to Kistler] and kind of look at what they were doing as an employee of ANSER.

I came out here [to Kistler] a couple of times, and they finally asked me to come to work full time, so I quit ANSER and came out here about two years ago..., so I've been here since '97, April of '97. It's a lot of fun, a lot of bright people here, old-timers, young people, and we're having a good time. All we need is dollars to keep going.

So, that's kind of my career. I guess I worked at McDonnell Aircraft for seven years, then thirty-one for NASA, and been doing this. So it's good.

BUTLER: Sounds like a pretty good career.

KOHRs: Well, I live here and I also still live in Virginia, so I go back and forth. My family's still back in Virginia. Just my wife. The kids are all grown.

BUTLER: That's quite a commute.

KOHRs: It's not bad...

BUTLER: That's a great overview. Thank you. Let's jump back and go over some things in a little more detail, if you don't mind.

KOHRs: Sure.

BUTLER: You were working at McDonnell, and you mentioned that you were working on their proposal [for Apollo]. What can you tell us about that?

KOHRs: Well, proposal work, any proposal work is very intense. In layman's terms, I was a grunt back in McDonnell. I was making viewgraphs, running copies, doing some engineering work, and I really think, my personal view is McDonnell Aircraft thought they had a good shot to win the Apollo because they had been on the Mercury and the Gemini, and they brought in the same team to bid the Apollo Program. It was intense work, you know, working on a proposal night and day, kind of around-the-clock-type stuff like all proposals are. My view is that McDonnell management thought they had a good shot to win, and what the deciding factors are at my level then, I had no idea whether it was cost or technical. I really don't know. I was in a little niche.

But I remember one thing. Originally the Apollo was going to land on land, and one of the concepts was where should it land. So we did a lot of studies about landing out at Holloman Air Force Base or landing out in Texas. Did a lot of land surveys and things like that. Somewhere along the line, they said, "Hey, a better place to land, like Mercury and Gemini, is land on water." Primarily part of that was due to the structural loads and the systems you had to provide. Of course, the Russians land on land. They have retrorockets that fire. But in NASA's thinking through this—and it probably was due to weight considerations, because, like I said earlier, weight was a critical factor.

So I think when that was all over and you found out that your company lost, and you still want to be involved, the natural instinct was to—you kind of had a couple of options, either try to go to work for North American or go to work for the government. At that time the government was just starting up the Manned Spacecraft Center, was moving from Langley [Research Center, Hampton, Virginia], and I forget how many people they hired in that time frame, but they probably hired a couple thousand civil servants. Maybe not that many. But they also brought in a lot of contractor support. So you had your choice. You could go with a contractor or go with the government. I decided to try the government route.

I was going to go somewhere to stay on the aerospace side, but it just was an opportunity that was there.

BUTLER: Seemed like it worked out pretty well.

KOHRs: Well, it's been exciting and it's been a real learning process. A lot of different people. I chose to stay in the systems engineering, systems integration, rather than get into a discipline like structures or thermal or environmental control. In my view, being in systems integration, you get a broader view of what's going on and what has to happen and how things play together.

And it just kind of happened, in those days, in '63, I remember the processing line for new applicants, you almost had to stand in line because every Monday they were probably bringing in probably twenty, fifty people from the outside. So I remember standing in line, waiting to get processed into the human resources, which back then we were not at the Johnson Space Center, we were at these thirteen buildings scattered around the Gulfgate area. The Apollo office was right across from the Gulfgate, in a couple of those buildings, I forget what they call them, but [we] basically were in one building. Support contractor back then was General Electric, and they were in the building next to us. But NASA itself, JSC, Manned Spacecraft Center itself was scattered, I think, in eleven or thirteen buildings. That was in '63. I can't remember, was it February of '64 or something, we moved down to the Clear Lake area.

BUTLER: About that time.

KOHRs: I think it was like January or February of '64, if I remember.

BUTLER: When you did come to move down there and to make the choice, how was it moving down to Houston?

KOHRs: Well, I was in St. Louis area. When I moved, it was snowing. I drove down from St. Louis to Houston. You always remember how flat the country is. A joke then used to be, the highest point in Houston was the freeway overpass. It probably still is.

BUTLER: It still is. [Laughter]

KOHRs: Still is the joke. But the people in the community were really friendly. It was easy to go in and buy a house, to get a loan. I remember my first house was \$20,000, right there by the Hobby Airport. Nothing down. "Just move in and start paying us low-interest rate." So, people in the community, I thought, were really friendly, bringing people in. I stayed up in the Hobby Airport area even after [NASA] moved down there. Finally I moved down to a little town called Dickinson in '75, just south of Clear Lake. But it was good. I mean, everybody was excited about the space program coming to Houston back then.

Back then they had private clubs. If you wanted to get a mixed drink, you had to either bring your own bottle into a tavern or you'd belong to a club. A lot of these clubs would pass out free passes to NASA employees, that type of thing. It was fun.

BUTLER: Good. When you did move down, you then worked in the Apollo Spacecraft Program Office. What were your responsibilities there, your duties?

KOHRs: Well, we started out—here again, I was still down at the grunt level. The first job I had, somebody said we needed to write a systems description of the program down to the detailed level of all of the subsystems on the command module and on the lunar module,

mission description. So two or three of us in that office worked on that. A couple of us concentrated on the lunar module at Grumman-Bethpage [New York]. The other couple of guys, people concentrated on the command module at North American.

Then we brought in the mission description stuff from the people over at MOD [Mission Operations Directorate], and we built this—probably three or four inches thick, that described the vehicle and the subsystems that was kind of used as something that went outside of the agency, that said, "Here, if you want to know what the command module's about." The service module was part of the command service module, the lunar module.

At the same time, Marshall [Space Flight Center, Huntsville, Alabama], who had the booster, the Saturn V, put out a similar book that said, "Here's what the Saturn V—Saturn I-C and the Saturn V are all about." So we had a pretty good what we called a systems description.

Probably did that my first year, and then we got into the details of performance, what things weigh, how we're going to improve performance. We used the terminology, what's your electrical budget, profile budget, because that was a battery thing and you worried about having enough battery power. So, systems integration. Worked those things across the program.

We worked...ground support equipment, what do you need at the launch facility to service the vehicle. I worked for a person by the name of Owen [E.] Maynard back then, who was a division chief. I'm not sure Owen's still around.

BUTLER: He is.

KOHRs: Is he still in Canada or is he still in Clear Lake area?

BUTLER: Canada.

KOHRs: He was a Canadian. There was about a dozen or so Canadians that came from [AVRO], I think, into Langley, and then when they moved the program down to the Manned Spacecraft Center, about a dozen of those people came down. Owen Maynard was in the program office, running the system engineering. I pretty much worked for him almost all the way through the Apollo Program until he left. I think he left—I guess he was there through the first mission. I think he left shortly after the first mission. I can't remember.

They went through a series of program managers. When I was there, a guy named [Charles W.] Frick, I think, was the program manager, and then before the fire, Joe [Joseph F.] Shea came down to run it. He had another guy that came with him by the name of Bill [William A.] Lee. When I became a branch chief, I was working for Bill Lee. Then we had the 204 fire, and after all the investigation, Dr. Shea went back to NASA Headquarters or maybe he went to Raytheon, and then George Low came down to run the program.

In my view, George Low probably had the most influence on my way of doing business, because he was a real disciplined person, treated everybody fair, used to come to work probably six o'clock every morning, would probably leave about nine or ten every night. Ran a pretty disciplined program in getting NASA back on track after the fire. I was in systems engineering, and then I got involved working pretty closely on the performance, the weight and performance, making changes, working with the contractors, working with North American, working with Grumman.

Back then in '68, if I recall, we were spending something like—to get that weight out of the lunar module, we were spending like up to \$35,000 a pound, at [19]69 dollars. So if you take that today, that's probably over \$100,000 a pound. Weight out of the lunar module was really critical because every—I remember these numbers. Every 17 pounds that you took out of the lunar module weight, down to the surface, you receive one more second of what we call hover time. So when the astronauts came in, we tried to have, when they got—

this is probably not exactly right, I can't remember—when we got about 100 feet off the ground, ready to land, we wanted to have 60 minutes of hover time where they could look for the right smooth spot to land. So, critical was trying to give them as much margin as possible. So, worked that pretty intensely for all of probably '67, '68, up until the time we flew.

So I spent a lot of time working on that and, as I said earlier, working on the—back there we called it the Apollo Spacecraft Operational Data Book. That involved getting signatures. Dr. Kraft, who was...[head of Mission Operations] then, and George Low, who was running the program, insisted that when we documented these data, we had to get the subsystem manager, who was in the Engineering Directorate, had to sign off on this piece of paper that that was good and valid data, because the operational people were using it to judge when they had an anomaly or they had an exceedance of a temperature or something, they wanted to have the best data on how the equipment really performed. The tendency back then was for the contractor to say, "Read the spec." I mean to spec. But in reality, when they went through their test programs and stuff, they found out that, like a black box wouldn't fail at 100 degrees temperature, it might fail at 120 or higher, and that was key to the operations people having that kind of data to do the better planning.

So, doing that, we got a lot of interfaces. I had a group of probably four or five civil servants. Back then our contractor that was supporting us was TRW [Thompson-Ramo-Wooldridge], both for weight, performance, and doing these data book, running around trying to get people to agree on the right set of real performance criteria. Put in a lot of time, it was a lot of fun, learned a lot, met a lot of different people throughout the Center, the contractors. So it was a good experience. So I did that.

Then once we started flying, the group I was in got into the lunar landing, where we were going to land the different missions. I don't know if you've talked to Jack [John R.] Sevier or not. Jack Sevier, back in those days...did all the planning with the geologists and

looking at lunar mapping from previous missions, trying to decide where we should go in each subsequent mission. Jack and I were office mates. He was critical to making that happen, and I supported Jack Sevier in that. I think Jack Sevier still works in Houston, works for USRA [Universities Space Research Association], I think, in Houston. He was working over as kind of the number-two person over at that building out there where the Lunar [and Planetary] Institute used to—the old building. Then they moved to a new building. I think they moved over somewhere. I think he's still part of that. He'd be an interesting person to talk to. He's got a lot of interfaces with the science side of the house, of choosing which landing sites to go to. I supported Jack in that.

Another interesting thing I did which was kind of a lark—and I still have some pictures, but they're back in Virginia—the first Apollo 11 did not have a lunar rover vehicle, it was just get on the moon and stay there a day and come back. Then we built something called a lunar rover, which was built at Marshall and, of course, driven by the astronauts. So, somewhere along the line they said, "The thing we need to do is we need to build a simulator, a ground simulator, not an electronic simulator, where we can drive the rover around over rocks and things."

So we decided to do that at Kennedy Space Center behind what then was the old crew quarters building. What we wound up doing, we went to—I think it's North Carolina or South Carolina, and we got one type of rock, and we loaded up about ten railroad cars full of rock. Then we went to Flagstaff in Arizona, I think, somewhere in Arizona or New Mexico, and brought about another ten carloads of rock down to the Kennedy Space Center. I remember it was the July Fourth weekend, probably in '64 or '65, and we were down there at Kennedy unloading this rock. The geologists came down and they distributed it around this area we carved out of the underbrush, and actually brought down a lunar rover trainer. They would go out and simulate driving up to a rock formation, jumping out, doing their thing like they were on the moon, and getting on with it.

Well, about five years after the Apollo Program was over, I was down at the Cape [Canaveral, Florida], and I said, "I'm going to go find this." Well, it turned out it had all been overgrown with underbrush. Nobody took care of it, probably for no reason. And now when they built the new process facility at the Cape, the Space Station process facility, that's where they built it. But there are very few pictures of that around. I've still got some pictures back in my boxes in Virginia that show that.

But Jack Sevier was key to doing that, and I worked with Jack setting it up, and the geologists from—I forget. I guess the U.S. Geological Survey [USGS]. There were a couple of geologists that were working on that, which Jack knows who they are. I can't remember their names. But that was an interesting side. It took us about—we did it pretty quick, because once they decided they wanted to do this, we kind of said, "Well, where's the best place to get rock?" Granite rock came out of South or North Carolina, and the more porous rock, shale-type rock, came out of the Flagstaff area somewhere, I think. It was an interesting side to not working engineering details, but working some real simulation-type work. So it was one of the things I remember that was interesting.

BUTLER: Very interesting and important. They need to be able to practice those. Every little bit. You mentioned the rover and you mentioned the systems engineering. While the missions were going on, were you involved in any way in operations?

KOHRs: Well, back then, started out for the first lunar mission—I guess they still do this even today, but the program office had a room over in Building 45 called the MER, Mission Evaluation Room, which had the subsystem managers in it, headed by—at that time it was Don [Donald D.] Arabian headed it up, and program office people would sit in there.

Then over in the Control Center, they had a room called—I can't remember the name, but what the room consisted of is when the people in the Control Center wanted to talk to the

people over in Building 45, they wanted to make sure that any questions and stuff that filtered through would go through management of the program office. So they had a back room over there... In that room were some senior mission operations people, MOD people, and then program office people. Aaron Cohen, who was head of the command module, that's where he spent his time during the mission. Owen Morris was head of the lunar module then. He would spend his time there. They had the contractor reps from Grumman in that room... If you saw *Apollo 13*, they kind of depicted that room a little bit.

The first mission, I worked in the MER. The subsequent missions, I was in that room over in Mission Control Center. It was a backup support room where the interface between MOD and the program office. We worked shifts. It varied. Sometimes we worked twelve-hour shifts. I think we basically got down to three shifts, the guys kind of synching up with the missions operations team. So, during the missions we would serve a shift over there. Primarily the kind of questions you got related back to this operational data book, or if there was some anomaly that happened or some failure, then the subsystem managers and people were trying to work—not trying—were working workarounds, how to solve problems.

We did that same through the Shuttle Program. Up until the time I left in '89, we were still doing—I think they still do that. I think they still have, every morning at eight o'clock, they have these management team meetings to review what happened and tie that all together.

BUTLER: Seems like a good system.

KOHRs: Well, it worked, and I think some highly competition between the MOD people, the E&D [Engineering and Development] people, and program office people, I used the word, were arbitrators in some cases, and sometimes emotions got high and people got excited, but it worked. So I think that was what was key. That's also the room, like if George Low wasn't

sitting out in the control room, he'd be sitting back there as a place to listen to the com going on between the air and ground, and working any issues that were out there. Of course, when we had Apollo 13, it was hectic back in all the rooms. Apollo 12 had the lightning strike. Joe [Joseph W. Cuzzupoli] probably talked about that. That was an exciting time, the strike during ascent.

BUTLER: Were you called upon with the data book for—

KOHRs: What we were doing, I worked a shift that varies each mission, kind of rotated first, second, or third shift, primarily dealing with questions and answers going back, trying to filter them out, trying to make sure they were getting worked. That was probably the right place to be, because back in your office over there, you probably weren't paying attention to work anyhow. You wanted to know what was going on in the mission. But in Apollo, we had another mission coming every—from July of '69 to, I guess we quit flying in '71, I think, or something, six missions in sixteen months, something like that, so it was pretty ambitious.

BUTLER: Very ambitious schedule.

KOHRs: A lot of people back there didn't really take vacations, that I can remember. People were pretty devoted to keeping things going, doing their job. It was good times. Good times.

BUTLER: Do you remember where you were and what you were doing when Apollo 11 landed on the moon?

KOHRs: I had just worked a shift over in the MER and had gone home about eleven o'clock at night. As I remember now, my kids were pretty young. They had been in bed. But I think

we landed on the moon about eight o'clock at night or something like that, but we didn't go out—I may not have this right, but we didn't go out until about two or three o'clock in the morning Houston time. So I'd gone to bed, set the alarm, got up, put my little camera at the TV, and recorded it on my—then it wasn't a videocamera, it was just an 8-millimeter camera. Somewhere I've still got that. There's a lot better pictures around, but it's something we just did. And woke the kids up so they could watch it.

So I went back, went to work the next day, we were working shift. Exciting times. Exciting times.

BUTLER: Very. You mentioned Apollo 12, the lightening strike, and Apollo 13. Apollo 12, of course, was worked on pretty quickly and pulled together, but Apollo 13 took many days of hard work. Can you tell us about the atmosphere at the time and how everyone was doing and what they were doing?

KOHR: Well, here again, I think everybody jumped in and wanted to solve, wanted to get the crew back. Lots of stories about who did what. I at that time was in this backup room over there and was working issues and trying to make sure we had the right people doing the right thing. So I think the people in the Mission Evaluation Room, led by Don Arabian, in terms of fixes and the E&D team, of how you route the plumbing and get the cooling and trying to stabilize the vehicle, did an outstanding job. The Gene [Eugene F.] Kranzes, the Glynn Lunneys in mission operation, their team, just unbelievable. Everybody just jumped in and wanted the right thing to happen, so it was great.

BUTLER: Everybody just pulled together.

KOHRs: People probably worked twenty hours a day back then, even they overlapped and had shifts. And...it was orchestrated by the flight directors. I can't remember the third flight director, but Gene Kranz was, I think, the lead, and Lunney was also in there as a lead. I can't remember if the third one was Pete [M. P.] Frank [III] or—I just can't remember. Two guys. Of course, I went to work for Lunney a few years after that. He was head of the Shuttle Program Office after the first flight.

BUTLER: Luckily it all worked out and they got back safely, thanks to everyone's hard work. As the Apollo Program came to a close, you then moved into working on the Space Shuttle Program.

KOHRs: Right.

BUTLER: Were there any thoughts at that time, with the transition, seeing the end of the era of landing on the moon, and then moving into the new with the Space Shuttle, any thoughts that really struck you at the time?

KOHRs: I think the thing that disappointed a number of people, including myself, is we were going to go Apollo 18. We had three more lunar modules and three more command modules. So we landed, what, five times, and Apollo 17 had the geologist, Jack [Harrison H.] Schmitt, on. I think they had appointed crews for the next mission, but the budget crunch really got to the system. The reason you see Saturn V vehicles at Johnson and at Marshall is because we didn't fly them. I guess it's unfortunate, because a lot of money was spent to build those vehicles, and I think there was a lot of good science that could have been learned. But I think the financial crunch, you know, NASA had spent 21 billion or something like that on the Apollo Program, and at one time there was probably 100,000 employees around the country

working on it. I think the Congress was looking to spend their monies on other things—Vietnam [War]. Is Vietnam right?

BUTLER: Yes.

KOHR: Probably right. So I think the people working in the trenches and working day to day, I didn't like getting off Apollo and going into Shuttle, but it was something you had to do because you had to work.

The Shuttle Program then was being run by Aaron Cohen, and then Owen Morris, who I had worked for earlier, was Aaron's deputy, so when the—that's right, yes. Owen Morris was lunar module manager. Then he moved out just before the last flight. He moved down in the Shuttle because they were doing the proposal evaluation, and the bidders were—McDonnell bid it, North American-Rockwell bid it, Lockheed probably bid it.

When [Rockwell] won, there was a lot, again, about how we are we going to organize. So a lot of the people came into the Shuttle Program, some stayed with the Skylab Program. At the Skylab Program, NASA went from like '73 to '81 before they had a launch, so there was a lot of—six, seven years there of no [Americans] in space. I think the interest in NASA, from a political standpoint, was going down. The budgets were coming down. So it was a tough time.

Some big decisions were made early in the Shuttle Program, which is kind of interesting, which are now coming back. The early Shuttle Program had flyback boosters. You've probably talked to Dr. [George E.] Mueller here. He was kind of the father, I think, of the Shuttle Program. He wanted to have flyback boosters, completely reusable vehicle, and financially the government couldn't afford it, so somewhere about [the late] '60[']s—maybe it was later than that, probably about '72 or '73, when they were just forming the program, they had to make a decision to go to the throwaway external tank and recover the

solid rock motors, but rebuild them. The cost tradeback then, that was what you had to do to make the program work.

Now there's proposals out there [today], to go back to a flyback booster on the Shuttle, and that's what I called a Phase A process. Lockheed's got one version, Boeing's got another version of how to do that, and it's not going to be cheap. It's going to be very expensive. And whether NASA can afford it, I really don't know, but it's kind of interesting. It's kind of come back to a full cycle.

BUTLER: That is interesting.

KOHRs: Yes. But I haven't been very close to NASA for the last four or five years. I still know a bunch of people and talk to them, but I haven't been active in anything they're doing.

BUTLER: Talking about the Shuttle now, when you did first come in to the Shuttle Program, you worked in the Integration Division?

KOHRs: They called it System Engineering and Integration Division, and Owen Morris headed it. I was [a] branch chief. People I had—we worked on the weights and performance, we worked on what we called then the interface control documents, which is the interface between the Shuttle and the external tank, between the external tank and the booster, between the vehicle and the ground. We had a rigor where you'd develop a drawing and you got all the parties signed off that that's the way we're going to have the interfaces work. The engines in the orbiter were built by Rocketdyne, so even though it was Rocketdyne, it was a Rockwell company, and orbiter was a Rockwell company. Sometimes, if you talk to Dr. Joe [Cuzzupoli] next door, sometimes they needed a NASA person between

them to help resolve differences because money was involved if one side had a change or another. So we worked those interfaces, the group I had.

We also worked back then the basic spec for the design requirements, what was back then called the systems spec, with the system level requirements, so many pounds of payload to orbit, so much mission duration, so much power requirement, that type of thing. The group I had worked that type of stuff.

Then as we started to build, as nature would have it, in all programs, even this program, you always have a weight and performance issue. That group went in and looked at Shuttle weight reductions and performance improvements. It cut across the orbiter and it cut across the external tank and the solid rocket motors. So we had a team set up with the contractors and with NASA that worked that, and we took out about 12,000 pounds of weight, improved performance by about 12,000 pounds. We took about 7 or 8,000 pounds out of the external tank, about 4,000 pounds out of the orbiter. Spent a lot of money doing it, but we had to do it to meet the performance requirements.

Back early in the program, the Department of Defense [DoD] was involved to a great extent and were pushing NASA for a certain amount of performance out of Vandenberg [Air Force Base, California]. They were the driving requirement. We never quite met their requirements, so we had a lot of interaction with them and they had a lot of interaction with our Headquarters people in D.C., and spent a lot of time going back and forth, telling people what we were doing and what we weren't doing. But here again, it was interesting and something you learned, and it kept you busy, so it was good.

Then we had three divisions in that systems integration, and somehow I think I became the deputy to Owen Morris. Then when Owen Morris retired, I took over that division just before the first launch. Then after the first launch, Bob Thompson, program manager, retired. Then the Skylab Program was over and the ASTP Program was over, so

Dr. Lunney moved down to run the Shuttle Program. After a while, I can't remember exactly, I became his deputy, probably after the first launch.

BUTLER: You mentioned the first launch. What was it like to finally be putting men back in space?

KOHRs: Oh, it was great. There was a lot of testing. In fact, we were talking about it here yesterday, the amount of testing we did to get ready for the Shuttle launch. Shuttle had a full-scale what they call ground vibration test article. I think it was the *Enterprise* that was the orbiter vehicle. Then Marshall built the full-scale tank and solid rocket motors. Took it over to the big facility over in Huntsville and they did what they call the "shake, rattle, and roll." They simulated the loads. Didn't actually fire the engines, but they simulated the loads as you go up through Max-Q.

Then we also built a quarter-scale version of that, where Rockwell did the same type of thing of the complete vehicle down in Downey [California]. That would be an interesting thing to try to research and where is that quarter-scale model, because it would be interesting to find out what happened to that, because it's probably something that ought to wind up in an exhibit somewhere. Maybe it is. I don't know.

Then for the three main engines, we did a series of tests. Rockwell built what was called a strongback, which simulated the inside of the orbiter's aft thrust structure. We took an external tank, put it down at the [John C.] Stennis [Space] Center [Mississippi], and went through a series of thirteen test [firings]. I remember we launched in April of '[8]1, and our requirements were, we had to finish the thirteen firings before we launched. The thirteenth firing, I think, was done on the last day of January in '[8]1, and it was critical to being able to go fly in April. That hardware got moved to the Huntsville Exhibit Center, that external tank. I think the orbiter part of it got moved to the Huntsville Exhibit Center, I think. So it

was interesting to go through all what we call the major systems test, and, of course, there were all kinds of what you call subsystems tests going on.

Up until the time we flew, people were still waiting to get that last set of test data that says this component was right and that component was right. We went through a series of two or three days of what they called a Flight Readiness Review—I guess they still do—at the Cape.

Went through the first countdown. I think the first countdown we didn't launch the first day for some reason. I don't remember why. Then we went back and came back, I think, two days later...and we did launch. It was a great thrill. John [W.] Young and Bob Crippen did an outstanding—all the people did an outstanding job on that at Marshall, Kennedy, people at Johnson. I can't remember when it was named Johnson Space Center. Somewhere along the line it was Johnson. Somewhere in the sixties, probably.

BUTLER: I think it was either the late sixties or early seventies, but definitely by the time the first Shuttle went up.

KOHRs: Oh, sure, yes. But anyhow, that was exciting times. We launched in April. I think the next flight was in August, something like that. Then just starting out, we had some problems on the second flight. I remember I was at Kennedy in the launch control room for the thirty-something flights I was involved with during the launch countdown. The early flights, we didn't launch the first time, and then the second flight, I think we got down to the very terminal count and we had a failure with the auxiliary propulsion unit. There was a little bit of "Who's in charge here?" and "Who's calling the shots?" But it all worked out. It was also a learning process between the centers working together. Although all this had happened on the Apollo. It was seven years later, some different players. So it was

interesting, but it worked out. People get excited and rant and rave, but I think, overall, it worked out great.

So we went through twenty-something flights before the *Challenger* accident. I think then after we got through the first two or three flights, people moved around. I think Dr. Lunney left after the second or third flight, and some of the other managers left Johnson, left Marshall, even Headquarters. So there was some people turnover. Getting to know each other and knowing how people worked was always interesting. Different views of how people do things. I think a lot of the people at Johnson, especially the Mission Operations and the Engineering Directorates, I was on there, I was on there for sixteen years. A lot of people that worked that were in longer than that, were familiar with the systems.

In fact, I was down at Michoud [Louisiana] where they built the external tank, and I ran into a Marshall guy by the name of Mike Pessin [phonetic], who started the original program office in 1975 at Marshall, on the Shuttle external tank, and he retired January first. So he's probably one of the longest guys that worked on one program.

BUTLER: That's quite a feat.

KOHRs: Now I think he works for USA [United Space Alliance] on the external tank out of Huntsville, I think is where he's at. But I ran into him down at the assembly facility for the tanks a couple of months ago, before Christmas.

BUTLER: When we were talking to Mr. Cuzzupoli yesterday, he mentioned that software on the Shuttle was one of the challenges, not necessarily a problem, but just a challenge. If I'm correct, you dealt with that to some extent.

KOHRs: In system integration, we dealt with the requirements for the software and then we got involved with the Engineering Directorate, who was developing the software. Of course, IBM was the contractor. Always hassling requirements, trying to make sure we had the right set of requirements, always working on anomalies with the software.

If I recall, as we were coming up to the first launch, people used to say the software is going to be the schedule driver, and it probably was for a while, but then we had this tile problem, with the tiles staying on the orbiter. So back then the comment was that the software made it because the tile provided what we called the umbrella. So we shipped the first orbiter to Kennedy in '79, I think, and then spent a lot of time working on tile, taking it off, putting it back on. Lots of analysis around the country. Langley had their group of experts, Ames [Research Center, Mountain View, California] had their group of tile experts, and Johnson had their group of tile experts. A lot of speculation on what was going to happen on the first flight on the tile, both on ascent and entry. Probably if you were a judge you'd say that JSC probably called it right. Probably everybody called it right, but, here again, when you get three different centers, three different groups of experts, you're always going to have disagreements or not total agreement. So those were interesting times, too. Spent a lot of time at the Cape talking about what's going to happen to the tile.

BUTLER: Was there a lot of discussion with the first launch when they did see that they had lost a few?

KOHRs: Lots of discussions about that. Here again, the people back in Houston in the Mission Evaluation Room, the subsystem managers, along with the mission operations people, did a tremendous job of analyzing what they thought was going to happen on entry, where was some damage. Some people will say we've got a conservative design, which was good. Our vehicle thermally was designed to fly the mission out of Vandenberg, and then to

come in and do a big cross range, it was a once-around orbit. To come back in, it required you to fly a big cross range, which drives up the heat on the vehicle, the heat load, heat rate. We never flew that mission. So, in retrospect, having that kind of a margin for a mission we didn't fly helped some of these anomalous issues we had, although we did some [damage on a few missions].

Debris from the external tank was always a problem. We used to have a Program Manager Review once a month, where all the Center program managers and the Center directors—it was called a management council. So you'd get the Center director from Marshall, Center director from Kennedy, and from Johnson, and you'd bring up a chart that says the orbiter was damaged. Of course, people would say the solid rocket motor did it, or people would say the external tank tiles coming off, and people would say the Shuttle tiles coming off. You had these constant discussions about who's causing the debris hits on the orbiter. Some of it was caused by landing on the runway at Edwards [Air Force Base, California].

We formed a team called the Debris Team, that was headed up by Mark Craig. Mark Craig was a JSC person. I think Mark Craig is now the deputy director at Stennis. He formed a group of about six or seven people. They called them the Debris Team for a while, and then we had an issue about ice on the launch pad as we were tanking the vehicle, how much ice formed between the orbiter and the external tank, and when you lifted off, was it going to damage the orbiter. So we developed, through Mark Craig's team, ice criteria, what says you can only have so much ice here, because if you lift off, it's going to damage the orbiter.

I don't know if they still do this or not. Back then, we formed what we called an Ice Red Team, that after you loaded the vehicle out on the pad and the ice had formed, Mark Craig and three or four other guys, which are, in retrospect, walking out around a fully fueled vehicle, had a little bit of danger to it, these six or seven people would go out there and do

what they called an ice inspection, walk out there with their binoculars and look for ice and cracks. I think we scrubbed probably one or two launches because of excessive ice, when the temperature was cold. In retrospect, we shouldn't have launched the *Challenger* on the 51-L mission, because that was a very cold, very cold day. In fact, it's just about the anniversary of that, 26<sup>th</sup> or something like that. But a lot of that went on that you forget about, but a lot of dedicated people making it work.

BUTLER: Absolutely.

KOHRs: Now I don't know where they all are now, because a lot of the people back from the seventies at Johnson have now retired, Marshall, retired. We have a few of them working for us out here.

BUTLER: You became deputy manager of the Space Shuttle Program after the first few launches. How then did your responsibilities change?

KOHRs: Well, when I was in systems integration, I was kind of worried about the integration, didn't worry too much about the details of the day-to-day hardware activity. What we had back then is we were processing orbiters. We had one, then we got two. The Orbiter Program Office would want to do one thing down at the Cape, the Kennedy guys would want to do something else, the Marshall external tank guys would want to do something. The Shuttle Program Office kind of integrated the project offices.

So what we wound up doing is trying to get the communications going. We started up what was called a noon board. Every noon, at twelve o'clock Houston time, we would get on the telecon and get all of the parties on, and we'd discuss what work we were going to do the next day at the Cape that involved the interfaces between the other projects. We would

have these debates about how long it took and whether they should do it or not. Of course, the program office had to make a decision, we were going to do it this way or that, and either I ran those boards or Glynn Lunney ran those boards at noon, at lunch every day.

Then I got more involved with working the detailed processing flow at the Cape, because the name of the game was to get this vehicle launched on time and beat the schedule. So it was one of setting up the communication lines. They were already set up, but it was kind of helping the communication lines. So I would get to work every day about six o'clock in the morning, because it was seven at the Cape. If you're familiar with the Kennedy Space Center, they had a meeting with the Center director like at eight, so then the division chiefs would say, "I want to know what you're going to say to the Center director at eight, so let's have a meeting at 7:30." Then the other guys would say, "Well, I want to know what you're going to say, so let's have a meeting at 6:30."

So you had these series of meetings at the Cape, and they wanted to know what we were doing, so I had a standard telecon, I think every morning at 6:30 Houston time. Then we had the noon board that would deal with the vehicle that was in flow. Then on every Friday we had what we called a configuration control board, but we went through changes and things that affected other vehicles that were not in the flow of the day. So the things at noon dealt with the vehicle in flow. Just about every Friday we'd have like an eight to eight, sometimes later.

George Low used to run these meetings on Apollo that would start at eight and go to midnight, eight in the morning and go to midnight, on changes and things. On Fridays, always, too. [Laughter]

BUTLER: Of course. [Laughter]

KOHRs: Then he'd expect minutes on Monday morning when he came to work, so we'd work on that over the weekend to get what had happened.

Anyhow, I got into this, like I said earlier, I learned a lot from George Low of how he ran a program office, so when I got into it—and it wasn't just me. The other guys had been in George Low's ways of doing business, so it kind of built up. Mission operations had their way of doing business. They had their staff meetings and things at the program office, and we'd have ours. It pretty much came together.

On Friday, in this configuration control board, we had reps from every division or every office of JSC, plus the Astronaut Office, plus Marshall, plus Kennedy, to deal with the system. We wouldn't get into the nitty-gritty of what the orbiter was doing, but we'd deal with the systems-level interface problems. So it kept you busy.

I was talking to my wife, the sixteen years—well, actually thirty-one years I worked at NASA, I only took eleven sick days.

BUTLER: Wow!

KOHRs: And when I left, I had over a year of annual leave, because I became Senior Executive Service, and then you could carry over your leave.

BUTLER: Oh, that's nice.

KOHRs: I just didn't have time to do it. And when I was a GS-14 or 15, I just lost it, because you lost it then. Now they've changed the rules. I think you can only accumulate something like 700 hours if you're Senior Executive Service. But you're just engrossed with keeping busy.

BUTLER: A lot to do. A lot to do.

KOHRs: A lot of fun.

BUTLER: There were, as you've mentioned, some parts that weren't quite as fun. You talked about ice and you talked about *Challenger*. After *Challenger*, you worked on the Shuttle Management Structure Team to review and revamp. What can you tell us about what you did with that?

KOHRs: Well, after the Rogers Commission Report came out, I think it was in June of '86, they had a number of recommendations. Admiral Truly had moved in to head up the Office of Manned Space Flight in NASA Headquarters. Of course, his goal was to get us back to flying safely. One thing he wanted to do was make sure that we responded to all of the Rogers recommendations. Formed a couple of groups, and one of them he formed was this Management Team Group, which Bob Crippen headed up. Bob Crippen and myself and Walt [Walter C.] Williams, who worked for NASA back in the Mercury, Gemini days. I think he was even launch director or something back in Mercury, Gemini days. Walt's passed away. And George Page, who was still at the Cape, retired. George Page was the launch director on a number of Kennedy missions, but he also was the launch director at the Cape the first two or three Shuttle missions. He had retired. Walt Williams retired. So it was Crippen leading it, [and] myself.

What we did is we went around the country, first talking to all the NASA Centers, interviewing people, getting their comments about how we should reorganize, the organization we had, what was wrong with it, what should we do differently. We did that first with the civil servants. Then we went around to the contractors. Went back to some retired NASA people and got their opinions. We built a set of recommendations, and, to my

knowledge, there are no copies of that briefing that we gave, that I know of, because we gave the briefing to Admiral Truly and his staff, all the Center directors, with a set of recommendations, and really said that—I don't think there's a copy around. If there is, I don't have one.

But basically what we recommended was really approved in how we would set up. We basically said, "Let's set up *the* guy and *the* person in Washington," which became Arnie Aldrich, and then have a lead person for development in Houston, and that's where I went. And then a lead ops person in Florida, and that's where Bob Crippen went. Then we had some other changes within that, how we did things at Marshall and the Cape, and how we set up these daily telecons and made sure we were communicating, because one of the issues was we weren't communicating. Day to day, I really thought we were, but when we got down to the day of the *Challenger* launch, there was some lack of communication going on.

So we set this up, and Admiral Truly announced the organization, and then what happened is these daily noon meetings that we were doing before the *Challenger* accident, essentially, Bob Crippen and I would co-chair them. If we had a change that dealt with the vehicle in flow, Bob Crippen was the deciding authority. If we had a change on a vehicle that was coming down the line, I was...the authority. But we always never disagreed with each other. [Laughter] That would be the wrong message to send, so we were always synched up. It worked very well. I don't know if you've talked to Bob Crippen or not.

BUTLER: Not yet.

KOHR: He would be a good person to talk to.

BUTLER: Definitely.

KOHRs: He was key to making this whole thing work, both in his team he worked for management and then his activity at Kennedy. Of course, then if I recall what happened, Bill Lenoir came back, and Arnie Aldrich and myself were working for Lenoir. I was director of—no, this is after that. This is getting way ahead. Crippen eventually went to Headquarters to take Arnie Aldrich's job, and then he went back to become Kennedy Center director, and he moved from Houston to Kennedy, Kennedy to Headquarters, Headquarters back to the Cape, in a different role as Center director, and then he left. He's now CEO, or president, of Thiokol, the people who build the solid rocket motors for Shuttle in Odgen, Utah. Got a lot of history of what went on back there.

BUTLER: In our research, we found that Arnie Aldrich gave you great praise for your role in bringing the Shuttle back.

KOHRs: Have you talked to Arnie?

BUTLER: We haven't talked to him yet.

KOHRs: We're good friends.

BUTLER: Good.

KOHRs: Have you talked to Jay Honeycutt?

BUTLER: Not yet.

KOHRs: Honeycutt, back then, was my deputy, and then he moved down to the Cape when [McCartney was] Center director. I can't remember exactly, but he moved down to the Cape. Now he's heading up Lockheed [Martin] in Houston. We had some good times. We spent a lot of time on the road. I think the three years after the accident, the highest one, I averaged 100 nights a year away from home.

BUTLER: Wow.

KOHRs: Mostly at Headquarters or Kennedy or Marshall, mainly that's where I spent time, which was a lot, but, here again, it was worth it. It's something you had to do to make things work.

Arnie and I talk to each other. We're friends. Our wives are friends. He'd be a great guy to talk to. He's in Virginia. He's at Lockheed-Martin in Bethesda, but he lives in Virginia.

BUTLER: Our list of people that we'd like to talk to keeps growing.

KOHRs: He'd be a key person.

BUTLER: Absolutely.

KOHRs: He was one of the key guys that went back after the accident to run the Shuttle Program.

BUTLER: Absolutely.

KOHRs: Lots of hours together.

BUTLER: I'm sure lots of stories to share, too. As the Shuttle Program did come back to flight status, came back on line, along in this time frame the National Space Transportation System Office moved from JSC up to Washington. Was this part of the changes that you—

KOHRs: Yes, recommended changes that came out of Bob Crippen's team. I forget the Rogers Commission, but they wanted to have a stronger influence out of NASA Headquarters. When the first Shuttle launch went off, John [F.] Yardley was head of the Office of Space Flight. John Yardley is probably the most technically capable person I've ever met in terms of knowing what was going on technically and making decisions that were technical as well as monetary. He was key strength at NASA Headquarters, and he, I guess, was ill right around the time of the first flight. He made it through the first flight, but shortly thereafter he retired. John Yardley was the lead guy at McDonnell Aircraft for Mercury and Gemini. He ran the Mercury and Gemini Programs for McDonnell, and in '76 they talked him into coming to NASA to run the Office of Space Flight, and he was key to getting the Shuttle flying. But he had some health problems, and after the first flight he retired.

[After Yardley left] I think the strength of Headquarters was not as great, and I think what the Rogers Commission saw is that we should...[go back to a stronger headquarters]. So Admiral Truly brought up Arnie Aldrich to run it, and we set up this organization to run it the way we had recommended. So we got a lot of trips back and forth to Washington, but a lot of good communications going on.

BUTLER: Looking back over the Shuttle Program, it's now about to enter the end of the 1900s.

KOHRs: Thirty years.

BUTLER: Thirty years. The technology on the Shuttle still going strong, but it is older. From all your experience working with it, do you foresee it maintaining and continuing for many more years?

KOHRs: I think with the improvements they're making, they can keep going probably another twenty years. It's designed for 100 missions. I don't know, we probably haven't flown it more than 30 missions on any one vehicle. A lot of upgrades have happened. Even when I was there, the new computers, new inertial measurement units, they've added the GPS, which is the Global Positioning System. I was just looking at a report yesterday that they're talking about going to a GPS INS system, which we're using in our vehicle, which will replace the IMUs and upgrade them—inertial measurement units. They've done weight savings.

They're looking at—Brian O'Connor just headed up a National Research Council study about Shuttle upgrades, and things like going to electrical mechanical actuators instead of hydraulic, so all that's going on. So I think they'll be flying another twenty years, with upgrades. With upgrades.

BUTLER: As long as it's maintained. It seems to be a pretty stable vehicle now. From working on the Space Shuttle Program, you then moved into the Space Station *Freedom* Office.

KOHRs: We made it through return to flight, which was September of '88. Then we flew four flights, 26, 27, 28, 29, 30, I guess, and my last flight was 30, which I think may have been the *Magellan* flight. I can't remember. And if you look at the manifest, there was a lull between that flight and the next flight, [unclear] six months, and also at that time Dr. [James

C.] Fletcher, who was [NASA] Administrator, and Dale [D.] Myers—I don't know if you've talked to Dale, Deputy Administrator—they both decided to retire.

So Truly had just brought the Shuttle back and he was nominated to be Administrator. So he called me one day, one Sunday, and says, "Hey, I'd like you to come work in Washington." So he asked me to fly up on Monday, so I went up and talked to him. Obviously I was going to do anything he wanted me to do, so I moved up. I thought I was going up to run the Space Shuttle Program, but when we got into discussions of who should run what, they asked me to take over the Space Station *Freedom* Program back there, and it had its own set of changes and things like that that were going on. I, in all honestly, had not paid any attention to the Space Station Program. I was too engrossed with the Shuttle Program and things we were doing, although I was, after we finished the Rogers Commission response, I was put on a Space Station management team by Gerry [Gerald D.] Griffin, who was [Johnson Space] Center Director then, and spent about three weeks at Headquarters doing that. But that was about my only exposure. That's when they were setting up.

You've probably been through this if you've talked to some people. There was a conflict about Johnson was the lead Center for Space Station and the people in Washington coming out of the *Challenger* accident said, "Hey, we've got [direction] from Washington, so let's move the lead Center up to Headquarters and put it in Reston [Virginia]." A lot of turmoil went on between Headquarters people on the Space Station side and the Center directors, and who's going to have what system and who's going to build what. I wasn't involved in any of that. I was on the outside. But when I went into it, it was already—all the contractors had been selected and Headquarters had moved the lead Center back up to Headquarters to a lead integration activity up there. So that was my only exposure.

So I did that for about four years, I guess, almost five years, I guess, from '89 to '93.

BUTLER: During that time you faced a lot of challenges, especially in the budgetary areas. What can you tell us about how you dealt with budget cuts and how you kept the program going?

KOHR: Well, it was interesting. I think I got there in about May of '89, and then Congress decided, about the end of May, that they wanted to cut the Space Station budget. It was—I can't remember this. We went through three or four budget cuts. In May of '89, it was like 400 million in the next year budget. I was brand new to the program, so what we did is—Bill Lenoir was also brand new, so we formed a team of people who were put down at Langley for about two months, trying to say, "How are we going to save this money? What are we going to do?"

The first thing we did, we messed up, is we decided that we didn't need our international partners to participate; we would do it all on the NASA side. International partners were not happy. There were a lot of things going on.

The other thing that was interesting, when I went to Washington on Space Station, I was never aware, but back then there was a local weekly paper named *Space Station News*, with a couple of reporters whose sole job was to write about Space Station every week, which I thought was kind of interesting. They merged into *Space News*, but there was a separate paper by one of the publishing companies. They had a lot to do with influencing, what they wrote about these NASA people not being nice to our international partners and stuff. So we went through that for about a month and a half.

Went back to Congress...and said, "Here's what we've got to do," and they agreed to that. So we went on through '89, and then we submitted a budget, always around the first of the year, back to Congress for the next year's budget, and Congress came back and says, "Okay, now we want to cut you 6 billion out of your five-year budget," which was a lot of money.

So then we went into another big review cycle about what we could cut out and what we shouldn't do. As a result of that, one of our contractors at Goddard [Space Flight Center, Greenbelt, Maryland] was General Electric, who was building a module. They called it a hangar. We had to just cut that program out completely, and a couple of other things. We had reduced the power from 75 kilowatts to 56 kilowatts, get rid of one of our power modules.

But we came back and said, "Okay, if you take out 6 billion, this is what we have to do and the program going to slip," because we couldn't deliver. So that's when the program was slipping. When I got there, we were launching in '93, went through these two exercises. We moved it to like '96.

Then the next year they came back and says, "We're going to cut you 250 million in the next year." So we had another exercise where we went through that. Then got that all through. But then the next two years, they didn't touch us, didn't touch Space Station. In my view, we made a lot of progress, because we had two years where we had the funding we asked for, and that took us into the '93. Then that's when it was decided to change the *Freedom* Program into the International Space Station, bring the Russians in. So everything kind of stopped and everybody regrouped as to what the budget was going to be and what the relationships were going to be.

In the Shuttle Program, we had gone through budget cuts, budget reductions that Congress wanted, Headquarters wanted, but they were kind of at the 100 million level when they came in and said, "You're going to have to take out 6 billion in five years" out of our planned budget. It was pretty chaotic, but we went through it, had a team. The contractors were great. Everybody realized that if we didn't do this, we'd probably get cut to zero and there wouldn't be a program. So, a lot of decisions to make. Went through all kinds of reviews internally and then with Center directors, the Management Council, which consisted of the Center directors involved with the program. So we did that. It kept you busy, again.

BUTLER: It seems that redesign costs money, and yet they're cutting budget. So you even had a challenge there as to, "We have to redesign it because we don't have as much money, but we have to spend the money to redesign it," so that takes more of your money.

KOHRs: Well, the result is that you wind up slipping the schedule.

BUTLER: How did you decide what to cut or what to change?

KOHRs: Well, we did it, as we liked to say back then, we do everything by consensus, meaning everybody would agree. I always considered that you could never get everything done by consensus. Somebody had to make a decision. But we would throw straw men on the table. We'd say, "If we do this, this, and this, here's what it means," and we'd integrate them through the Centers, then through the contractors, and kind of get down to the point that says, "Got to make a decision." Try to go the right way. Not everybody liked it.

Anyhow, those were not good times. A lot of people would get angry with each other because they thought you were cutting—a typical thing, Marshall would say, "Well, you're cutting me more than you're cutting Johnson," or, "You're cutting Johnson more than you're cutting Goddard," or, "You're messing up Kennedy." You'd work it with the program people, and the Center directors would get their influence in and would talk to each other. But that's the name of the game. You just had to work it. I guess it worked out. We went back and said, "Here's what we did." I think Congress, the last couple of years, finally agreed that enough was enough, and then it [Freedom] was upset by the decision to put in International Space Station.

BUTLER: You mentioned your work with the Space Station *Freedom* and mentioned that you retired in '93 as there was going to be a turnover into the International Space Station. At the time, and even now, that actually modules are being placed in orbit and it's actually being constructed, what are your thoughts on the configuration and the operations?

KOHRs: I think it's great. I think what the country needs, or the world needs, is, I've always said, a laboratory in space. It will probably help bring the world together, at least the partners that we have. So I think it's great. I think it's a major accomplishment to have something up there orbiting, actually have some hardware. It's got its set of problems just like every other program, and money is probably one of their big problems. I'm sure it is. From what you read, they have the Russian problems with delivering hardware. But I think it's great.

I always said, back when we had the *Challenger* accident, people came out and said, "We're going to fly in six months." Then they said, "We're going to fly in nine months." Back then the papers would say, "NASA missed their schedule. NASA missed their schedule." I was on Space Station, and we were slipping schedule, and I would always say to a group of sometimes reporters, I said, "How many in this room can remember when we flew, that we returned to flight on Shuttle?" Not many of them could. I mean, the fact that we had said we'd fly in six months, then nine months, then a year, then we said we'd fly in fourteen months. It was twenty-two months, I think, before we flew.

But in the heat of the day, you know, people worry about that, but three or four years from now, if the Space Station is up and is successful, people will forget that they were three or four years behind schedule and that type of thing, as long as there's something useful happening. You spend money, but I think the benefits will outweigh that. It's going to be a tremendous effort to put it all together, the complexity of bringing in additional partners and for good reason. It just adds complexity to it.

In this *Freedom* Program, we tried to keep our international partners out of what I call the critical path. In other words, if they didn't show up, the U.S. part of it could continue and we'd have a lab up and we'd have a module up to do science. Getting in with the Russians has put them into the critical path, and that's some of the problems they've got, but will probably be overcome. It's a decision that was made, that that's what we've got to do to make the [ISS] probably work. That's fine. No, I think it's great. I think it's great that all the people that have worked on the station have done a great job.

BUTLER: When you retired from NASA, you went to work for ANSER.

KOHR: I took off for about nine months, almost a year.

BUTLER: Took some of that vacation time?

KOHR: I just took off.

BUTLER: When you did go back to work then, you mentioned that you worked with Moscow and with aerospace operations. Did this involve anything along the lines of the Space Station, or was this different?

KOHR: Primarily ANSER was run by John Fabian, ex-astronaut who actually flew with Dan [Daniel C.] Brandenstein. ANSER is primarily a military support contractor working for the Pentagon. John Fabian had his vision of setting up an office in Moscow, trying to work with the Russians and promote their activity. When I first went to ANSER, that was not what I was going over there for; I was going over there to help them work on bidding on a NASA contract, on something else.

As we got into it, I got involved in the Russian operation, and so we got about a dozen people. Three or four of them rotated through Moscow. But most of our support was related to the science side, interfacing with the Russian science community and NASA Headquarters, not really into the Space Station activity or into the Shuttle activity or into the *Mir*. It was primarily working the science interface, and then we did some other things for some other commercial companies. But small group, eight, ten people. It was the only part of that company that did any commercial work. All the rest of their work was tied to the government, and most of mine, other than NASA, was tied to doing work for commercial companies.

So I came out here to do some work for this commercial company, and I knew most of the old-timers out here, and after a couple of trips I decided I might as well come out here and work, because it's more exciting and something I wanted to do, getting back closer to what I call closer to the hardware. The previous company was more of a paper product company as opposed to building something, not for profit, analysis and research. It was interesting, I enjoyed it, but this is a lot more interesting, a lot more fun.

BUTLER: Tell us about what you do here.

KOHRs: Well, it really gets back to be systems engineering, systems integration. Kistler's building a reusable launch vehicle. We wound up at Kistler becoming the systems integrator. We have two or three prime contractors, principal contractors. Here again, the job is to take a propulsion system and make sure it goes into the—which is a propulsion contractor—making sure their stuff is integrated into the structures contractor, and all the systems analysis and integration work is done by Kistler.

So we have a group of probably fifteen full-time engineers, probably twenty full-time consultants. Consultants are old-timers like myself who have worked for Rockwell, worked

for NASA at the Cape, worked for Rockwell, and we have a bunch of—not a bunch, a number of young engineers that are out of college two or three years, that are just incredible, I mean really sharp. So the old-timers and the young people are mixing, and we're all learning from each other. They've got the computer skills and stamina.

But the job is pretty much what it was in the early days of Apollo and Shuttle. It's an integrations job, and here you're communicating, getting people to talk to each other, and working out the issues. And it's a lot closer. We're fifteen or so technical people here. There's not a lot of bureaucracy. Although we have a lot of paper floating around, there's not a lot of bureaucracy here. We can make decisions on which contractor is going to do what, without going through a lot of formal paperwork and proposals and that type of thing. So that part is unique. It's fun. All we need is some additional funding and we'll be moving pretty quick.

BUTLER: That age-old problem.

KOHRs: Right.

BUTLER: Looking back over your career as a whole, especially with working with NASA, what would you say was both your biggest challenge and your most significant accomplishment?

KOHRs: Oh, I think probably some of the biggest challenges were keeping the people motivated, coming out of some of the—I don't know, "disaster" is probably the wrong word, but the 204 fire, that was a big setback. Everybody rallied together. Apollo 13, the *Challenger* accident, getting through all that, the emotion and getting people back up.

The people I'll remember is George Low, who really brought back the Apollo after the fire, at least from a Johnson Center perspective, and probably for the agency. The Center directors, [Robert R.] Gilruth, Kraft were very instrumental in all that, influencing what I did and how I worked.

Probably the biggest accomplishment was getting back to return to flight, personally from the *Challenger* accident. I mean, it was an incredible amount of teamwork, overcoming hurdles and that type of thing. We had to go back and redo everything, just hours and hours and hours of reviewing things and asking questions and making sure. But that was probably the biggest accomplishment.

I've been to a couple of these things, they say, "Who's influenced you most in your career?" Probably George Low, Dr. Kraft, Admiral Truly. Arnie Aldrich has had a lot of influence. We've worked together for, gosh, probably fifteen years, something like that. So it's the people you've worked with. And there's interesting people all through this thing. General [Forrest S.] McCartney, who was a Center director at Kennedy, is one of the most interesting guys to talk to, a four-star general, has got all the rigor and is a pretty interesting guy. He's still around. He's down at—I think he runs Lockheed. He's still at the Cape. He runs Lockheed's expendable launch vehicles, I think, out at the Cape. He came back in to run the Kennedy Center after the accident, and he was there until four or five years. Bob Crippen replaced him. Interesting people. Bill Lucas at Marshall Space Flight Center, interesting person. He's retired, too. I think he's a minister. John Yardley, in the early days of Shuttle, was key to making it all happen out at NASA Headquarters, pulling it all together.

Administrators. I was never too much in direct involvement with the administrators, except when Admiral Truly was administrator. Then I was at NASA Headquarters. A lot of times the people at the Centers don't know or don't really care what's going on in the Headquarters arena unless you're at the Center director level or program manager level. I think they're more concentrating on getting the day-to-day job done, which is good, which is

the right concentration. There's a lot of war stories and things like that, that's probably not worth talking about. There's one time [unclear].

I think Space Station was interesting because when we got into Space Station, at Johnson Space Center I primarily interfaced with the manned part of the program, Marshall, Kennedy, and Johnson. When we got into the Space Station, we got involved with the Lewis Research Center [Cleveland, Ohio], involved with Goddard, and a little bit with JPL [Jet Propulsion Laboratory, Pasadena, California] and a little bit with Ames. But in that respect, when you went into those type of meetings, it's kind of a cultural thing. If you're in the human side of it, those people all seem to work one way. Then you get into the unmanned side at Goddard and it's a different set of people, and you learn from them. It was a good experience, the last four or five years. We were really working across all the centers.

In retrospect, that may not have been the right thing to do for NASA, because one of the things they did to sell Space Station was to try to get everybody involved, to have a piece of the action, and my personal view, that was done to get the political support from all of the Center directors and the local congressmen and politicians. And it worked. They got the program approved. What happened to us as we got into these budget cuts, we had to just trim back.

I think it really wound up that Goddard got completely out of the Space Station Program. They had two contractors. They had General Electric that was building this house that was going to be an on-orbit assembly-type facility, and then Martin Marietta out of Denver [Colorado] was building a robotic device. When it came down to cutting budgets, we had the Canadians building their robotic device and they were supplying their own money to build it. You had to make a choice that says, "Do we really need to do this?" And so we wound up on one of those budget exercises, we actually took Goddard out of the Space Station Program, and the two contractors essentially canceled their contracts. Lewis stayed in and Marshall and Kennedy and Johnson, and most of the stuff at Ames was analytical

work that Ames and JPL was doing. JPL had some support contractors on the Headquarters Reston office. They had about twenty guys, twenty people up here supporting them. It was interesting, because you got to learn different parts of how Centers worked around NASA. Didn't always agree with them. They didn't always agree with you, but that's okay. It was good experience.

Probably the thing that I would recommend to younger people, and I know it's always tough, when I went to Headquarters—I'd been up there a number of times, but never really worked there, and when I went up in '89, after about six months I said, "Man, if I'd come up here when I was about twenty years younger and spent about a year just to learn about the Washington environment, I'd have been a heck of a lot better off going back when I did," because I was fifty-something years old. So it took about six months to nine months to figure out how the system works. In my days back there, we were really driven from the outside, from the staffers, from the Congress cutting our budget, that type of thing. But here again, it's interesting because you get to meet a lot of different people and staff people and congressmen. Congressmen are kind of interesting when you go talk to them.

My advice is, the problem is, when you're sitting there and you've got kids in school and someone says, "You want to go to Washington for a year?" you say, "Why the heck would I want to do this?" In retrospect, people who do that, I think, if they ever want to go back and work in the Washington environment, they'd be a lot better off. But it's not necessary, but in my view it sure would have helped me. Just making a day trip or a two-day trip, you don't even learn how to drive in the city, much less know what's going on.

BUTLER: Definitely a different environment.

KOHRs: But being there four years, five years, was another good experience. In fact, I still live there. My wife lives there. I live here.

BUTLER: When you think back to when you began in aviation and in aerospace, would you ever have imagined where it would lead you?

KOHRs: No. We were a family of five boys, one girl, and my oldest brother was an engineer, went to Washington University in St. Louis. I grew up in St. Louis. He went to Washington U. in St. Louis, became an electrical engineer. He was the oldest. I was the second youngest. The other two older brothers went off and did things, and I was the only one who really followed him. My older brother and I were probably pretty close together, so I went to engineering school, went to the same school. He worked at McDonnell, I went to work at McDonnell. I had a very influential uncle who worked at McDonnell. So that's how I got involved... And having my brother and my uncle there helped me get a job. So as you work that three or four months, you kind of get your engineering thoughts going down the—really, then it was in the aircraft line. But then you start going down—you're a mechanical engineer, you could do a lot of things, go build bridges, build roads, but when you get into that aircraft side, you kind of just keep thinking that way. That's how I got into it. I never had any idea that's where it would lead to. Like somebody says, "I want to be an astronaut and that's what I'm going to go work on." I just went along with the flow.

BUTLER: It seemed to work out pretty well for you.

KOHRs: I don't know if a lot of people do that or not, but that's just the way most of the people you talk to, I think, never imagined they'd wind up.

BUTLER: Keeps life interesting.

KOHRs: Keeps you busy. I think the biggest thing is being happy with what you're doing. If you're not, you might as well try something else.

BUTLER: Absolutely.

KOHRs: You may not be able to afford it if you've got house payments and kids and things like that, but that's what you do. When I went to work for NASA, I thought I'd be there three or four years and I'd wind back up with a contractor. But when you got down there and got working on the Apollo Program and got into the day-to-day routine of making this thing work, it really gets you excited, so I spent thirty-one years there.

BUTLER: Hopefully those were happy.

KOHRs: It was good.

BUTLER: Do you have any questions? [Addressing Summer Bergen.]

BERGEN: I have a couple. You mentioned briefly about 1993, after Clinton had come into office, he initiated the redesign procedure. I was wondering if you could go a little bit more in depth about the impact that had on you, what you thought about the time, and how that affected the people you worked with.

KOHRs: Well, we had gone through on the Space Station *Freedom* with a real good team of people both at the Centers and at Reston and NASA Headquarters, and had really been successful in restructuring the program. We were going along, had two years of funding where they didn't cut our budget. We had gone through what we called a critical design

review, and we really thought we were making progress. So when the system comes in and says, "Hey, we want to change what you're doing," there was a lot of "What are we doing to ourselves" type of thing. It aggravated a lot of people. I was amazed that we were doing this, but I think we were driven to do it—I'll use the word "political reasons"—to go down the path we went.

I'm not against it. I think the thing that was probably the most disturbing to me is a lot of the good people who had worked on the program were told they couldn't work on it anymore. In retrospect, that happened to some of the higher people, but today if you go look at the Space Station Program, a lot of those people are working on it today. There was turmoil where this group at Reston of 100-and-something people had to move to Houston or do something, and the families had to go through that. Some of those people quit... That was five or six years ago. Most of the people are probably as happy as they could be where they are.

See, I was always one that said that the strength of NASA is at the Centers, and that's where we ought to put the technical people. Space Station was kind of counter to that. They tried to say that the strength of the Space Station is Reston or NASA Headquarters. In my view, that wasn't right and never will be right, and I think the way NASA is reorganized now, the way Johnson and Kennedy are, the technical strength of NASA is at the Centers, and I think that's the right thing to do.

The Rogers Commission argued against that, but I think if you plot the history of NASA, you can almost see it's kind of like NASA Headquarters is strong, then it gets weaker, then it gets stronger, then it gets weaker, and right now I'd say it's kind of in the weaker side as opposed to the stronger side. That's the way it's been set up. Some people will say it ought to be the other way, but I personally believe that the technical strength should be at the Centers. And I think it is today.

But to answer your question, back then there were some things said that probably shouldn't have been said about the way we were doing business, but a lot of it was emotional. That's why I decided the best thing for me to do is to leave, so I just left.

BERGEN: Looking back, since you've had experience working with the Russians, how do you feel about the international partners, especially the Russians?

KOHR: I think it's fine. I never interfaced with the Russians too much at NASA, but we did interface with the Europeans and the Japanese and the Canadians, because they were part of the original *Freedom* team. Here again, a great group of people. Some of them are still there. Some of them are retired. But when historians write about the Space Station, they'll say this is what the government probably had to do to make it successful, to keep it going. I don't know if that's right or wrong, but that's where we are, so everybody ought to support it. I think they've got a couple of modules up. I just hope they're successful the next two or three years, because there's a lot of things that have to happen right. In the Space Station *Freedom*, everything had to happen right, too, as well.

BERGEN: That's all the questions I have.

BUTLER: I have one last question for you. Talking briefly about the international partnership, you mentioned that may be what needed to be done to make it happen. Do you think the future space programs are going to have more international cooperation to help make them happen?

KOHR: Oh, I think so. It's already happening. If you look at what's going on at Johnson, which is called the X-38 vehicle, or called the ACV, [all] crew rescue vehicle, built for

station, one of the next programs that Johnson's going to come forward with, it has the Germans building part of the heat shield, it's got the French doing part of the guidance system. I think it's natural to get more and more of the international flavor into these programs.

I think that the big—not problem, but the thing you've got to really watch out is how the money flows and how you set up these what I call offsets, because no foreign country like the U.S. wants to send money—I use the word "across the water" if they're looking for offsets. So if they contribute a thermal protection system from France, what's our payback? Our payback could be flying one of their astronauts, it could be giving them some payload space on Space Station. But they really don't want any money to go back and forth. It's another job that someone's got to manage to keep it all straight.

On Space Station *Freedom* we had a set of criteria that was agreed to and signed by the administrator and all the heads of the European, Canadian, and Gemini Space Agency that says, "Here's the way we're going to divide up the pie." Well, when they brought in the Russians, all that had to change again. But it happened and they got it straightened out. From a technical standpoint, those type of things—if somebody's trying to build a vehicle, you'd say, "God, I didn't have to worry about this. If I could worry about building a vehicle... But the nature of the game is, you've got to work them all. And I think what's happened is that NASA's developed some talented people to work those type of things, working with the different international partners.

But to answer your question, I think it will be more and more international, probably. Probably competition as well, but probably involved more in competition.

BUTLER: And you're even having some international involvement yourself. You're planning to launch from Australia.

KOHRs: We're using Russian engines that Aerojet has bought through their contacts with the Russians. Our contract is with Aerojet. Our first launches will be out of Australia, a government interface. We don't have any technical partners, if you will, building our hardware; it's all U.S. companies. And here again, it's easier for the government to deal with international partners than it is for commercial companies, because you have kind of a little different set of regulations, of getting through the government treaty agreements and that type of thing. Ours is one of "build what we've got," if you will, and get on with it. There's no really new technology that we're doing. It's pretty much what we call off-the-shelf technology.

BUTLER: We want to wish you luck with that, and thank you for talking with us today and sharing your experiences.

[End of Interview]