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ORAL HISTORY TRANSCRIPT

CARL B. SHELLEY
INTERVIEWED BY CAROL BUTLER
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BUTLER: Today is April 17, 2001. This oral history with Carl Shelley is being conducted for the Johnson Space Center Oral History Project at the offices of the Signal Corporation in Houston, Texas. Carol Butler is the interviewer, and is assisted by Kevin Rusnak and Kirk Freeman.

Thank you very much for joining us today.

SHELLEY: My pleasure.

BUTLER: To begin with, if you could tell us a little bit about how you got interested in aviation and aerospace and what kind of led you toward NASA.

SHELLEY: When I graduated from college, I was committed to go to the military, to the Air Force, and I was assigned to White Sands Missile Range out in New Mexico. I showed up for work out there as a brand-new second lieutenant, not knowing anything, and they promptly told me that "You are now the weapons systems evaluation officer for something called a GAR-11 missile," a Guided Air Rocket missile. That was an air-to-air rocket, guided, for interceptive purposes, for shooting at bombers and things like that. But the thing had a nuclear warhead in it and everything else. It was a significant project with millions of dollars, and I knew nothing

about what a GAR rocket was or anything, but I learned in a hurry. They put me in charge of evaluating the thing.

So I had three years of service in the military associated with missiles and weapons systems. The prime contractor on that activity was Hughes Aircraft Company. When my three years in the service was up, it was somewhat natural for me to ask Hughes for a job, you know, basically. So they were more than happy and willing to offer me a job, and I went to work on the Surveyor Project. I don't know if you know what that is. It's the first soft-landing on the moon.

So I was working Surveyor, supporting Jet Propulsion Laboratory, in the mission analysis area, mission and systems analysis. As it turned out, I'm sitting at my desk there one day, and a fellow that I had worked with in the Air Force had gotten out of the Air Force and had gone to work for NASA. He was the deputy division chief down here in what then was the Flight Control Division in the Missions Operations Directorate, a fellow by the name of Dave [David H.] Owen [Jr.]. They were looking for people, staffing up, getting ready to make the run for the Moon. So he calls me up and offers me a job.

I notice you had this question in here [referring to documents] about [job] interviews. I never had an interview or anything like that. In fact, I agonized for a couple of months before taking the job to come down here, because I had a good job. I mean, we were landing on the Moon, and we were going to get there first. But ultimately, they twisted my arm, and Dave talked me into coming down here.

So I came down in November of '64, which turns out, in retrospect, it had been a pretty good time to come to JSC [Johnson Space Center], because we were just beginning to make the preparations for flying the first Gemini mission out of the new Mission Control Center. That

was just being built. Anyway, I came in and reported in to the Flight Control Division. They had asked me to work in the area of simulation and training and just general preparation activities for getting the flight control team ready to fly. So that's how I got here.

BUTLER: Certainly an interesting path.

SHELLEY: It was an interesting path. I thought at the time—well, Hughes didn't want me to leave. I'm one of those guys who took a pay cut to come down here, but we're going to the Moon. Those are the guys that are going to do that, so this was the place to be. I don't regret having made that trip.

I came down. Things were chaotic. The office, I was in Building 30, the administrative wing. The Space Station side had not been built then obviously, but the control center, the original control center part was there, and the office wing was there. We were in the office wing. That's where our offices were, and there was stuff piled everywhere. The hallways were littered with all the office supplies, and everything from copying machines to papers and everything was scattered. It was crowded up. Not enough room. They had just moved in, of course, because just before I got here a couple months earlier, most of them had been in offices up the freeway there, the Stahl & Myer's Building, and you may have heard of those. So they were trying to get people on site. So everything was really chaotic. It was a fun time, I'll tell you. There was nothing bureaucratic about anything, though. If you needed to do something, you just went and did it.

Chris [Christopher C.] Kraft [Jr.] was the Director of Flight Operations at that time. A fellow by the name of John [D.] Hodge, whom you've probably heard of, was the Division Chief in the Flight Control Division. John was an Englishman. You're familiar with John?

BUTLER: Yes.

SHELLEY: Running the division. And, of course, this guy, Dave Owen, whom I had worked with in the Air Force, was the deputy division chief.

There must have been, I don't know, maybe 150 people in flight control. Might have been 200, counting the contractor staff. Most of the contractors were Philco people in those days. Philco later became Ford, later became Loral, but they were Philco in those days. Most of those people had experience in remote-site operations of various types and had been brought in to help the flight control team gets its act together here.

But there were a number of civil servants, 100 or so, maybe. [Eugene F.] Kranz was here. Glynn [S.] Lunney was here. Cliff [Clifford E.] Charlesworth. Most of the names of the people of that era that you're familiar with, they were all there in Flight Control Division at that time. Jerry [C.] Bostick, Arnie [Arnold D.] Aldrich.

I went to work for a fellow named Harold [G.] Miller. You may not know Miller. He was heading up the Mission Simulation Branch. There was another fellow named Jim [James A.] Miller, who was also in that branch. Those two gentlemen probably don't get as much credit as they should for developing, in particular, the simulation and training systems that were put in place. Harold was a thinking individual, very quiet fellow from Tennessee. Jim Miller was kind of an outgoing fellow from Missouri who was responsible for developing the

simulation system, building it and everything. But, anyway, both those people played major roles in getting the early simulation system on line.

BUTLER: Had they been involved with it in the Mercury Program and followed through?

SHELLEY: Harold had. I'm not sure exactly when Jim came on board, but Jim was a computer guy, primarily. He was a hardware builder. But Harold had been involved in Mercury in training and simulation. In fact, he and Glynn Lunney and fellow named, I believe, Dick [Richard A.] Hoover and Stan [Stanley] Faber were pretty much the Mercury simulation team, if you will.

So when I came to work here, they already had some idea about what they wanted to do. And what they wanted to do, of course, was to build this fairly sophisticated closed-loop simulation system. It was called SCATS in those days, Simulation Checkout and Training System. It had a name like that because it was to be used for checking out the control center as well as for conducting the simulation activity for training flight controllers. But what it was, of course, I think we had 7094 computers, IBM 7094 computers in those days, which was as big as you could get, but still not too impressive compared to today's computers.

Anyway, one of those things was called a ground systems support computer or ground support systems computer—I'm not sure, GSSC [Ground Support Simulation Computer]—in which we developed models of the spacecraft for the purpose of not only simulating the control center telemetry systems and command systems and tracking and data systems activity, but also to represent the systems to flight controllers for purposes of training. So that's what we were doing. We were building these math models and these computer models with the intent that we

would conduct these closed-loop simulation exercises using this computer as a supplement to the Gemini Mission Simulator, which was the primary crew trainer, which also could be tied into the control center and conduct closed-loop simulations with both the crew and the flight controllers. We basically developed all the capabilities that exist today, the way you still do it today. We did that in Gemini as well.

In addition, in those days, we had the tracking networks around the world, still had these remote sites out there, so we had to worry about how do you integrate those flight control teams which were deployed for every flight. How do you integrate those people into this overall training environment? So we built a couple of simulated remote sites that were here, and the computer would sequence them in sequences they would be acquiring the vehicle if they were in a real flight. So as they rotated around the world, we would turn the telemetry on and off into these remote sites, and the flight controllers would be in there, and they would function back to the control center, which was just through the wall next door, but it made it look more real. So that's what we were doing.

We flew the first—well, I guess on Gemini III was what we call a flight-following mode. The new control center here was used in a flight-following mode to monitor Gemini III, which was controlled from the Cape. But on Gemini IV, we flew the first mission using the local control center, so we had to do all the preparation activities, training preparations, and everything for that flight, for Gemini IV. Then we flew every remaining Gemini mission from the control center here.

My job was one of basically preparing the flight control team, making sure that it was really understanding how they did business, what their procedures were, what the flight systems were, and try to find weaknesses in that entire process, and to illustrate that and demonstrate that

through these simulation exercises, with the understanding that we were using the simulation exercises not only to train people, but to help develop the mission plans, if you will, the flight procedures.

Probably the major benefit of simulations, really, is in the business of developing the procedures and validating the plans for a flight. Most flight controllers, by the time they show up in a control center, already understand the systems. I mean, they've already gone through a lot of classroom training, they've done a lot of flight preparation activities, developing handbooks, procedures, etc.

Even in those days, really the prime training mechanism for training people to become flight controllers, it was almost OJT [on-the-job training]. They trained by doing the job. They wrote the procedures, developed the procedures, they developed all the reference handbooks, they developed the flight rules, and that is a very good training exercise. If you have to go through the thought processes where you have to decide what are we going to do, in all these "what if" situations, so they are already very smart people by the time they get to a simulation. So the simulation is really a validation exercise, a verification activity.

But this was the first time this had been done at this scale. It was a very large system. We had a lot of trouble developing the systems. IBM built the 7094 computer and developed the GSSC software and everything for us. There were a lot of long hours in the middle of the night, checking those systems out and trying to get the system up and running and keep it running.

BUTLER: You mentioned that the flight controllers had been through a lot of classroom training on the systems, that they were familiar with a lot of that beforehand. How did you, on the simulation side, build up that familiarity with the systems?

SHELLEY: We went through the same courses, did the same things. The simulation team had all the same disciplines as the flight control team. They had us outnumbered, because they had to have four or five teams, but we only had one team. But we always had the advantage of knowing what we were trying to do in the exercise, whereas they didn't. It was an exam for them. They didn't know. So we had to struggle at times, but we could keep up with them pretty well. But we went to all the same courses, took all the same formal courses. And we would bring contractors in, like McDonnell [Aircraft Corporation] might come in and conduct a class on the Gemini spacecraft and just different areas. We did a lot of that. But the training people were basically just like controllers who had the job of training the other guys associated with them.

And during flights, in fact, we used the training people many times to support the main flight control team functions. We would put people in them. Not out in the front room activities, but in the back rooms, in the staff support rooms, we would use training people to supplement the flight teams. They would do things like data analysis and monitoring of various events, those kinds of things. For a couple of reasons. One is, we needed a lot of good feedback from the missions, and the flight teams needed help. We never had enough people, it seemed like, so we did a lot of that.

BUTLER: For you all it was a lot of on-the-job training as well, then.

SHELLEY: Everybody was learning on the job. This whole thing was just one whole big on-the-job thing. This was all young people. If you were thirty years old, you were an old man in that group. In fact, by the time of Apollo 11, I guess, I think Gene Kranz was probably thirty-four, and he was the oldest guy around. I guess maybe Charlesworth was older than Gene, but Lunney was like thirty-two, I was thirty. So most people were younger than we were. So it was a young men's activity, which probably nobody told them they couldn't do it, so they went ahead and finished it off. But it was a lot of fun in those days, a lot of fun in those days.

The actual training and simulation activity is very much the same as it is done today, conceptually. We changed it a little bit in Shuttle, but fundamentally the same types of activity go on. Training teams spend a lot of time doing what is very similar to the work I was doing at Hughes as mission analysis, really understanding what are you trying to do and what can go wrong in this situation, or how does the flight control team plus its infrastructure really gear itself up to support this activity, and where are the weaknesses in the overall plan. So the simulation people did a lot of thinking, if you will, scheming. Flight controllers would tell you it would be scheming.

But the idea was to see if you could poke holes in the plan, and if you can, then the plan needs to be revised. Or if, through the attempt to poke a hole in it, you demonstrate that the individual doesn't know his material quite well enough, then you know you have to go train some more. We hadn't flunked people out. You don't do that. These guys already, you've got so much invested in them, you just don't flunk them out. If they need more, you do more.

It's the same as we do with the crew. You don't flunk a crewman if he doesn't quite understand the electrical power system. You go give him more time in the simulator until he

does get it. That's the way we did flight controllers, too. Once a person was assigned to a team, he was going to get whatever training we had time to give him.

Now, probably there was some weeding out before people were assigned to teams. In fact, there was a lot of that. But those judgments were made by the branch supervisors of those people before they put them on the teams. The training people didn't get involved in that. So there were no grades given, nothing like that.

BUTLER: A team effort all around, trying to make it happen.

SHELLEY: The simulation organization in those days was organized pretty much the way it is now. You had systems controllers. You had flight dynamics controllers, and then we had an integration group, basically, that pulled the whole thing together. I think we called them probably Gemini Operations Sections. In fact, I think we had Gemini Operations Sections 1 and 2 at one time, and an Ops and Test Section, which was an Integration Section. Later we had an Apollo Section, we had a Gemini Section, because they were all in the same branch. But it's all the same thing, and it's a mirror image, if you will, of the rest of the Flight Control Division at that time, is what it was. But it was all just to make sure we covered the proper disciplines.

Well, we did have one discipline the rest of the flight control people didn't have. We had to simulate the astronaut. When we did those math models, we had to play the role of the astronaut. We called that position astro-sim, I think is what we called that. Some of the guys enjoyed doing that, because they would take the opportunity to jab the flight controllers a little bit from a crew perspective. But that was always fun.

BUTLER: What were some of the challenges in bringing all this? Because you were building from the Mercury background, which was rather limited in scope.

SHELLEY: And which most of us didn't know anything about. I mentioned Harold Miller had been there, so he knew a little bit about it. So he conceptually knew what was going on. But we quickly figured out what it was we were trying to do. It was basically an analysis problem to understand what the mission requirements were, what we were trying to do. I think the biggest challenge we had was in actually developing the system to represent the environment that we wanted. We spent a lot of time.

You know, it's pretty easy to define a math model if you've got an infinitely-sized computer, but it's very difficult to scale it down and still have it represent the proper functions that you want, to a fidelity that is proper for flight controller training. We spent a lot of time developing math model requirements, defining which telemetry points do we really need, you know, to make dynamic versus which ones can we make static. By that I mean a dynamic parameter would be one that would be computed in real time in closed loop with the environment. Another one could just be a static number we put in there. Maybe it's a temperature that doesn't change very much, so we just put a number in.

Anyway, wading through that mass of data and deciding what you really needed and what you could get away without simulating was always a choicy situation. We spent a lot of time on that. We spent a lot of time developing the proper command responses, defining each model so that a flight controller could sit at his console and command this computer and see the proper response. So we spent a lot of effort building what in that day was called the ground system support computer.

At the same time, we also defined a lot of the malfunctions and things for the simulator. We did a lot of work for the simulator, because the crew really couldn't care less if the telemetry stream coming out the end of the simulator was proper. He wasn't looking at it. So it was pretty much up to us to make sure that the simulator represented the proper interfaces back to the control center, too. So we spent a lot of time on that.

I've got an estimate. I was going to look and see. Probably at a peak, we maybe had seventy-five or eighty people just working training and simulation, which was a pretty good-sized branch, you know. But we did ultimately have to get to the point where we had to have multiple teams because we were flying every two months, remember now, flying Geminis every two months. They were just leapfrogging each other, coming along there. So we had to get some more people.

Plus, you have to also remember that while Gemini's going on, we're getting ready for Apollo. So we're building, trying to build the Apollo simulation system, and it's a different animal from the Gemini simulation system. Conceptually it's the same, but you have to define all those math model requirements and things all over again for a different vehicle. So we had quite a bit of activity going on there in the late sixties.

BUTLER: How did you keep up with the changes from mission to mission in such a time schedule?

SHELLEY: It was very difficult. Before that, it was difficult to keep up with the vehicles. We had to concern ourselves with what does an Apollo command and service module even look like today, or more particularly, what's it going to look like two years from now when we fly. The

difficulty we had was, it's always very difficult to simulate something six months before the flight, because we had requirements for systems knowledge in order to write these math models that didn't exist yet. I mean, or it wasn't very good anyway, if it did exist. So you were always guessing as to which way the designer's going with a particular system. But you had to start early, because if you didn't, you couldn't finish it and have it ready in time. So we made a lot of guesses, made a lot of them wrong, but we got a lot of them right, too. So we had that problem.

Then you had the mission planning activity that goes on. Mission Planning and Analysis Division really initiated the first products associated with the mission plans. We got to the point where they would do a reference version and then we ended up with a basic version and, finally, a final version. We staged these deliveries so that we had a pretty good definition, as best they could define what they were doing. Of course, the flight planning people had to respond to that and build crew timelines to fit those mission profiles, and the flight control team had to prepare all of their activities to fit those profiles. So everybody had the same problem. We were all trying to stay abreast of what was going on. So we helped each other out quite a bit. But there were many instances in which we didn't get the final configuration until just a few weeks, two, three, or four weeks, sometimes, before flight.

Geminis were similar enough, though, that that wasn't a real problem. At least the spacecraft was pretty much the same going through there. We were doing different things, but the fact of the matter is, the real thing we tried to do in Gemini was to develop rendezvous techniques. Some people think that's when the Russians lost the space race, was when the United States actually demonstrated the rendezvous capability. I sort of agree with that myself. That's a very important event that occurred during the course of all this activity. But, anyway,

those techniques, once we got beyond Gemini, '76 or so, rendezvous were all pretty much standard.

There were some things that came along later, things like astronaut maneuvering units [AMU], which were a lot of trouble with those things. So EVA [extravehicular activity] developed during the later courses of Gemini there, and that led to things like neutral buoyancy trainers, the water tanks, you know. We didn't have those in the beginning. They are a direct outgrowth of the experiences we had during the Gemini astronaut maneuvering unit activities and a lot of other things, I guess, that pretty much got validated as an approach and cast in concrete in the training world that came out of Gemini.

Certainly, going in, we weren't too sure how well all of this big fancy simulation system was going to work. It was very expensive. It was very expensive. If it didn't work out, well, who knows, you know. But it did. And we were confident enough early on there with the results that we got from it, that we felt comfortable in proceeding to Apollo with the concept. So the SCATS system was rebuilt for Apollo and it was called ASCATS, Apollo SCATS. All that meant was that it was just reconfigured to reflect Apollo. A lot more work, though. More models, more vehicles.

We did change one thing. During Gemini, the launch vehicle was part of the Gemini mission simulator. For Apollo, we built the Saturn launch vehicles as part of the ground system support computer, and we actually launched the crew simulators from the computer systems here. That just made it complicated, because we had to have a unique simulation computer-to-computer link between the simulators, which were at the Cape. The ones we were always using would be configured, and the configuration we wanted would be the ones that were at the Cape.

We had the launch vehicle sitting up here, so that was always fun to get that working. But it worked. We had no problem with that.

We did start Apollo with the AS201, we did the 501, unmanned shots and everything. Those were all done with the math models and computers early on. By this time, let's see, I did Apollo 7, which was the first manned vehicle. I was the simulation supervisor on it, and I had done several other Gemini missions as sim sup.

Incidentally, that's how we organized the teams, the same as they are today, pretty much. We had all the disciplines represented under a guy we called a simulation supervisor, who was responsible for developing all the scripting materials and things for exercising the flight control team. The sim sup, his major interface with the flight control team was with the flight director, so he and the flight director would sometimes collectively scheme for certain kinds of problems.

I know Kranz had ideas. He'd say, "Well, you know, I'm not real comfortable with the way these guys are reacting over in this other area here. Dream up something you know that will exercise that." So there was very much a collusion going on between some of the flight directors and the sim sup. But there was also a lot of exercising that was done in which the flight director was not a party to what was going on, because he had to take the exam, too.

But, anyway, by the time we got to the early parts of Apollo, the job was large enough that we were rotating assignments in ways that certain guys would go off and do the unmanned missions and other people would do the manned missions.

Dick [Richard H.] Koos, whom you may have heard of, ended up doing most of our Apollo 11 simulation supervisor stuff. I think he'd maybe done 201. I think Gerry [Gerald D.] Griffith did 501, if I remember, but I don't remember exactly now who did what. But, anyway,

I did Apollo 7. I got the first manned mission. That was Wally [Walter M.] Schirra [Jr.] and [R.] Walt[er] Cunningham and Donn [F.] Eisele flew that. It was a real simple mission, I mean in terms of complexity. All we had to do was launch this thing and bore holes in the sky for a couple of weeks.

But the thing I wanted to mention was, it was, of course, the first flight involving man, so the spacecraft systems and everything were all the topic of interest for the training. We had, I wouldn't say a rebellion. Well, maybe it was that. I'm not sure. There was some disharmony between the onboard crew and the flight control team, because Schirra felt very much so, or at least he wanted to think, that the flight director was now on board. So we had some issues that surfaced in the course of doing Apollo 7. Later on I think that all kind of worked out, but during the flight some of that surfaced. It took Deke [Donald K.] Slayton and those guys getting on the loop and talking to Wally to tell him how it was going to be, things like that. But other than that, there was no real issue on Apollo 7 that I remember. We just turned the crank, because there was nothing new about it other than it was a different vehicle.

BUTLER: Mentioning things arising during flight and during real time, and this obviously was more of a personality issue, but things with equipment, too, how would that affect your simulations for later?

SHELLEY: If we had an experience in flight that we thought was something that we hadn't thought of or that was worthy, it always got added into the repertoire. Something like that would get added in. Not many things happened in flight.

Well, I should back up. Remember, now, you're not trying to define all the "what if" situations. You're only trying to define those that the flight control team or the crew can do something about. For example, an obvious example, something like a *Challenger* accident, we didn't bother to simulate something like that. There's no training value in it, and there's nothing anybody could have done about it. So we never did any things like that.

But problems that would occur where they are solvable, and if we didn't have a flight rule to cover it or if we didn't have a malfunction procedure to cover it, we were always on the lookout for those kinds of things. The flight control team was, too. If they had a problem that occurred for which they didn't have a malfunction procedure, then, of course, one got written. We trained on all malfunction procedures. That was the thing we spent a lot of time on, was going through all the malfunction procedures to make sure that we had sampled enough of them so that we felt that they were comfortable with how they were applying them. In fact, all simulations are based on malfunction procedures. Even today, that's the way they pretty much have them. So, yes, we were always looking for closing the loop back to the training. Actually, the training program probably exercised so many things that missions tend to be kind of boring sometimes. We had a lot of mal procedures.

BUTLER: While we're sort of on the topic, how would you build those simulations and how were they designed? Would you start with smaller scale and work up to full mission duration? If you could talk through some of those.

SHELLEY: Sure. Well, as I said, it's a mission analysis problem. You back up, you look at what do we do from liftoff through reentry. Which are the phases, where are the critical events,

where are the defining events in this profile? You analyze that. You decide, well, okay, what could go wrong here, what do they have to be able to cope with, you know, to respond to, in order to keep things headed down the right path in the face of maybe a couple of problems on the side.

So you look at that and you start doing a little scheming. It is a scheming thing. But there are some guidelines you use. Initially, you say, okay, let's give them just maybe one or two problems here, you know, something that would be easy to deal with. You build their confidence up a little bit that they can deal with it. But pretty soon you get to the point where these are very expensive operations we're running here, several thousand dollars an hour to run these simulations, even in those days. And you've got half the team sitting around there twiddling their thumbs while two guys are over here in sheer terror, you know, so you try to spread the wealth a little. So you start looking for things to give everybody, so you try to keep everybody busy, give them all something to do, while making sure that it converges toward a solution that continues the mission. That's the way you do these things.

The training people really deserve a lot of credit for innovation by being able to scheme these things and dream them up in ways that accomplishes that objective without destroying the whole exercise. Sometimes things don't happen the way you think they do, though, because the flight control team may respond differently than you thought they were, and it screws the whole thing up. It may destroy the simulation.

But there's a very worthwhile thing that goes on at the end of those, these debriefings. I don't know if you're familiar with how they debrief them over there, but after you do the run, you do debriefing then. It's kind of a confession session. Everybody stands up and confesses to how he didn't do it right, or whatever. But the idea is that you sit down and you say, "Okay, we

need to do X number of launch exercises and maybe Y number of midcourse corrections on an Apollo mission," for example, and so many entires covering the different cases that are involved. You add those up, and they are always more than you have time to do, so then you start prioritizing them.

So you sit down with the flight director, and they will decide, "Well, okay, if we got to give up something, we'll give up one over here and two over here." And you make it fit the schedule. You go run those, and hopefully you're okay. We haven't slipped any missions yet because of flight control team training. We haven't slipped any for crew training either. Well, there was one we slipped one day, as I remember. I can't remember which mission that was, though. Somewhere in Gemini, I can't remember, there was one mission that was slipped one day, which probably wasn't worth it, in retrospect. Which is just another way of saying when the hardware was ready to go, we launched. I mean we were, after all, in this race to the Moon, you know, so people had to be ready to go.

BUTLER: How much did you feel that pressure on—obviously, you were trying to meet the time schedule.

SHELLEY: The competition?

BUTLER: Yes, the competition.

SHELLEY: You know, we didn't talk about it a lot per se, but everybody knew that we were in something of a competition. But I think all that did was made everyone more enthusiastic to get

on with it. Everybody thought, well, here we are, we're doing something important, you know, and we have a chance at this thing, anyway. We didn't know a lot about what the Russians were doing. I mean every three months or so something would come out in the news. You know, they've just launched something else, you know. In the early days, it was always bigger than anything we had. But you didn't dwell on it.

I think maybe after Gemini when, hey, we beat those guys in learning how to do rendezvous, and they never did master that very well. I don't know if you know, but even when we got around to doing the Apollo-Soyuz Test Program and everything, we did all the rendezvous. They didn't do anything, which meant that they had to have a much bigger rocket. I mean, that's basically what it boiled down to. The lunar orbit rendezvous activity, as I mentioned, is probably one of the more significant things that happened in those years, because a Saturn V now didn't have to be quite as big as it would have otherwise had to be. It's still pretty big, of course. Of course, in retrospect, what we found out is that was the approach the Russians were originally taking and it didn't work. But after Gemini, I think people were feeling pretty good, pretty good.

Then the Apollo fire, of course, was devastating to everybody. But after we got around to recovering from that and flying Apollo 7, everything worked pretty well. You know Apollo 8, the story on that. That was really a morale booster.

BUTLER: How much were you, in the simulations department, aware of the decision for Apollo 8 beforehand and how did that affect your—

SHELLEY: There were very few people that knew about that beforehand. Beforehand wasn't very long beforehand, in any case. They just decided to do it, and we were just kind of told, "Guys, we're going to go do this, so go do what you can." And that was it. The history of that, of course, was the lunar module wasn't quite ready anyway for some of this stuff. But I remember we all thought it was kind of crazy. I mean, you're going to put this thing in orbit with a single-point engine and expect to get back out? Boy, that's really sporty, which it was. But it worked, and after it worked, people did get to feeling pretty good about things.

Then the lunar module finally was launched into Earth orbit and seemed to work very well, reasonably well. Then, well, Apollo 10 could have landed. It worked very well. Then Apollo 11. So Apollo really worked amazingly well, up until 13, of course. But we didn't dwell on the fact that we were in a race or anything like that, but people were just motivated to work on it.

The job itself is interesting enough, you know, just to keep you motivated, and I think that's mostly what happened. I don't ever remember anybody ever having to be given a pep talk to motivate them to do their job. Everybody was doing their job, and everybody knew everybody else expected them to do their job. It was just kind of an environment. That's the way it worked.

BUTLER: Talking about that environment, and you've mentioned working as sim sup and the flight director would come together on some things, but then, of course, on other times the flight controllers would almost consider the simulations folks as scheming, which in a sense it was. But what was that team environment like? How were the relations? And tying in the astronauts and the crew and everything.

SHELLEY: Very close, very close, yes, probably more so than they are today. Fewer people, to begin with. Today you've got as many astronauts today as we had, almost, whole people.

The crew tie-in with the ground controllers was close, but it was certainly not as close as the relationship between the flight control training team and the flight controllers, because we were all the same people. At that time we were in different organizations. There was a Flight Crew Operations Directorate and there was a Flight Operations Directorate. The crew, of course, was over there.

But I don't mean to say that people went off and defined these exercises in a way that was designed to "gotcha"-type things. They always had some purpose. I think if you read Kranz's book, he talks about his experiences with Koos on the program alarm simulations, you know. That was the case where Koos and his team of people just said, "Hey, guys, this is some stuff that we haven't done yet, you know. We just didn't get around to getting everything done, and it happened late in the flow." But that's a good example, of course, of having guessed really correctly about a problem that could occur, that did occur, and that probably saved a mission, because had Steve [Stephen G.] Bales seen those program alarms for the first time during the flight, he would have probably called an abort. That's what his procedures told him to do.

But there was a lot of discussion that went on. The systems guys and the training organizations spent a lot of time with the systems controllers. The whole idea was to know as much as you could about what they were doing, and when you had some idea that was constructive to them, you would go tell them about it. They would fold it into their procedures and everything. So it was a close relationship, very close, and very productive one, too.

The other thing that occurred in those days, all the contractors were on site. They were scattered up and down the hallway just like everybody else. People didn't notice badges. It was a badgeless society. So that was very good. Today we tend to read contracts. You're responsible for that, you go do that. In those days, it was a matter of which controller is the smartest guy in a particular area and who can contribute the most to the overall understanding of this problem. So it was a different operation. That was before the procurement people and NASA policy dictated separation of contractors and civil servants. So it was a good exercise.

By that time I was head of the Mission Simulation Branch in '68 or so, I guess. I stayed there through Apollo 12. Apollo 12 was the last Apollo mission that I had anything to do with, which maybe was fortunate that I got out before 13. Maybe not.

We were beginning to start Skylab activities, and Skylab was a new animal. It was to be a user-driven operation, not an exploration-type thing. We had done some science experiments on Apollo, most of them later. They were planned to be done on later flights. At this time we hadn't done them yet. Things like the Apollo lunar surface experiments package, ALSEP, and there were going to be some what we called SIMBE, scientific instrument module-based experiments that were going to be flown.

But, anyway, Skylab had a whole bunch of experiments. Kranz asked me to go set up an experiments branch that would set up the operation for Skylab, most of the Skylab experiments. At the time, we were primarily concerned with medical experiments. There was something called the Apollo Telescope Mount [ATM], which was a solar observatory that was on this thing. We had a bunch of other things that were sort of filler or catchall experiments. We called them corollary experiments. Later there was something called the Earth Resources Experiments Package [EREP] was mounted onboard the Skylab.

So the idea was, okay, we're going to have all these visiting scientists in here, so how are we going to operate this new space station with those guys and make sure they are participating in the way they want to participate and yet don't allow them to get dangerous? There's that kind of thing. So I had the job of going off and doing that. As it turned out, we ended up splitting, because the workload was just too big for one branch, we split the Earth Resources activity out, and I was concerned about the other three, the medical, the solar physics, and the corollaries, if you will.

The medical guys, they were sort of easy to deal with because they had top priority. They had the protocol that they had established to conduct this battery of experiments every three days throughout the duration of the mission. The whole idea, of course, was we're going to go for thirty days, and we'll look at that data, and if it's safe, we'll go for sixty, and if that's okay, then we'll go for ninety on the third increment. So they sort of had free rein to plug their things into the timelines where they needed to occur and everything. So they were happy and they were always kind of easy.

Plus the fact, most of them were not around here. We had what is now the Space and Life Sciences Directorate, had surrogate representatives in it, so we could work directly with them, and we did. That all worked very effectively.

The solar guys, though, boy, they were some high-powered guys, and they didn't know anything about the Johnson Space Center and really couldn't care less about the Johnson Space Center. They'd rather be off doing this thing themselves. I suffered through more than one speech from those guys on how JSC didn't appreciate them and how they weren't getting all that they wanted, and of course they always wanted more than they'd get.

But they had some fairly powerful people on there. There was one old gentleman, I know, a Dr. [Richard L.] Tousey from Naval Research Lab, very prominent X-ray astronomer. I remember one day he called the Secretary of the Navy in my office, and the guy took his phone call. I said, "We have to deal with these guys." But Dr. Tousey, he was an elderly gentleman even then, and he had a hearing aid.

They wanted to have routine access to the crew, voice access to the crew. Well, the crew wasn't too keen on having all these undisciplined scientists calling them all the time. "No, we want you to talk through the capcoms." But I remember this ultimately culminated in a big meeting with Kranz and several guys one day about whether or not they were going to be allowed to talk to the crew. So we finally ended up, Gene made the decision, "Well, okay, you can talk to the crew. We'll set up this teleconference for you once a week. We'll let you summarize the activities for the week."

So I was walking back—we were in Building 45 at the time—walking back with Dr. Tousey. I said, "Well, Dr. Tousey, how do you feel? You've been given the okay to talk to the crew. How do you feel about that?'

He says, "I don't want to talk to the crew."

I said, "Excuse me?"

He said, "No, that static just screws up my hearing aid. I don't want to talk to them. I didn't want anybody to tell me I couldn't do it." And he never did talk to them. He never did. Later on, he had some of his people talk to them, but he never did. He wanted his way. They were very good people. They were very motivated. Of course, they had invested a lot of their lives in this solar observatory, and these were the principal investigators.

We had a Dr. [Edmond M.] Reeves from Harvard and Dr. Tousey from NRL. I remember Dr. [Robert M.] MacQueen from the High Altitude Observatory and Dr. Gianconi from American Science and Engineering. I don't know if you know him. Gianconi is the Hubble guy today, from the Hubble Science Institute, among other things. But those people all started on Skylab, were down here on Skylab. So we had that contingent of people who had solar objectives in mind, and these medical guys over here who had all this medical stuff they wanted to do, and then we had these catchall guys who some were observatory-type guys. They had these instruments that would go in the scientific airlock that would either look at stars or whatever they wanted to look at. So we had a number of those.

Then we had this Earth Resources contingent. The EREP package was a problem for us because it required us to orient the Skylab into what's called Z-local vertical attitude, so it could look at the Earth. All those instruments were looking down. The solar instruments, of course, wanted to be in solar inertial. They wanted to be looking at the sun all the time. So they were totally mutually incompatible. In retrospect, a bad design, but, anyway, that's the way it was.

So we had to debate all the time who was going to get what. So we ended up, well, the medical guys had top program priorities, because they went every three days anyway. The solar observing guys were mostly concerned about crew time availability and the solar inertial attitude. The Earth Resources guys wanted to look at all these ground sites that had been defined for them to take passes over. How do you decide who gets priorities?

So we ended up with this thing called a program scientist, our first program scientist. We talked to Bob [Robert A. R.] Parker. I don't know if you know Dr. Parker, the astronaut. Well, he was the first one. Probably never forgive us, but he was the mediator we talked into working with these guys. And even within those groups and within those disciplines, for

example, within those solar scientist discipline, there were five of those guys, and they were all from different organizations like Harvard. Neither trusted the other. There was a lot of professional jealousy among those guys. So we dreamed up this thing called a czar-for-a-day concept, and we rotated chairmanship of the planning team among them. Every fifth day, you get to be the boss. So if that guy doesn't do well by you today, you can get him back tomorrow, you know. It worked amazingly well every day.

We told them, we said, "Look," I don't remember the exact times now, but said "At six o'clock tonight, you pass the solution out from under the door, and we'll go implement it. If you don't pass one out, we'll build one for you." But we never had a problem with them. They worked fine. They worked great.

We built the first Payload Ops Control Center in those days, POCCs. Maybe you've heard of those. We built the first ones over here in Building 30. We had one for the ATM guys, one for the medical people, and there was one for the Earth Resources people. So that's how that all got started.

Of course, before we started flying, we had done a lot of preparation activity. We had brought people in from mostly Ball Brothers, who had built most of the major experiments, had a lot of people here that we used to build this informational database, do the procedures, train the crews, do all that stuff. We had done our normal flight control job on Skylab in that sense, and it worked very well.

I think if you go look today, the medical database gathered off Skylab is still probably the best one. Now, we flew a Spacelab here on Shuttle for a week or so that added quite a bit to it, but there was no long-duration stuff on that. The Russian stuff, they never took too much data in their long-duration things. Maybe the [Shuttle-]Mir [International Space Station] Phase

1 stuff we did has supplemented that somewhat, but for a long time, Skylab was the defining database for medical effects of space flight.

Same kind of thing with the solar physics activity. We had a lot of difficulty with the solar physics thing, because when it was proposed to be flown, it would have been flown like in '68, which is a solar maximum. Do you know what I mean by a solar maximum, solar minimums, those kind of things? Yes, the sun's on an eleven-year cycle of sunspot activity and everything. Well, we ended up flying at a solar minimum, because we flew in '73. So they weren't terribly happy with that fact, but given that that was what they were going to get, they made the best of it. And we did have a few flares anyway that they were able to get, so they were pretty happy with that.

So that took us through Skylab. We ended up, as you know, I think we flew thirty days, fifty-seven days, and eighty-one. Is that it? Eighty-something, anyway.

BUTLER: Eighty-four, maybe.

SHELLEY: Maybe eighty-four, something like that.

BUTLER: During the missions, were you still coordinating some of this activity?

SHELLEY: Actually, that's another thing we did during the mission. During Apollo and Gemini, we had something called SPAN rooms, Spacecraft Performance Analysis rooms, and through which we would access the development activities. If we needed to ask the contractors questions, we worked through the SPAN rooms. Well, Skylab, we had to invent this new

animal to replace all that. It was called a FOMR, Flight Operations Management Room. We did that because Skylab was basically a Marshall [Space Flight Center, Huntsville, Alabama] program. We flew it at Johnson, but Marshall built it. So we had to develop this management room that properly integrated all the Marshall people down here.

We had the Johnson guys. There was a Johnson Skylab Program Office, also, and we had them in here. Of course, we were in MOD [Mission Operations Directorate], so we were the big mediator of these two program offices. I had the job of defining what the flight ops management room was going to be. That was a job I personally had to do, along with Joe [Jones W.] Roach, who was in the division at that time. He was Kranz's deputy at the time.

So we sort of planned this thing out and laid it out. So I worked the entire mission in this flight ops management room. It was interesting. A lot of the priority debates ended up in there for resolution, you know, and all the questions relative to system support always came through there that we ever had to ship [back] to Marshall or ship wherever it needed to go to get answers to it.

Let's see. Who all was in there, I guess, at the time? You probably don't remember these guys, but the Marshall people brought George [B.] Hardy and Luther Powell and Dan [Daniel M.] Germany, who later moved to JSC as the Orbiter project manager, were in there. Jay [F.] Honeycutt was in there with us. Jay had worked for me in training before. He was in the old Training Simulation Branch. Joe Roach and Mel [Melvin F.] Brooks were the principal people.

That all seemed to work very well. I don't remember any major difficulties that came out of that. I do remember that we did have a problem with personal things. Kranz dreamed up this really weird shifting arrangement. What we would do is we would work five days and

you'd be off two. Then you'd come back eight hours, shifted from where you had left off, and you'd work five days and you'd come back eight hours shifted from where you had left off, so you never got used to any shifting activity. My body felt like I was going to die the whole time, I think. And everybody had the same problem. But that's the way we did it. It equalized the misery. Well, the idea was we would equalize all the graveyard shifting and everything for everybody. But I think most of us would have volunteered for a permanent graveyard shift.

BUTLER: So the folks in the FOMR worked the same shifts as the—

SHELLEY: Oh, yes, we worked the same shifts as the flight control team. Anyway, the shifting was a problem. I think we had like 10-percent divorce rates in Skylab. That's serious. But we survived it somehow.

BUTLER: During that time, were you also involved with any discussions between—well, you had mentioned any issues would come through there, especially on the last Skylab mission when there was some problems getting everything integrated between the ground and the crew, that people were working at a different pace. Did it come at all through your area?

SHELLEY: Yes, we talked about that stuff a lot, you know. What we ended up doing, basically, was saying, "Well, look, why don't we just give you guys a shopping list, and you go work on what you need to do." The ground has a tendency to overplan the crew's activities. I say that, having been responsible for crew activity planning and a lot of that stuff. But you really need to take advantage of the crew's ability to control his own work pace and do the right things every

now and then. That turned out to be the way a lot of the issues got resolved on the longer duration Skylab missions.

That was particularly true with something like the solar observatory activity. We had these things called joint observing programs, which were big long sequences of precanned camera operations. We were flying people, Owen [K.] Garriott, in particular on the first mission, was smarter than most of those scientists on what you want to look at anyway. Ed [Edward G.] Gibson, later, was the same kind of thing. So you didn't need to tell them what to do. Just tell them I'm interested. "Look at what's interesting up there, Ed," or whatever. And we did a lot of that later on, let them decide what to look at.

It was the same with all the other activities. I said, "Look, guys, you know what you've got to do. Here's twenty-five things you got to get done next week. Go work on them, and call us up in a couple days and tell us how many of them you've done, so we'll know where we are." The guys who don't like that, and the problem with that, are the scientists who travel halfway around the world to be here when his experiment is going to be conducted, and he doesn't know when it's going to be conducted. See, that's the problem you get into. But we soothed their ruffled feathers, and they learned to live with that. As long as they got their data, they were okay.

Actually, we had very good relationships with the scientists on Skylab, I think. I don't ever recall an incidence. We had a lot of discussions, a lot of debates, you know, what we were going to do, what we could do and couldn't do. I remember, I guess this was again with Dr. Tousey and Dr. Reeves and those guys, floor space was really critical in the control center in those days. They had come down here and were expecting that we would put them up in nice offices, you know, in the control center. And we didn't have it.

I got this phone call one day from John [E.] Naugle, who was the AA [Assistant Administrator] for science in Washington [D.C.]. He says, "I understand that my scientists are not real happy down there with what you guys are doing facility-wise for them." I didn't know John Naugle. He didn't know me. I mean here I was a branch chief. My god, the AA was calling me direct on this stuff. What is going on?

I said, "Yes, sir."

He says, "Well, I'm coming down there next week. I want to see what you're doing." Oh, boy. But he did, he came down. He looked over the situation, and I briefed him on what the situation was and everything. All he said is, "Well," he says, "it looks like you're doing about as good as you can with what you've got. So I'll see what I can do." The next week he rented the building across the street, which was walnut upholstered walls and everything. So we took care of them, but that's the only time we ever had any issue with them, was over the accommodations here. It's a status thing with those guys, you know.

I don't know how well you know Gene Kranz, but that didn't cut it with him. He controlled the floor space. For me to get more floor space, I'd have to go convince Kranz, "Hey, you need to give it to my scientists, you know, and take it away from some systems flight control over there." That wasn't going to happen. So we had those kind of issues, but by and large, at the end when it was all over and said and done, everybody was very happy, very pleased, seemed to me.

At the end of Skylab, of course, Johnson Space Center is sitting here. Man, we've just gone to the Moon, we've got this big operations organization, we've done Skylab, what do we do now? The decision was made, while the ops organizations are too big relative to what we have to do for the next four or five years, you know, so everything got reorganized. Dr. Kraft

was [Johnson Space] Center Director by this time. The decision was made to merge the Flight Crew Operations Directorate and the Flight Operations Directorate. So that was done. In fact, parts of the Flight Crew Operations Directorate were actually transferred over to E&D [Engineering and Development Directorate], parts associated with the crew systems mockups, the 1-G mockups, and those kinds of things.

Kenny [Kenneth S.] Kleinknecht, who had had a number of responsible jobs around the center, was made head of flight operations, and Gene Kranz was his deputy. They decided that I should go work over in the flight crew operations people in the Crew Training and Procedures Division, because we were trying to cross-pollinate everybody. Jim [James W.] Bilodeau was running that division. It was a new division. Jim had been division chief of the Crew Procedures Division, but it was going to be merged now with this Crew Training and Procedures Division, because we were joining up, organizationally-wise, anyway.

So they wanted me to go over and be Jim's deputy. So I ended up over in Crew Training and Procedures Division. Jim was a character. He's a good engineer. He had to be. He was a structures engineer, had come down from what was the old Chance Vought Company up in Dallas. Of course, he'd been there several years then. I don't remember quite how many. But Jim was very much a hands-off manager. Of course, Kranz is very much a hands-on guy.

I never will forget. I went over to talk to him, and he told me, he says, "Well, I guess you've been sent over here to make sure I toe the line to meet Kranz's requirements and everything." But he says, "The way we are going to work this, all those action items that he's prone to generate," he says, "you're going to get to work them all." And he was right. He never worked a single one of Kranz's actions. I had to work them all.

But, anyway, Kranz had some of us over there to bring some flight control people over into that world. I had brought Jay Honeycutt and a guy named Phil [Philip C.] Shaffer, who had been a flight director, and John [A.] Wegener. We brought them in. Tommy Holloway was already there as one branch chief. Dave [David C.] Schultz, who's retired from NASA about three or four years ago, was the other branch chief. And Honeycutt was branch chief. So that was our team on Crew Training and Procedures.

We had two major jobs to do, two major programs to work on there. They decided the Apollo-Soyuz Program was ready to go fly. It was going to be flying in '75, which was eighteen months away. We also were starting to work Shuttle. In those days, Shuttle had something called approach and landing tests [ALT] that were going to be flown in 1977, '76, '77, so we had to build a simulator to train the crew on how to fly the Shuttle. What we ended up building was, of course, the moving base [simulator]. If you're familiar with the Shuttle mission simulator over here now, the moving base is what we built at that time to do that job.

The Apollo-Soyuz [Test Project, ASTP] thing wasn't much of a technical challenge or anything. They had to go build a docking module, you know, with the Russians, or a docking ring. But as far as the operation, it was pretty simple. I mean, it was a pretty simple rendezvous. As I said earlier, the Russian vehicle was a passive vehicle, so we were going to do all the maneuvering, the active maneuvering and everything, and we knew how to do that.

Anyway, the Russians don't speak very good English, and the way the Center decided to work the Apollo-Soyuz thing was to create just a small team of people to go off and work with them. Glynn Lunney headed up that aspect of it. Tommy Holloway, we put him on it, as our guy. They basically took care of Apollo-Soyuz. They just took it and ran with it. So we didn't have to worry about that so much.

So I spent most of my time worrying about getting ready for Shuttle in those days. We did go out. We let a contract to Singer-Link to build the front end of the Shuttle mission simulator, which we called it the OAS, Orbiter Aeroflight Simulator, in those days. We bought the computer system separately to drive it. We went through all those same old things of defining the models and defining the telemetry and everything. By this time we had to work it from in depth for the crew as well as the control team.

In fact, the flight control team, Don [Donald R.] Puddy, was asked to head up a group of people that were going to provide the flight control support to the ALT and, of course, Fred [W.] Haise and Joe [H.] Engle. Who else was there? Fred and Joe, I guess. So they sort of took care of the mission planning for that thing, too.

In the meantime, the rest of us—you need to remember, in those days Shuttle was going to fly sixty times a year. Remember, we had sold that thing on the idea that it was going to be very routine to fly this thing. My job was, well, how in the world are you going to get enough astronauts through this pipe to fly that many flights. How many flights a year can an astronaut fly, for example? Nobody knew. We finally concluded, well, under the best conditions, maybe we could get him through four. So you go through the numbers and the training requirements and everything, and that turns out to be a certain sized astronaut cadre that you needed and all of them had to be trained. So we were trying to put together a plan for what the training program would be.

There was a new technique. Well, I don't know how new it was, but at that time it was pretty much in vogue to use something called a systems approach to training, which was nothing more than some of the training experts, I think, had finally decided what systems engineering was. So they applied systems engineering techniques to the training problem. We did a lot of

work in trying to define, well, okay, how much of this information does an astronaut really need to go fly, as opposed to how much does he want to go fly. Astronauts want to know everything they should probably know. But that's very expensive and takes a lot of effort to do that.

So we were busy working this systems approach to training, in which we were trying to evaluate on a task-by-task basis everything that was involved in flying the Shuttle, and to define the minimum training program that you could get away with to do that. So we spent a lot of time doing that. In fact, we ended up defining the training program that is pretty much intact still there today for the basic Shuttle flight training.

We also, in this time, went ahead and bought the other half of the Shuttle Mission Simulator, the fixed base simulator. We had that. The other thing we were doing is, it may surprise you to know that the Shuttle didn't come with any operating instructions. Rockwell never told us how to fly it, so we had to write the procedures on how to fly the Shuttle. We had a procedure simulator, an SPS over there, Shuttle Procedures Simulator, that we used to develop flying procedures for the Shuttle. They didn't give us systems procedures either. We'd had money problems, and we couldn't afford to buy all those things, which is one reason why we brought these flight control experienced people over into the Crew Training and Procedures Division, because we knew we were going to have to write these systems operating procedures for the Orbiter.

So we spent a lot of time doing those kinds of things, and we involved a lot of the flight control people as well as people in the Training and Procedures Division to do this. Given that we were going to fly like in '79, so '75, '76, and '77, up in those timeframes, we were very busy trying to define how you fly a Shuttle. All the time we were trying to define how they're flying it, people like Fred Haise is over scrubbing the software, trying to figure out how you can build

it cheaper, and get things out of it. So it was pretty much of a hit-and-miss-type thing. It was dynamic, I'll put it that way.

Of course, the two major things that people were really concerned about on the Shuttle didn't really affect the training so much, but it was the thermal protection system and the main engines. Those are the things that ended up causing us to slip, you know, a couple of years or so, but they didn't really affect our training so much. It turned out to be fortunate that we had the two-year grace period in there, because we could not get the simulator to work. That thing didn't work, and it didn't work, and it didn't work, you know. We had a lot of trouble with it.

In fact, even on STS-1, the first flight, we had a lot of difficulty. We could fly it and do the launch and the ascents and everything would be okay, but we couldn't fly it into orbit. We'd have to reset it into orbit, start the orbit phase. We had a lot of trouble with the simulators. Even though we put a lot of money on it, we ended up supplementing the Link contract. I don't know, seems like we had about 500 people working on it over there.

But the Shuttle Mission Simulator is a complicated bear. I don't know if you're familiar with it. At the time, it was probably the biggest computer system on site. We had trouble with everything from the stability, and it also had flight computers in it, remember. Incidentally, some of the problems we had were with the flight software, too. It wasn't simulator stuff, but we found a lot of problems in the flight software using the Shuttle Mission Simulator, and that's because that's where the crew interacts with it. The software people didn't have a way of really having a lot of good crew interaction with their software until it hit the simulator. So that simulator served a major role in helping to check out the onboard software modes.

It's had stability problems from day one, in those days. It was a very complicated thing. We had light valve problems. You know the visual system that's in there? We also had

problems with the light valves that drive those visual images. John [W.] Young and Crip [Robert L. Crippen] and those guys who flew the earlier missions, they probably wondered whether or not they were being positively or negatively trained. I don't know. [Laughter] But we had a lot of trouble with it. But, finally, today I guess it's pretty stable over there. I don't hear too much about it. But that was the Shuttle simulator.

BUTLER: If we could pause here for a moment, change out the tape, and take a brief break. [Tape Change.]

You were mentioning coming from Skylab, working into Shuttle, and that was your main focus rather than Apollo-Soyuz, building first the motion simulator and then into the fixed-base simulator and the systems simulators. All of this was coming in time while Shuttle was still being developed and being worked on. How did you tie in? Again, you're in kind of a similar situation as to before.

SHELLEY: We went over and made a deal with Bob [Robert F.] Thompson, who was the Shuttle program manager. Normally, what we would have done is we would have paid Rockwell to supply us with the information. Certainly, as it relates to building the simulator, they would provide all the internal change traffic that was internal to Rockwell, in this case. That would have been fed to us as soon as it was available, and we would use that within Singer-Link to develop the various systems and things, configuration control and the simulator.

We didn't have a lot of money. The program never had a lot of money, but we did have enough so that we could buy one guy in the plant who did nothing but go around and find information that he fed out. We also made this deal with the program manager that MOD, the

number sticks in my mind, it seems like it was nineteen people, nineteen or twenty Rockwell employees that had been in MOD through Skylab, and we wanted to keep them because they were experienced people, of course. Basically what was decided was, okay, you can keep those guys, but you've got to write the Shuttle procedures in-house. That's basically how we ended up having to do that.

So we had the feed from in-plant on what the hardware was, and it was more than just change traffic. He'd go round up drawings and whatever technical information he could locate. We'd ship that down to these nineteen people, and they were primarily the interface back to the plant. Then they would spread it out throughout the organization. That way we would get information on what was being built.

That was a better path, frankly, than the program path, because the program path's too slow. The change traffic and everything might get approved there, and you'd say, "Okay, I know they're going to build that thing up there." But if you asked the guy, "Well, what is it exactly, today?" he doesn't know. You have to go ask Rockwell. And we had a straight path to kind of minimize the time delays. But that's how we did it. It was scrounging. That's what it was. But that's the way it had always been. You have to go scrounging. If you build simulators, you have to scrounge a lot of information, because it's generally not available at the time you want it. But that's how we did it. Some of those guys are still over there today. Well, they're most in USA [United Space Alliance]. But some of them have a rich history of being scroungers.

BUTLER: A very important task.

SHELLEY: It is important. It's good that they could do that.

BUTLER: Were there often any major changes that hadn't exactly been anticipated or that affected many different systems?

SHELLEY: Because we'd have to restart?

BUTLER: And those.

SHELLEY: No, I don't remember any that caused major changes. We changed out the main engine models that came from Marshall. There were some major changes of those, but they came as a block to us. We just had to integrate them in. They didn't affect a whole lot of things other than just the vehicle performance, you know. I don't recall anything that was a major surprise to us or a major redesign of the Shuttle or anything. No, it was just bad from day one.

BUTLER: The Shuttle is obviously a very different system than had been used before in Gemini, Apollo, very different than Skylab. You had even mentioned that originally you were planning for all these flights per year and trying to figure out, okay, how much could the astronauts be used. How did that transition between all of those programs occur, and then the transition to Shuttle being a little bit less than—

SHELLEY: Well, I think in the beginning, we were not successful in making Shuttle a little bit less. The early crews on Shuttle basically got as much training as previous crews on other

earlier missions. I think that even today—well, I don't know this, but I would suspect that if I walked over through the Training Division, they're still trying to figure out how to reduce Shuttle training. I know we did for the first three or four years, anyway.

So it wasn't a step function to go from where we had been doing business to a new way of doing business in terms of "This is maybe something you're interested in knowing, but we're not going to tell you about it because you don't need to know it." We didn't do that. We filled up all the available time with information.

The other thing, of course, that happened was that the flight rate didn't go to sixty a year. It's considerably less than that, and we never had the number of astronauts that would have been required for sixty flights a year. The other thing is, of course, the Shuttle crews are specialized. I mean there are specialties among the crew. The commander and the pilot do certain things, the mission specialist who rides the jump seat does certain things, limited things, and somebody else worries about the manipulator operation, somebody else worries about the payload activation, and the mid-deck stuff is still again something different. So everybody doesn't get trained on everything.

EVA is a good case in point. There used to be just a cadre of people who were trained on EVA, but everybody doesn't get trained on EVA because it's too expensive. Largely, you can't do it because there never was enough time available. The productivity of the water facility is just not large enough to train a lot of people on EVA. So it's a combination of things like that. So you specialize the guys.

The other thing you do is we have to worry about reconfiguration for payloads and everything. The Shuttle simulator was built with a generic math model, if you will, in there that could be initialized to look like certain kinds of payloads. The visual systems were built so they

could be more readily initialized to reflect out-the-window views for the payloads, things like that. So it's just a series of things that were done to make the whole operation a little more efficient. The Shuttle Mission Simulator uses the flight software. You don't have to go through a conversion process. You just take a data tape from the Software Development Lab and you just take it in and you load it. Theoretically, it works. And it works. I mean, obviously, we use it all the time.

So there were a lot of innovations put into the Shuttle simulator that made it tough to work in the early days, but it works pretty well now, apparently. People tell me it's stable. I haven't worked in training for twenty years, so I don't really know. But it seems to be working okay. Today, the whole operation, I believe, is contracted to USA. I mean there are no civil servants involved in training astronauts, not Shuttle astronauts, anyway. So it seems to be working pretty well. Now they have probably changed the computers two or three times since then, and who knows what else has been changed.

BUTLER: Speaking of the computers, when you had started with Gemini, moving up through the early times of Shuttle, not even up through today, but when you were working in it, computers changed drastically in that timeframe. How much did that help, and yet did it also in some ways cause problems for the simulations and the training and procedures?

SHELLEY: I think every time they changed, it helped. We didn't have a whole lot of computing power in those early simulators and things. So the more power you can put in there, the better off you are. You can now make more of those parameters dynamic, we were talking about earlier, as opposed to static. You can take men—we used to actually have people that would sit

on the output side of the simulators, something called a telemetry monitoring console, and he would actually tweak the data stream manually with potentiometers and switches and things like that that was coming over the control center. Well, you can imagine what kind of job that was. Anyway, with more computer power, you didn't need to do that sort of stuff anymore. Computers take care of all of that, so it made it better. The Shuttle simulator, fortunately, even in those days was capable of getting rid of that aspect of tweaking.

I don't know exactly what kind of computers they have in the thing right now. Of course, the flight computers are still the same. They've been upgraded in the Orbiter, and I'm sure they were changed in the simulator, too, but the host computer or the environmental computer in the SMS, I assume, used to be an 1100-something, 1180. I'm not sure what's in there now, but it's a big computer. So they've got plenty of computing power and they're doing okay. I think it improved, helped them quite a bit.

Let's see. Shuttle. I worked on Shuttle maybe two years, maybe the first two years' worth, and then it was decided that we would split back out the Flight Crew Ops Directorate and the Mission Operations Directorate. Prior to that time, Kenny Kleinknecht had moved on to other things, and Mr. [George W. S.] Abbey had been made the Director of Flight Operations. So the split occurred after George had been made the Director of Flight Operations. George took the crew office and the Aircraft Operations Division, and that was really what is today the Flight Crew Operations Directorate. Everything else was given to Kranz.

Shortly thereafter, the intent, even at that time, was to merge what was called the old Data Systems Analysis Directorate with the MOD, which would mean things like the Mission Planning and Analysis Division [MPAD] would be coming into MOD. But, anyway, Kranz was made the Director of MOD, and he picked me to come up and be his deputy, so I moved up

there. That was in like ’83, I think, or somewhere along in there. So I worked up there for a couple years, where my job was basically one of helping him develop the overall directorate management plans and keeping things running while he went off and played games with the control center. He wanted somebody to keep the office going, keep things moving. That’s mostly what I did, because by this time I had worked Flight Control Division, I had worked experiment operations, I had worked training, I had worked crew training, I had worked flight planning, I had worked everything in MOD. So I knew a little bit about everything and not much about anything, I suppose. But, anyway, so he thought that I should be his deputy, and so that was done.

BUTLER: Did you have much direct involvement with any of the missions during that timeframe?

SHELLEY: About as much as anybody did at the directorate levels. We were always reviewing the status of what was going on. There’s an environment in MOD, though, that you need to understand that was very prevalent in those days. The idea is to give a person the job and let him run with it. It was very common for very young people to be told to go over and brief the program manager on this system. You did the work on it, you’re the expert, and you get the credit, you run with it.

So MOD didn’t have a culture that required a lot of detailed oversight from above. I mean people were expected to go do their job, and they got support from the directorate level even when they were wrong. But we felt it was better to let those people know that we supported them and let them go charge the mountain. I think if you look at all the people who

came out of MOD that have gone on to other jobs around the center and everything and even within the agency, there have been some pretty good people growing up over there.

A lot of it derives from the environment that you're thrown into, and I don't want to say it's a sink-or-swim thing. It's not that. But it is very much an environment where you can control a lot of your own destiny. You get to do your own thing within the confines of the job you've been given, but some manager doesn't go present your work for you. You get to go do it. And it helps a lot.

So, anyway, we didn't ride herd on people from the directorate level. Periodically, you would have them do a show and tell, if you will, just to convince yourself that everything's still okay. But by and large, most of the activity that I was involved with was everything from making sure the budgets were right, that the manpower levels were properly allocated and assigned, and that we have some way of testing or checking how well they're being used.

You may have heard of Marvin Manpower. Have you heard of that term? Well, we had to invent Marvin Manpower to do a lot of that stuff in those days. Gene was always a stickler for having detailed information on how people were spending their time, not because he didn't trust them, but because he was used it on program managers to argue for manpower. I mean who could argue with a book that thick on "Here's how I spent my time"? Nobody had any data to challenge that, so we won more arguments with that stuff.

But, no, we didn't work missions per se because we had a flight director office by this time that did all the flight directoring, and the divisions were set up so that they had their functions. We had the Flight Control Division. We actually had a Crew Training Division and a Flight Planning Division by this time. So they were all broken out. They had their jobs to do,

they knew how to do them, and as long as things were happening, everything was okay. It was actually a pretty well-run organization, in retrospect.

So that went on for a couple years or so. About this time, Space Station was beginning to happen. Al [Allen J.] Louviere—I don't know if you remember Al. Do you know Al Louviere?

BUTLER: No.

SHELLEY: Al Louviere was the individual in engineering who was responsible for the early work on Space Station definition here at JSC in '81, '82 somewhere in that time frame, he and a guy named Jerry [W.] Craig, but mostly in this case it was Al Louviere. He had a group of people out over there behind the astronaut gym, about forty people, and they were conceptualizing space stations, you know, more how to manage them than anything else. So that was going on, and he wanted a couple of guys from MOD to support him out there. We sent Dick [Richard A.] Thorson, I think, out there for a while, maybe a couple others. Actually, I think Hal [Harold A.] Loden. I don't remember now who was over there. But that was the only involvement we had on Space Station.

Then it had gone through the Phase A definition and activity up in Washington, and John Hodge had come back to NASA and had headed up that activity in Washington. So the Space Station was looking like it was going to happen, but we had to go do these definition Phase B studies. Anyway, big debate was who's going to manage the Space Station. Now, "who" being which center, Marshall or Johnson or Goddard [Space Flight Center, Greenbelt, Maryland] or just who, you know.

To be honest with you, Hodge had left here somewhat in a huff because he had thought he was going to be Shuttle program manager, and Kraft didn't make him the Shuttle program manager. But he had gone off to work for what initially was the Electronic Research Center within NASA, which was in Cambridge, Massachusetts. That had gone defunct and had been taken over by the Department of Transportation. Anyway, Hodge had been up there, but now he's back to NASA and in charge of Space Station in Washington. So he is not real keen on JSC managing the Space Station, not because I suppose he has a real problem with JSC, but about this time we are having a lot of criticism on how we are running the Shuttle Program, utilization, the users. The users are complaining. They don't like all this big long red tape to get onboard the Shuttle. So the problem is that Station is going to be the ultimate user-oriented vehicle, "So we don't want those Shuttle guys defining how we're going to run a Space Station." That was the prevailing thought.

Anyway, this big debate's going on with the center directors about how we're going to do this business, and they can't decide, because Johnson clearly is the place that had all the systems engineering capability that you need to build the Space Station with, Goddard has the reputation for being the most friendly user organization to operate Space Station. So what are you going to do? Are you going to split the program and have half of it run from Goddard and half of it from Johnson or what are you going to do? It was a mess.

Anyway, to make a long story short, a guy named Bill Keathly had been the ATM project manager at Marshall when I was flying the thing over here for them, and he had since gone on to Goddard to be the director of all flight projects at Goddard. So he comes up with the brilliant idea that, "Well, we don't want the Shuttle Program guys running the Space Station

thing, but why don't you guys send Shelley over there to the Space Station office to do the customer integration and Goddard will back off." So I was sacrificed, if you will, basically.

Gerry [Gerald D.] Griffin, who was the center director, jumped on that. I was told, "You need to go work on Space Station." At the time, I was doing this STSOC [STS Operations] Contract. STSOC is the contract that RSOC [Rockwell Space Operation Company] had for MOD, big contract. We were consolidating all these eighteen different contracts back in '84 to form the STSOC contract. Jim [James C.] Stokes [Jr.] and I were the only people that had been working on that, and Stokes was retiring, and so I was the only guy. I told Kranz, I said, "What do you know about me going to work on Space Station?"

He said, "Well, you're not going anywhere on Space Station. What is this noise?"

I had found out about it because Keathly had called me up and said, "I want to congratulate you on your new job."

I said, "What new job?"

He said, "Oh, I've screwed up. You need to call your center director." But I didn't have to, because he called me in about fifteen minutes later.

But, anyway, so I got pulled off the STSOC thing to go work on Space Station for six months. I was going to be free to come back then, but you know how that works. So I got over there, and that's how I got in the Customer Integration Office business on Space Station. That turned out to be an interesting job, very satisfying job, because what it was, what I was supposed to do was to go find out what does this mysterious thing called the using community want in the way of a space station. What does a space station look like? In those days, we didn't know. What would these users want it to look like? What kind of capabilities should it have? All those things.

So we go off, and all I knew, all I was told was, well, okay, we know we've got a bunch of scientists. We know we've got to go find out what they want. We want this thing to appeal to the technologists also, so we've got to go find somebody to work the technology-type demonstration projects on it. But we want this thing to be commercially appealing. Who in the world is that?

So we went off, and in working with the Headquarters guys, we set up three different advisory groups, basically. There was something called the Task Force for the Science Utilization of Space Station, there was a Task Force on the Commercial Utilization of Space Station, and one on technology utilization.

Now the science utilization guys, we went off and had the Code E at that time, which was a science code in Washington, recruit membership of advisors. We found, seems like it was about thirty-two scientists, all outside NASA, who came together to form a group under Peter Banks, Dr. Banks out at Stanford, to form what was known affectionately as the Banks Committee in those days. They would tell us—you know, we would work through them on science advice.

We did a similar thing on commercial activity through what was Code C in Washington in those days. It had people on there like representatives from 3M Corporation, General Motors, and John Deere, I remember, and a few other companies like that. In those days, people thought they would agree to do something on Space Station.

Then on the technology side, we basically signed up Langley Research Center [Hampton, Virginia] to manage that activity for us, because they had an interface with the aeronautical community and people who were interested in building structures in space and things like that.

So we set them up, and then we had all these workshops that we would ask people, users, potential users, to come in, and we basically picked their brains. What kind of experiments are you planning to do here? What kind of capability is needed to do that in, etc.? So we compiled something called a Mission Requirements Database, big thick book about that big, more experiment requirements than the whole country could have afforded to build. I don't know how much money it would have taken to do that, but anyway, we went through those.

Then we reviewed those in context with the [NASA] Headquarters people who would have to pay to build all those experiments, so some priority orders were established. To make a long story short, we ended up defining a set of capabilities that the Space Station ought to have. Al Louviere, by this time, is the manager of Systems Engineering and Integration for the Space Station, Phase B. We were both in the program office. Neil [B.] Hutchinson is the program manager at that time. Neil and I, we'd worked together back in MOD.

But my job was to advocate these user requirements into Louviere's designing activity to make sure he designed the thing right, and that's what we did. We had a lot of debates, a lot of fun discussions on what should be the cabin pressure. Shuttle likes 10.2 [psi, pounds per square inch]. Well, users didn't like 10.2. They wanted 14.7.

You find out all these interesting things, like it turns out that the medical database, they have these humongous databases on medical history and everything. We even went through and calculated what the average altitude was of that baseline data, and it's like 400 feet. So if you decreased cabin pressure down to 10.2, you have to calculate the bias or the offset for your data in order to relate it back to what your history database is. We liked cabin pressure at 1 atmosphere, and that's why the Space Station is at 1 atmosphere today.

We had discussions on power. Do we go DC power? Do we go with a 400-cycle power that the aircraft industry liked and Boeing and McDonnell preferred? Or do we go with 20 kilohertz? There was something called solar-dynamic power in those days that Lewis Research Center [Cleveland, Ohio] was pushing. But they wanted to build a 20-kilohertz power system. In that case, it turns out that if you use like 400-cycle power, you had beat frequencies that were established through the surrounding plasma around the Station, and in particular around 13,000 cycles, the scientists were concerned. That's the reason they wanted to look at it. They didn't want NASA running any beat frequencies or anything through there and polluting the environment. So they liked either the 20 kilohertz or DC. It turned out 20 kilohertz didn't happen, for other reasons, so DC power ended up on the Space Station.

So you've got those kind of things that are there. We were really concerned about the microgravity environment. At that time people were trying to grow large wafer crystals. About five-inch diameter is about as large as you could grow one, we were told, in an Earth environment, before the effects of gravity would distort the crystal-growing, and then defects would start showing up in these crystals.

So the idea was, this was going to be a big commercial business. Remember, now, that we've had studies done at this point in time that said by the year 2000—this was like in '85 or so—this would be a 50 billion-dollar-a-year industry. Fifty billion, that was a lot of money. So we said, "We'd better build this thing right, you know."

Well, anyway, so we had to locate the laboratories at the center of pressure and the center of gravity of this thing to create the best environment. Shuttle could give you something like ten to the minus-four-G environment, which is pretty good for most processes. These

scientists were telling me, "Well, we really need ten to the minus-eight to really extend our knowledge of the physical processes that are involved here."

"Well, we can't get you ten to the minus-eight, because a crew just sneezing distorts that, you know." So we ended up arm-wrestling, and we finally said, "How about ten to the minus-six, guys?" So that's where you get ten to the minus-six-G on the Space Station. That's where it came from. Just about that much thought, too. [Laughter] But, anyway, we went through it.

I remember there was about thirty-nine of forty fairly significant white papers that we prepared, called CADSI papers. I can't remember what C-A-D-S-I stands for now, but, anyway. But it was to present the user perspective of the requirements on the Space Station. So the Space Station has a large input from the user community. If they don't like it, it's because they didn't specify it right to start with.

At the same time, Space Station in those days, when we first did the Phase B studies, you may have seen pictures of the dual keel, and we had service bays on there. We were going to haul the Hubble Telescope down to it and service it and then reboost it. All that's gone by way of the budget. There was a lot of activity that—well, there were polar orbiting satellites. We had two satellites that were part of the Space Station Program. We had an orbital maneuvering vehicle, an orbital transfer vehicle. That's all gone. What else is gone? A lot of things have gone that were in the original Space Station.

BUTLER: It's interesting, though, how much of the basic requirements here that you were defining have stayed, even though the configuration has changed so much.

SHELLEY: That's because the—well, the United States' contribution to that thing still looks a lot like *Freedom*. It's still mostly *Freedom*. There's some internal changes like the avionics system has changed and the computer system, but mostly in the fact that they simply deleted the central computer system and then the things that we had for MDMs [multiplexor-demultiplexor] is what you're left with for the current Station.

But working the Phase B studies on Space Station was really enthusiastic. People enjoyed that. The Johnson Space Center, I must say, really put, I think, their best foot forward in trying to support that program. I don't remember the exact number, but it seems like there was about 175 people that we put into the Space Station Program Office, and it was the best people we could find around JSC to do that. And they were very enthusiastic. In particular, Louviere and Norm [Norman H.] Chaffee and Mark [K.] Craig, who's down at Stennis [Space Center, Hancock County, Mississippi] now as the deputy director, they ran the systems engineering and integration activity, and I did the customer integration, and Dick Thorson, who's passed on now, but was around here for a long time—I don't know if you knew Thorson—managed the operations activity. Collectively, we really tried to put together a good system for them.

Freedom was a good system. It never was $8 billion. The first number I ever saw, it was $12 billion, internal number. But, unfortunately, the administrator, who was Jim [James M.] Beggs when he sold it to [President Ronald] Reagan and company, had used the number 8 billion, and somehow or another that got cast in concrete. Maybe, in retrospect, we should have never started it with the design that we had, but what happened was that people tried to build the station that people thought was required to meet the requirements.

So that went through Phase B. People turned to and were really working the problem, but there was a lot of politics. That's about all you can say it was. The program had been sold politically. The State of Virginia had been promised a piece of the action. The State of Florida, State of Texas, Alabama. You know, everybody had a piece of the action. Lewis Research Center in Ohio. It forced a distribution of responsibilities that at the time didn't make a lot of sense to us. For example, why would Lewis Research Center, who didn't have any background in power systems, be given the job of building a power system? We put the ECLS [environmental control and life support] systems at Marshall. Well, they should have been over here. Structures was brought here. Well, Marshall was better at structures than we were. It was just all jumbled up.

There was a lot of turf protection, or maybe survivorship, that was being uppermost in everybody's mind. Marshall was concerned about their piece. JSC was concerned about its piece. Everybody was. The fact of the matter is, and we thought at the program level, not at the project level that was down here also, but at the program level we thought we were trying to be evenhanded with everybody, you know. But I don't think people away from Johnson ever accepted the program office as being something other than a Johnson advocate, whether we were or not.

So there was a lot of discontent on how the program was being managed. They didn't like getting their money through another center, for example. So Headquarters had a study performed. Sam [Samuel C.] Phillips, you may have heard of the Phillips Study, and they concluded, "Well, you ought to move the program office somewhere away from Johnson. Get it out of here. Move it back to Washington."

At the end of the Phase B studies, that was done, and [the] Reston [office] was created. Then it came time, well, okay, how are you going to staff up Reston [Virginia]? Nobody at Johnson moved to Reston. Nobody. I mean, there might have been two people. So the whole program memory structure, corporate memory was gone, but they proceeded. Reston was set up. They staffed it up with wherever they could find people and they struggled along there for a while. But it started from the *Freedom* definition. In fact, *Freedom* was the program all the way through Reston's existence.

At the end of the program, I'm trying to remember the center director. Who was the center director that was the AA during the *Challenger* explosion, came down here for just a few months? I told you I couldn't remember all those names.

BUTLER: We can look that up.

SHELLEY: Anyway, he had been the Associate Administrator in Washington. In the *Challenger* accident, he had been reassigned to JSC as a center director. At the end of the Phase B studies, Headquarters had decided they wanted to run an operations study to figure out how to operate the Space Station, and they wanted Kranz to go off and head that up. Gene begged off and threw my name into the hat, so I got tagged by this new center director. I'll remember his name in a minute. I should remember him, but I just can't call it.

So I got sent to Washington for several months to co-chair this Space Station Operations Task Force, co-chair it with Peter Lyman, who was deputy director at JPL [Jet Propulsion Laboratory, Pasadena, California] at the time. So we pulled a group of people together, maybe up to fifty people at a time, for several months to do a complete reengineering of how Space

Station was going to be operated, or how it would be operated, reengineering of the way we currently did Shuttles and things like that. We produced a big stack of stuff, four volumes, the program baseline, said, "Okay, that's the way we're going to do it," which they have since forgotten about, or seemed to. We produced that, and that took the better part of a year.

I came back and Aaron Cohen was the center director then. So he turned around and sent me back to Washington for a couple of months to work on a Space Operations Task Force, which was a restructuring of the Headquarters organizational structures and the programs.

The idea was to try to—well, NASA Headquarters didn't have an ops organization; it only had development organizations. They were trying to get the charter, if you will, for developing the next generation launch vehicles. The Air Force was sitting over there saying, "Why should you guys do this? You don't even have an ops organization in Washington, and you've already demonstrated with the Shuttle here that you don't know how to build an operational vehicle."

Anyway, so there was an effort to create an ops organization in Washington, and we went up there to help them plan that. But that turned out not to happen, either, because it got too close. The implementation of it got too close to the *Challenger* recovery flight, and nobody wanted to take the risk of reorganizing just before we were going to re-fly the Shuttle, which was probably a safe thing to do.

By the time I got back to the center here, Aaron Cohen says, "Well, what do you do? Who are you?" Not really. But he said, "Now I want you to go down to the Space Station Project Office,: where basically I ended up as deputy to Clarke Covington at that time. Clarke was the project manager. So we started working on what was known as Work Package 2, which

was the JSC part of the Space Station. Things were already bad, and they just got worse in terms of budgets. I mean, every year was a reduced budget coming out of the Congress.

In retrospect, I don't think NASA really ever sold Congress on the Space Station, because I don't think they ever had a good understanding or an appreciation for what the benefits were going to be coming off the Space Station. So we had to redesign everything always. Every year, budgets were being scrunched. It got so bad that Clarke ended up being replaced and John [W.] Aaron was brought in. John and I had worked together back on Phase B. So that was good. John's a good systems engineer and everything, but he couldn't solve the budget problems either. I mean, they weren't solvable.

We had made, in retrospect, really, an error in judgment—we, JSC, I think. When the Space Station contracts were let, McDonnell-Douglas underbid what we thought the Work Package 2 effort would cost by about a billion dollars. We had numbers that said that the thing should cost about $4 billion, and Rockwell bid about $4 billion. McDonnell came in with like 2.9 billion, said, "We can build this thing for 2.9 billion." And what we should have said is, "Well, that's not credible, you know. We need to add some money in here before we sign this contract." But what we decided to do is be very innovative and say, "Well, okay, you want to sign it for 2.9 billion, we'll sign you up. If it overruns, we won't pay you any fee on the overrun. We'll have to pay the costs, but we don't have to pay you any fee." So that was the way we signed it up.

The same thing happened at Marshall. Boeing bid like 800-and-something million dollars, but Marshall said, "You missed it. We want 2 billion." So they signed a contract for 1.9 billion, a billion-dollar overrun before they even started work. Nobody remembers that. But here we were at Johnson, we signed them up for what they bid.

But then when the thing started growing, we budgeted the 4.2 billion. We had the money. But even so, the thing started overrunning, exceeded the 2.9 billion fairly early on, and the thing kept getting requirements added to it. Reston would add a lot of requirements and not add a lot of money, and it kept adding up.

Anyway, we had gotten to the point where ultimately before the thing was terminated, the Estimate at Completion had gotten up to almost $6 billion to do Work Package 2, but only 100 million of that was really due to true overrun. The rest of it was due to NASA's changing all the requirements and stuff. I mean NASA Headquarters, not us. But it didn't matter. We were taking a lot of bad press for that.

In the end, '92 or so, when the budget had really gotten scrunched, we redesigned it two or three times. The last time they cut the budget, I remember there was a big meeting held down here with the center directors and the Headquarters guys. The outgrowth of that meeting was, "Well, look, guys, we can go forward and say we can't build this Space Station with this amount of money, and they'll cancel it today, or we can take it as a challenge and go see if we can work on it and see what we can do."

Well, people like McDonnell-Douglas at the time, they certainly couldn't afford to say, "We won't take the challenge," so their position was, "Give us the job and let us run with it." But the planning that we had done had us laying off people before we got the CDR [Critical Design Review] to make it work, and that wasn't going to work. And it didn't. It didn't work. By the end of '92, I guess it is, it was clear that this thing was about $500 million or so in the drink. Certainly in the early part of the year, it was indicated to be that much over.

I remember another mistake that we made. We had a performance measuring system [PMS] on the McDonnell contract, which was telling us this thing has got a problem. But we

let—John allowed McDonnell to convince him that the data wasn't valid, that we just needed to turn off that PMS system for several months, and they would return, I remember, like $3 million to the project, in exchange for turning that thing off. And later in the year, when things stabilized, they'd turn it back on and we would reinstate it. When we turned it back on, it was $700 million in the hole.

To make a long story short, you may or may not remember a Senator [Robert Charles] Krueger from Texas. He filled out Ralph [Webster] Yarborough's term, I think, had been appointed by Ann [W.] Richards. Anyway, he called for heads, and John's was the first one to roll, I guess. That was late '92, maybe early '93. Anyway, we had already brought in earlier than that, because when I had moved over to the project control deputy job, because we had all these money problems and things we were trying to create a little more emphasis, but we also needed some help.

I didn't have any experience in actually building a lot of software-hardware type things, specifically. We had this feud, if you will, that was ongoing between [Robert W.] Moorehead in Washington and John here. They weren't getting along too well together. So Moorehead wanted to put somebody in there that he trusted, that he knew, and Jack [C.] Boykin, who's a great guy, incidentally, was selected, over his dead body. [Laughter] He didn't want anything to do with that, but he got drafted like the rest of us. So he came in to help out. Then when John was asked to give up and move on, Jack was made the project manager. So we worked on there for about another eight months, I guess.

But all during this time, we were taking all the heat in the press. There was a little thing called *Space Station News*, a paper that was printed by Phillips up in Washington, had space news, and everybody was on our case. We were getting it from all sides, not the least of which

from our new administrator, who was just criticizing Space Station *Freedom*, you know, from being poorly managed and all this sort of stuff. We never got any suggestions on how to fix the problem; all we got was what was wrong with it.

But, anyway, the upshot of it was that I guess it was in '92 the program survived by one vote in Congress. It was 217 to 216 the year that that vote occurred. Of course, Mr. [Daniel S.] Goldin and Mr. Abbey were all vocally critical of the program. So the upshot of it was that they decided that we needed to consolidate all the contracts under one single contractor, and Boeing was selected, because McDonnell, of course, was the outfit that was doing all the overrunning. They weren't going to give it to them, although, maybe we should have. I'm not sure. But it was given to Boeing, and it was restructured.

They moved the program back to Johnson, again, but this time it was supposed to be a small focused program office that was going to have no more than 300 civil servants at any time working on Space Station, and we were going to buy the program from Boeing.

Well, that didn't work very long. They had all these integrated product teams and stuff like that that was going to be the mechanism through which all this was going to occur. So that didn't turn out too well. So they went back to pretty much managing the program the way we've always managed programs, but it was more than 300 people, too. So, anyway, that's how Boeing ended up with the job, and it turns out later they bought both Rockwell and McDonnell anyway, so they've all been folded in. They bought Rocketdyne, which was the Work Package 4 group. They were already Work Package 1. Work Package 3 was the Rocketdyne, or 4. It was 4. Anyway, all of them belong to Boeing now, and that's the way the Space Station is happening.

Now, also, the thing that Goldin did, of course, was make the thing—I'm not sure whether Goldin did it or whether [William J.] Clinton did it. I'm not sure who brought the Russians really in, but that certainly bought the votes in Congress, I mean the program has been supported very well in Congress as you know, vote-wise. Not so much money-wise, but vote-wise. So that has helped. You can have your own opinions about whether or not it really has been good for NASA or whether it's been good for the costs, because the costs have been considerably more than they would have been with the Russians involved. And the schedule has slipped out. When *Freedom* was going to fly in 1992 originally, and could have flown probably in '94, could have been up there by then. But, whatever.

So anyway, we worked on Space Station there until *Freedom* was replaced with ISS [International Space Station]. At ISS, all of us *Freedom* guys had to go find work somewhere else. None of the senior executives on Space Station *Freedom* was allowed to go to work on ISS. Not one. There were forty-one or two senior executives, SES types, on *Freedom*, and none of them went to ISS.

BUTLER: What was their reasoning for that?

SHELLEY: Mr. Goldin didn't want them. He didn't want them. Nobody ever came down and actually fired us per se, but we just never were offered the opportunity to go to work on the program, any program. So that was done.

Anyway, so what we are going to do right now? John [W.] O'Neill—Kranz had retired, was retiring, you know, and MOD had this $400 million worth of contracts between the STSOC and the MSC, which was a Mission Control Center contract and a training contract, which they

were really struggling with administering those things and managing those contracts. So they asked me to come over, basically if I would go to the Business Directorate, basically, and head up the MOD Business Office and help them manage those contracts. The problem was, of course, what we were going to do is we were going to convert the contracts to completion form. Do you know what completion form contracts are?

BUTLER: If you could—

SHELLEY: Well, it's a performance-based contract. It was basically to make the contractor accountable for certain discrete functions and get the civil servants out of the job and divide the job up, basically. In the case of RSOC, the STSOC contract, you were talking about 90 percent of the job would be RSOC. So how do you get the NASA civil servants out of that loop and get this contract set up in a way that you could manage that and control that activity? So that's what I was to go do, was to set a lot of that stuff up. We did that. We worked on that. I was only out there for a little over a year, but we struggled for about a year on it.

Then somebody decided—somebody being Mr. Goldin—"We're going to do that for the whole Shuttle Program. We're going to create a contract. We're going to give the keys to the Shuttle to a contractor to go off and operate it."

By this time, Tommy Holloway is the program manager. Brewster [Shaw] is already gone. As I told you, Tommy and I worked together a long time back in the past, so Tommy called me up and said, "I need somebody to come do that, worry about that, and you're the guy." So I got drafted to go over to the program to set up what turns out to be the SFOC [Space Flight Operations] Contract, the USA contract.

At the time we were setting that up, Kraft had done a study back in '93, or '94, somewhere along in there, that said, "You ought to contract this thing out." It was that that Goldin was responding to, partly, to go do that.

I told Chris once, I said, "You know, you're consulting with Rockwell and you're making this kind of recommendation, you know. I kind of wonder about this." But be that as it may, he believed, and still does believe, that the Shuttle should have been frozen design-wise and contracted out and it should have been flown, taking full advantage of all the redundancies that were built into it, and that you didn't need all this big ops infrastructure for a lot of the stuff.

Well, anyway, that played well with Mr. Goldin, so he said, "We're going to do that. So you guys at JSC go figure out how we're going to contract out the Shuttle operation." So what we thought we'd do at JSC, because the program was at JSC, not because ops was at JSC, but the program was responsible not only for JSC ops but also KSC [Kennedy Space Center, Florida] operations. And we thought that what we would be doing would be setting up a competition between RSOC, Rockwell's Space Ops Company up here, and the Lockheed company, who was the incumbent at KSC. We thought we'd get some competition and get some good pricing on Shuttle operations. We could get a winner there.

Well, they had other ideas. They went off and said, "Why don't we just team up into a joint venture, and then we don't have to compete with each other for this job. We'll each be happy with half the job, see." So they did that, and once they did that, we ended up with a noncompetitive situation. There was nobody else that could compete with what was now the United Space Alliance for operating the Shuttle. The determination was made that that was the case, and so JSC was basically directed to go off and negotiate a direct contract with USA for operating the Shuttle. It was sole-sourced to them, and so we had to go do that.

By this time, once they decided, "Well, okay, we're going to have this contract and get on with it." Do you know what a COTR is, contracting officers technical rep? Well, I didn't want to be the COTR on that contract, because I was getting too old by then, and we needed somebody who was going to be around for three or four years to live through the transition of it.

I knew just the guy, Boykin, who said he didn't want anything to do with that job the second time. But he was the only choice we really had, somebody that was young enough that was going to be here a while, and who had the background to do it, really do it well. So he had his arm twisted to come over and do the COTR for the thing. So he and I and a few, Jim [James B.] Costello mainly, and a couple other guys, put a lot of effort, Randy [K.] Gish, put a lot of effort into setting up this SFOC contract.

The part I had to do was to do the program management plan, which is a big, thick book on how we're going to manage the program, what role USA is going to have versus what NASA's going to retain, and how we would oversee their contract and how we would transition the jobs. We had all these subsystem managers. There were twenty-eight of them scattered throughout E&D. Those jobs were going to be transitioned over to USA, as well as many of the other lesser jobs.

We were basically giving USA—well, we were going to give them the whole job except the astronauts. Later on, we backed off a little bit and said, "No, we'll keep MOD." So there's about 200 MOD civil servants over there that worked Shuttle. But everything else in the program belongs to USA, and their contract is structured such that they are accountable, in the strictest sense, for the performance of those jobs.

Working that out, as you can imagine, was traumatic, because the first thing we had to do was to say, "Okay, well, we no longer need an Orbiter Project Office at the Johnson Space

Center," so we had to abolish that. Well, Jay [H.] Greene didn't think that was such a good idea. He was the Orbiter project manager. So he had strong opinions about how that would be done, but he lost. So we ended up abolishing the Orbiter Project Office. We transitioned the remaining functions that needed to be within NASA into what was called Level 2 in the Shuttle Program Office. Jay was to work in there for a while.

We had all these contracts. To give you an idea what we were dealing with, there were eighty-something contracts on the Shuttle Program. We had gone through an analysis of all those things, and twenty-eight of them we had decided could be consolidated into the USA contract. The others we were either going to just let expire or we were never going to move them into the Shuttle Program, because they were shared with the Space Station or something else, you know, some reason why we wouldn't put them in there. But twenty-eight of them, we said, "Okay, these are going."

Those included the major contracts at Marshall, the solid rocket booster, the main engines, the external tanks. You can imagine how far we got with those kinds of discussions, too, but that's where we were headed. So we had a lot of debate, a lot of discussion. Some of those are still transitioning, like the main engine contract was scheduled to transition into USA. Now I don't think they'll ever do it, because there's no real motivation for doing it anymore. But the solid rocket booster has transitioned to USA. The external tank may very well be in USA's camp now, I'm not sure.

But it was a big deal, because we're talking about half the Shuttle Program budget going to USA. You're talking about a billion and a half dollars a year going to USA. So that's what we were all about. Well, we did all that. That started in late '95, I guess. I think we started the

contract, was it in fiscal year ’97? The first of fiscal year ’97 the contract was awarded. I mean they were in place.

We took a couple of years, what was scheduled to be for two years, for transitioning the activity over, which took me to the end of ’97. So it was time then for me to say sayonara. Actually, things were pretty well set up and running. Boykin had the contract and he was in position. The contracting officer, Randy [M.] Gish, and everybody was in position, had everything reasonably well defined. The transition of these other contracts was going to occur later, longer than I wanted to stay anyway. So it was just time to move on.

I had worked with the Japanese back during the early days of Space Station quite a bit, bringing in the international requirements on the Space Station, and they were proselytizing me real heavy to go to work with them. They were setting up an office here to more or less just be a full-time consultant with them. That’s what we’ve done.

We’ve got another ten people over there, mostly who are ex-NASA, retired NASA people. We advise the Japanese on how to avoid all the briar patches around JSC and actually help them in setting up their operations in Japan. I don’t know, you may not be familiar with how the Space Station operation is being set up, but Japan has a space center at a town called Tsububa. You may have heard of Tsububa, I don’t know. But it looks like JSC East. All the buildings are there, the facilities are there. They’ve got water tanks. They’ve got simulators. They’ve got all the things you’d find at JSC. They have a control center that looks like this one over here. What they don’t have is the people to use all that stuff, you know, and that’s what we do, is we advise them on establishing the teams of people to interface with the local MOD guys and the local program people.

We also help them understand what's going on in the program. Language is a terrible problem. They are too proud, frankly, to ask for interpreters. They speak English, but they don't really speak English, because we don't speak English. You walk into a room with them, and some American will say, "Well, what's up?" And they look up. That's what it means to them. They've been formally trained in English, but most words just go by them. They miss a lot.

So we spend a lot of time interpreting stuff as to what it really means, advising them on how to interact with the NASA people. There are problems in a cultural sense, or beyond the language. They don't make decisions the way NASA makes decisions. NASA gets a half a dozen people around a table, and they discuss it, argue about it, and decide "This is what we'll do."

Meetings in Japan are held for photo opportunities, basically. If you have a program manager who wants to meet with Tommy Holloway or something, he doesn't expect to do any work. I mean, work's already been done, and it's a matter simply of consummating, if you will, the agreement or blessing or validating what's already been decided. By and large, they are that way. They work by consensus at a working level. It makes for some interesting discussions about how in the world did you guys expect to interface with a flight director who's a dictator, who's over on these ops teams? I don't think we have a real answer for that yet. They are pretty much prone to go along with whatever NASA wants to do, so they're probably just going to let NASA make the decisions.

But at the same time, they are responsible for conducting a large part of the crew training, will be done in Japan, a lot of the mission planning associated with activities that go on in their modules, there will be half of their laboratory is allocated for U.S. usage, so there will be

a lot of American experimenters who will have their experiments flown in a Japanese module. So all the activities that go on to make sure that that all works right has to be worked out, and that's what we try to help them with.

People like, well, Bob [Robert K.] Holkan works for us. He was a division manager who built the Space Station simulator over here for NASA and managed the Crew Training Division before Pete [Peter J.] Beauregard and Frank [E.] Hughes were over there. So that's the kind of people. We've got safety experts from here at Johnson. We've got information systems people who retired here at JSC. We're in the consulting business, just as full-time consultants. We sit over there and they send us questions and we answer them. We review NASA proposals and stuff for them.

To us old NASA guys, it was a place where we thought, well, this is a good place to ease into full retirement. I'll tell you, if you work the way I had been working and you just walk out the door, you might die the next day if you didn't have anything to do. So we ease into it a little bit. I told them I'd give them three years, but that was up this past January. So I'm still trying to figure out whether or not I can—we had hoped to be flying the Japanese experiments module by this point in time, but it's still three years away. NASA slipped the schedule. It looks like I'm not going to make it all the way to the flight date, so I'm not sure how much longer I'll stay around to help them with what's going on right now.

But that's pretty much it. I worked thirty-three years here, three years in the military, so I had thirty-six years of service, plus I had about a year and a half of leave accumulated. In 1998 when I retired, I had over thirty-seven years of service, so it was time to go. I miss a lot of it. The pace is certainly slower when you move out of here. And the people. People have always been great at JSC as you know. Some of them don't know how good they are. When

they ultimately retire and go out and work in the contract arena, they'll find out just that they're really better than they think they are. That's been my observation, anyway. They've got their hands full right now, though. Tommy [Holloway] does, anyway.

BUTLER: Very much so.

SHELLEY: But they couldn't be in better hands. I mean the Space Station couldn't. I don't know what your center director status is. You need to go find a center director. [Laughter]

BUTLER: Yes, I think they're working on that at the moment.

SHELLEY: I guess you need an administrator, too.

BUTLER: Yes. It will be interesting to see what happens with all of it.

SHELLEY: Well, I know Roy [S.] Estess very well. He's a nice fellow, but he, of course, he doesn't want to be center director at JSC. He wants to retire, I think. He and I went to school together a long time ago. So I expect he's not going to be a candidate. I don't know. They need to go find a good fifty-year-old guy. Have you got any of them floating around out there somewhere?

BUTLER: I'm sure there's quite a few out there that have experiences such as yours to build off of, that will—

SHELLEY: There's not as many of them internal to JSC as they need, but they'll find somebody.

BUTLER: I know time is just about up. We appreciate the time that you've shared with us today and the experiences that you've been able to—

SHELLEY: Well, I don't know if that will help you any or not, but.

BUTLER: Absolutely. Absolutely. It's been very useful. There are a couple things, if you might consider coming back at a second time, but maybe after we've had a chance to get the transcript done, you can review what you've said. But I think there were a couple things I'd like to go back and touch on in a little more detail, but not long.

SHELLEY: Sure. Well, you have my office number. We're over there, just five minutes away. We're not usually so busy that we can't break out. One thing I find about working for a Japanese company is, you know, they are very paternalistic companies, but, you know, something like a performance plan or something, that's unheard of. They don't do anything like that. I mean you just go do the thing, and that's it. So they're very easy to work with, very personable, can't do enough for you, that sort of thing. Certainly they would never tell you how to schedule your day or something like that. So we have pretty much free rein to do.

BUTLER: Certainly a different environment, having come from NASA and the government background and then—

SHELLEY: One of the things which they did last year, which they didn't have to do, we did a study for Joe [Joseph H.] Rothenburg on basically Space Station operations, but it was for utilization of the Space Station. I don't know if you know, but the National Research Council did a study on how the utilization should be managed on Space Station. Basically, what they concluded was that you ought to take the whole operation and turn it over to an NGO, a non-government organization. Do you remember this study?

BUTLER: A little bit, yes.

SHELLEY: A little bit. They don't publicize it too much, because it has a lot of ramifications, but, anyway, so that study comes floating across to NASA that says, "Here's what you ought to go do." Rothenburg was responsible for responding, and he said, "Oh, my god, what am I going to do with that?" So he decided to hire what turned out to be Computer Sciences Corporation [CSC] won the competition to do a study on how should we, in fact, manage the Space Station operations. CSC wanted me to go consult with them in responding to this thing. The Japanese, they just volunteered and said, "Sure, go do it." They're free, because they didn't have any money, and NASA didn't have any money, not enough to count for anything. So they volunteered. I worked probably three or 400 hours, I guess, with them on that stuff. So they do things like that. Now, they probably figure, well, maybe we'll learn something about what NASA's about in the process of doing it, but they haven't so far. But they try to be good citizens. Of course, we're Japanese-owned and operated and I only work for the Japanese, so

there's no conflict-of-interest stuff with NASA. We don't get paid by NASA or anything. So they don't mind helping out a little bit every now and then.

Things may change in the future, though. The economy's gone south in Japan, as you know. They may have difficulties in the future, but right now they're still trying. They are probably the best partner. They've always been about the best partner that we had on Space Station. They still are.

The Russians, of course, have been here with hat in hand, "Send me money." The Europeans, I guess, haven't asked for any money yet, but they've scrubbed out their contribution. The Japanese contribution is still 100 percent of what it was in the beginning. They're building the laboratory. They're building the Exposed Facility. They built the manipulator arm. They even added an HTV into the equation.

BUTLER: That's great.

SHELLEY: So they're trying to get into the space business. What they're going to do with it, I don't know.

It was kind of interesting back in the early days of Space Station when we were looking at the user requirements. The one thing that always interested me that I never could find out any detail on but really interested me, all the Japanese users were companies like Sony and Toshiba, which made me always wonder who exactly was in charge of their stuff. It's still that way to a large measure. They very much are in this thing for whatever they can get out of it commercially for the long haul. It will be interesting to see how it turns out.

BUTLER: See what happens with it, yes, very much so.

SHELLEY: The Station is probably going to fly more than the fifteen years, too. Why would they turn it off after ten or twelve years? Because we won't be able to build a new one by then.

BUTLER: This one took long enough.

SHELLEY: Well, you don't have any money. Congress won't give you the money, so this thing will be like the B-52. Do you know how old the B-52s are?

BUTLER: Yes.

SHELLEY: They started flying that about 1952. Been over fifty years.

But, yes, if you need me to come back and answer any questions, I'd be happy to do that.

BUTLER: Great, we appreciate that.

SHELLEY: Anything else I can help you with.

BUTLER: Appreciate it. You certainly had some very interesting times.

SHELLEY: Well, some of them were tough. Some of them were tough. We had some dark, dark periods there in the late eighties and early nineties. I mean NASA did. The Station was really in the dumps, and we weren't sure where Shuttle was there for a couple of years. Things are looking a little better right now.

BUTLER: Tried to learn from those experiences and make the best of them as could be done.

SHELLEY: Well, the country probably can afford us more so now. We don't have to fight for it. Well, you do. I mean you're still imposing the budget constraint on the Station now, and I don't know, I haven't talked to anybody over in the Space Station Program Office, but if you have to live with these cuts that leave you with three people, three astronauts, that doesn't work. So that has to change.

BUTLER: Yes, that's hard.

SHELLEY: And it will. Tommy [Holloway] will at least work toward that. I'm not sure he's going to be around long enough to make it all happen, but he's, Tommy's sixty. He's got about thirty-five, thirty-six years of service, maybe now. And I know Shirley is ready for him to retire.

BUTLER: Sometimes that's a very large consideration.

SHELLEY: Well, he's got grandkids that she likes to be close to. I don't blame her. You live to work, or you work to live. There's a difference.

BUTLER: There is. There is.

SHELLEY: Most of us have lived to work for most of our lives, but now it's time to change. He should work to live and get on with what he wants to do.

BUTLER: All right. Thank you so much. I appreciate it.

[End of Interview]