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ORAL HISTORY 2 TRANSCRIPT

CARL B. SHELLEY
INTERVIEWED BY CAROL L. BUTLER
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BUTLER: Today is November 8th, 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 Sandra Johnson.

Thank you so much for coming back in to talk with us today.

SHELLEY: My pleasure.

BUTLER: Just had a few things to follow up on, to start with. You talked in your first oral history about leaving the Air Force and going to work for Hughes [Aircraft Company] on the Surveyor Project.

SHELLEY: Yes.

BUTLER: You were working on analysis. If you could tell us something about what that entailed and your duties on that.

SHELLEY: Well, the title is pretty much self-descriptive, but specifically what I was doing is the Surveyor was assumed by Hughes, control was assumed by Hughes once it was inserted into orbit, in the Earth orbit or immediately upon separation from the booster, basically. So we were responsible for controlling the flight to the Moon and landing on the Moon.

The two major events involved in that, of course, were the midcourse correction activities and the terminal descent. Specifically what I worked on was a lot of the work associated with what we called the nonstandard operations associated with those two events, what could go wrong, what would be the response to it. It was basically malfunction procedures. Had I been doing the same thing here at Johnson, we would have called them malfunction procedures. I think we called them nonstandard procedures or something like that out there.

So that's basically what I worked on. I was responsible for developing the contingency operations activities for the Surveyor. That's what I did for two years, basically.

When I went to work on the project, I thought we were closer to launch then we were, but it turned out this thing was launched by an Atlas Centaur. Centaur had some development difficulties, and we ended up slipping for basically a couple of years. They ended up having performance problems. Surveyor had been designed initially for 2500-pound weight, roughly 2500 pounds. Turned out they couldn't launch that much to the Moon, so we had to knock about 400 pounds out of it.

BUTLER: That's pretty significant.

SHELLEY: So we had some time there to redesign it and rework it, and so that's what went on in the two years that I was there. When I left, I don't remember exactly how far we were from launch, but it was probably a year or so from launch at the time I left. So I worked in the preparations Phase, getting ready for what we thought was going to be Surveyor I, was mostly what I was doing.

BUTLER: Once they were able to launch, even though you weren't there any longer, did you follow those missions?

SHELLEY: Oh yeah. I worked for a fellow by the name of Ed Pfund, really a dynamic fellow, who drank Maalox like it was going out of style, but a very sharp individual. He went on to become a laboratory manager at Hughes, which was maybe a little bit higher elevated than what we would call directors here at the JSC [Johnson Space Center].

He used to stay in touch. He'd called me up and tell me how things were going and what was happening, so I was able to cheer them on, if you will. I never went out there to monitor any of the launches. That thing was flown out of JPL.

What we were working on were the procedures and processes to be used in what was called the Space Flight Operations Facility, which was their control center at JPL. But, no, they flew it and seemed to have been very successful. Everything seemed to work very well. It's all very good.

BUTLER: When did you learn about—this is later—the selection of the Surveyor III on the Apollo 12 landing site, and did you have any special thoughts on that?

SHELLEY: Well, I learned about it the same time the rest of us did around JSC here. I was not involved in picking that as a landing site. But I thought at the time, I said, "Well, that's really neat. It will be interesting to see what they find," what sort of shape the Surveyor would be in, because we had done a lot of work. I said terminal descent was a major Phase, but of course the initial operations on the Moon was a major activity, too, setting it up and getting all the antennas pointed in the right direction, some of the power system, the solar array oriented properly, and experiments activated. So I think I was looking forward to seeing what they would find. Was it sitting there cockeyed and had all the paint blistered off of it, or what sort of shape was it in?

Turned out it was in pretty good shape, if you remember. They cut off a piece of it, remember, and brought it back. But, yes, I felt sort of a special affinity to it, although I didn't specifically work on Surveyor III. But knowing something about the project, it's a small world, you know, as it turns out.

BUTLER: Yes, it is.

SHELLEY: No, I thought that was very nice. That was neat. Good to see that happen.

BUTLER: Yes. Well, you had mentioned in the first interview that it was a difficult decision for you to come to NASA and to leave the Surveyor Project.

SHELLEY: Yes, because working for Ed Pfund, we only had staffed up to about eight or nine people. I was his kind of number two guy there, and we had approval to go to like thirty right off the bat. So I walked away from a pretty good opportunity with Hughes.

But in terms of job satisfaction, this was the place to be, and I don't regret that. In terms of financial rewards, I'd probably have made more money at Hughes. In fact that's, what they told me, "We'll always pay you more money than the government will ever pay you," and they're right. But at the same time, this was the place to be, so I don't regret it.

In fact, I consider myself pretty lucky to have worked at JSC in the time frame that we worked there. It would be a much more difficult choice nowadays, I mean, for a fellow who was at my age at that time. It doesn't look as bright here as it did in those days. But, no, I don't regret coming down here. Enjoyed it.

BUTLER: Good. It certainly is a very different world nowadays.

SHELLEY: Yeah. Oh, yeah. It's very much different than it was when we came down.

BUTLER: Well, we talked a lot in the first interview about the simulations area that you moved into, which seems now it was very closely connected with what you had done on the Surveyor Project. I wanted to go in a little more detail on some of that simulations work, some of the different types that there were and maybe if you had any examples or particular memories of a particular simulation where something might have—

SHELLEY: I don't know that I remember any particular thing that was of major significance or noteworthy on Gemini. Most of the Gemini simulations all worked very well. The scope of them was essentially the same as the scope today in training. Everything was either a launch, a launch abort sim, or an on-orbit simulation or an entry simulation. The on-orbit activities involved rendezvous. Doing the initial rendezvous simulations, those were nice. We had not done those before. That was nice.

But by and large, the system, the training system, was conceptually comparable to even what you have today almost. We had a simulator that was a closed-loop environment that the crew was in, and we closed that loop with the control center people. We could command that simulator just like you could command the Shuttle simulators and everything we have today.

So we were doing all the same things that people do today. We spent a lot of time on launch aborts. We spent a lot of time on the on-orbit activities, and we spent a lot of time on entries, as you would expect, balanced pretty much the way they are today.

We didn't have as many people to work on them because everybody had to work pretty much every flight until it just got so far behind. We ultimately were able to get enough people that we could sort of leap frog a few people anyway, the key planning people for the flights, simulation planning people.

But the Gemini operations were all very good. We had this ground support simulation computer, and we used to run mission simulations in which we would play the role of the astronauts. We had a guy we called astro sim. We didn't call them astronauts; we called them astro sim. So it was always fun for guys to play that game, because they enjoyed poking fun, if you will, at the flight controllers every now and then.

But it was always very difficult because nobody on the ground could know as much as the crew was supposed to know about the onboard operation. So as often as not, they would screw up the crew procedures sometimes, and the first line of defense for flight controllers was, "Well, the guy didn't do it the way the crew would have done it. That's what happened." And sometimes that was the case, but by and large, we did the best we could with those things. That was a little different than today. We don't do things like that today. As far as I know, they don't. I don't think they do.

So that was a dimension on Gemini, that training that does not exist now. I notice later we're going to talk about network simulations and things. We did a lot of those kinds of things too that are different than anything you do today. But Gemini, we just did the typical things. Launch aborts, we planned those for the different conditions that occur one might be expected to abort the thing from. The orbit activities, we just analyzed the flight profile, figured out where are the major activities in this flight. Of course, the flights changed, of course. Gemini IV, if you remember, had—was it IV or V that Ed [Edward H.] White [II] did EVA [Extravehicular Activity] on?

BUTLER: Gemini IV.

SHELLEY: Gemini IV had EVA, a standup EVA and everything on it. Gemini V was just boring a lot of holes in the sky. 76, that involved the first rendezvous activity, and we emphasized those activities.

I guess VIII was the one in which Neil [A.] Armstrong and Dave [David R.] Scott had to abort earlier, remember?

BUTLER: Yes.

SHELLEY: It was also the one that I think was supposed to have the ATDA [Augmented Target Docking Adapter] on it, wasn't it, the alligator? We were going to practice a docking on this.

BUTLER: Yes. Practice docking.

SHELLEY: In fact, that's what caused the thing to spin out. Actually, that was with an Agena, didn't have ATDA on it.

So we tried to emphasis those aspects of the flight as you progressed through this thing. There was nothing really unusual about it. Just a matter of turning the crank and getting it to do what you thought it should do.

BUTLER: Sure.

SHELLEY: We had all these different kinds of simulations.

BUTLER: Yes.

SHELLEY: I notice [in your notes] you broke them out into simulated remote site exercises and launch aborts and reentries and everything. But the best way to look at this thing, if

you're having trouble figuring out what in the world was going on there, all the simulations involved either the launch, the on-orbit, or the entry mission phase. But depending on who you were training, it was either a simulated remote site exercise or a simulated network simulation or a network simulation.

BUTLER: Okay.

SHELLEY: Now, we had these simulated remote sites. So what we did in simulated remote sites—remember also in those days we were still deploying teams of people to all these remote sites, all these—

BUTLER: Yes.

SHELLEY: Because the communications, at least in terms of data flow communications, was not good enough, was not of a sufficient capacity to allow you to do a good vehicle analysis back here. You had be on the other site out here to do this.

We didn't have TDRS [Tracking and Data Relay Satellite] satellites. We didn't have full-time coverage. Anyway, the simulated remote site exercises were designed to be just exactly that. It was the remote site team, and it was practice for them contained within their own team.

BUTLER: So just their aspect of—

SHELLEY: Just their aspect of it.

BUTLER: Okay.

SHELLEY: They were tailored for those people. We call those simulated remote site exercises.

Now, once they reached a certain level of proficiency there, we could integrate that activity in with the full flight control team. If we did that locally using the internal simulation system, the GSSC [Ground Support Simulation Computer] thing, we call that a simulated network simulation. In other words, it was a full-up simulation with a simulated network. That's what that was.

Now, to take that a step further, once they deployed and they're out on ship or out at the site and everything, you can no longer do that. So the only kind of exercise you can run then is what we called a network simulation. Network simulations used prerecorded tapes for data sources, and we would make these hundreds of tapes. We'd ship those things all over the world. We'd play them back in time sequence, as well as play them on-site. We would actually exercise the real network.

So we would play these data tapes out at these remote sites, and they would ship the data all the way back through Goddard [Space Flight Center, Greenbelt, Maryland], all the way back to Houston. We would do that on a time-ordered sequence so that it would look like a real mission. It had the benefit of exercising all of the data flow processes on the network, the real data flow processes. It involved all the real communications, voice loops

and everything, the real teletypes and things that you don't know about anymore. That's what a network simulation was.

Very difficult to run a network simulation, because you can't respond to anybody. If somebody does something you didn't expect them to do, you can't reflect that in the environment because it's taped. But we did a few of those. We didn't do too many of those on each flight, two or three maybe.

But the sequence was typically to progress from launch aborts to entries, and then we'd plug in the orbit sims. Before we do the orbit sims, we'd do any simulated remote site exercises we wanted to do. We'd do the sim net sims, and we did mostly sim net sims, certainly for all the orbit activity, because we always tried to have as much of the flight control team participate as possible. So we did mostly sim net sims. I don't have the numbers, but if you go look at them, you'll see that there were more of them done than any other type.

Then we would do the network simulations. So the purpose was, as you would expect, to just ease into it and ultimately do as best you can on the network simulation. You do that as close to flight, usually, as you can because it was always then that you got the software deliveries and everything. They were never available earlier. And it was something of a validation run on the network. So that's what network simulations were.

BUTLER: You mentioned with the network simulations that you were running these on tape and that occasionally something would not mesh up with the tape. Did that happen very frequently and when it did—

SHELLEY: All the time.

BUTLER: — was it a big—

SHELLEY: All the time.

BUTLER: Oh. [Laughs]

SHELLEY: If you're a flight controller and you're involved in a network simulation, you have to be very liberal and tolerant. The flight directors played a major role there in keeping people headed in the right direction. So usually a flight director might know what the intent of the exercise is anyway, and we had to rely to him sometimes to keep the team headed in the right direction, if it gets too bad. But everybody just has to recognize you had those limitations to contend with.

They didn't look at it that much as a training activity as it was a data flow validation activity. In those days there was a lot of activity in which validating your data was really a prime thing, and it was not unusual to have a flight controller call some telemetry technician out at a remote site and have him give him actually a PCM [pulse code modulation] readout or something on a parameter from a ground station or something. They did a lot of that to make sure they had the right information. They didn't trust all these computers yet.

I don't know if you've ever heard this story or not, but even when we built the control center over here the first time, all these digital displays, CRTs [cathode ray tubes] and all this

sort of stuff, the first displays the flight controllers defined were pictures of analog gauges as they used to have.

BUTLER: Oh.

SHELLEY: They didn't make that transition quite so easily.

BUTLER: That's interesting.

SHELLEY: They liked to look at bits. They did in those days. So anyway that's—

BUTLER: Interesting.

SHELLEY: That was mostly a data flow exercise. The training took place when we could close the loop on the simulation system.

BUTLER: So the more detailed anomalies would be—

SHELLEY: They were in the sim net sims.

BUTLER: — really worked out in this.

SHELLEY: They were in the sim net sims.

BUTLER: Okay.

SHELLEY: The network simulations, the way we generated those tapes was by recording sim net sims.

BUTLER: Oh. Okay.

SHELLEY: We would record those. You would run one that was fairly nominal. We called them nominal. But it meant that you didn't have many problems. That's what we normally use for network simulations, something that didn't have a lot of problems to it.

BUTLER: All right.

SHELLEY: So they're data flow exercises.

BUTLER: And so both the sim net sims and the network sims were for the entire mission then? Would those be run continually from start to finish?

SHELLEY: Sometimes they were. We have run twenty-four-hour-long network simulations, run them around the clock, just to exercise the handovers and everything. But, yeah, they are mostly full mission. In fact, we used to call them full mission simulations.

BUTLER: Okay.

SHELLEY: That term was used at times. In fact, I think we called the simulator a full mission simulator. I think that's what we named it. But most of the exercises, launch sims, of course, you run ten minutes and you turn around and you try to run as many as you can in a day. Entry sims are sort of the same kind of thing, but they are a little bit longer, forty minutes or so. So you can run a half dozen in a day. Launch sims you could do more, though, if the crew can tolerate it.

But sim net sims are typically one a day. Sometimes you might run a four-hour model, but usually they're eight hours to last all day. And occasionally you run them twenty-four hours to exercise the team handover operations. We used to do that quite frequently. Well, once or twice a mission we would do those.

BUTLER: Do you recall the frequency of—I know you're not going to recall the exact scheduling, but of, say, how many times in a week or how many hours in a week might be dedicated to sims?

SHELLEY: Yeah, we'd run three or four days a week.

BUTLER: Okay.

SHELLEY: You might run two sim net sims in a week. You might run a day of launch aborts and maybe a day of entry, all in one week. It was very common. Things were tight schedule, remember. We were flying every two months, remember.

BUTLER: Right.

SHELLEY: It was very tight. It was very tight. We were still very much rushed. But, yeah, we didn't like to train every day, because people do need to do some work. They need to go back in the office and react and get ready for next week's simulation.

BUTLER: Sure. Work through some of the problems they encountered.

SHELLEY: But with the team shifting and everything that was available with the flight control team, you're talking about maybe five teams of people, you see, flight controllers.

BUTLER: Okay.

SHELLEY: Not that many on launches or entries, you might have two teams or maybe just one occasionally. But you might have three or four teams of orbit people. So if you run a couple days of simulation a week, somebody is still not getting as much time as he would like to get. But we ran quite frequently.

BUTLER: You said that basically this pattern of simulations that was set up at this time is essentially what they're still working with today?

SHELLEY: Conceptually it is.

BUTLER: Conceptually.

SHELLEY: What they do, they simply go take a look at the activity plan, the on-orbit plan, figure out where the major activity is and they play what-if games with those activities. What can happen that would cause something to go wrong here, and how would the flight control team react to that?

So they start looking at what sort of condition is the planning in, are the procedures in, do they have all of the bases covered, if you will. If you think they do, then you at least go exercise them on the practice of that. If you think they don't, you define an exercise that demonstrates that they don't.

BUTLER: Okay.

SHELLEY: But I think that's the way they attack the closed-loop simulations today.

BUTLER: Okay.

SHELLEY: I'm not sure how they're playing Space Station games so much because it's already up there.

BUTLER: Different.

SHELLEY: They probably are emphasizing the added-on components or the elements as they come up each flight.

BUTLER: Sure.

SHELLEY: They're probably emphasizing the assembly part more so than the payload activities. The assembly thing has to work.

BUTLER: Right.

SHELLEY: Then the payload stuff ultimately will have to work, but right now it doesn't have to right now. They'll get to a point where they'll be emphasizing payloads probably or either no training at all. It may get to the point where the crew just goes up and does it.

BUTLER: So was Apollo then essentially similar as well to Gemini?

SHELLEY: Same thing. The initial Apollo flights were a few more unmanned, 201 and 501, 502. Those were, I don't want to call them lob shots, but that's what we called them. In those days they were just up and turn over and fire back into the atmosphere.

The first Apollo manned mission was Apollo 7, which was boring more holes in the sky. It was just a couple of weeks of demonstrating that the command module and command and service module [CSM] was a suitable vehicle to sustain the crew and could do all of its normal functions. That's what we did with it.

Since there wasn't a lot of maneuvering—there was some maneuvering around to fire the engine and demonstrate it would work, but it wasn't like we did any rendezvous or anything like that. So it ended up being pretty much a systems, we emphasized the systems, spacecraft systems on those simulation. How do the fuel cells perform? What can you do to exercise the power people? What about the communications, the propulsion, etc.? So those simulations had the character of exercising systems performance and the ground controller's knowledge of those systems.

You move up to Apollo 8, though, that's a different ball game, you see. That's going to the Moon. It's got all of the maneuvers, all the translunar injection burns and more systems, too, because, if you remember, we went in orbit around the Moon with a single point failure engine to get us back out. So there was a lot of exercising done in that regard.

Then, of course, you get up to Apollo 9. Now you've got LMs [lunar modules] and command modules both in orbit, so you've just got more pieces. By Apollo 10, for sure, you've got the whole dress rehearsal for lunar landing. So those simulations had to exercise a little bit of all the major activities in the flight profile, and they did. So that's what that was all about.

All the others, all the Apollo missions following that, did the same thing. They all had at least touched on every major event that had to occur.

The later Apollo missions, 15 and beyond, also involved SIM [scientific instrument module] bay experiments. There were some science experiments on those that they had to worry about. Lunar rovers and lunar EVAs are hard to do in a flight controller sense. You can't do much in the way of EVA training. Even today you can't do too much because it's done in a water tank. There's just no way of closing that loop as well as you could. So those parts didn't receive quite as much emphasis. But on the dynamic flying part and everything is what they emphasized on the training then.

Shuttle is the same way. Shuttle emphasizes those things that had high crew-ground interaction, major events that occur, launch Phase or entries or whatever, rendezvous. Rendezvous have gotten so cut and dry, I think they can probably do them in their sleep. I'm sure some crewman would tell me that that's not the case. Some guy who's probably hasn't done it, this may be his first one, it's a big deal.

BUTLER: Sure.

SHELLEY: But I suspect the flight control people are pretty competent at it right now. But that's what you're doing in the training. You do flight analysis, profile analysis, and you pick the high-activity phases.

I think maybe I mentioned to you before also, I don't know how today's flight directors are, but when we were working with [Eugene F.] Kranz and [Glynn S.] Lunney and [Clifford E.] Charlesworth and those guys, they always had strong feelings about how good

their teams were and where they needed more effort. So they were always offering suggestions of things that we needed to improve on, so we got a lot of help. We got a lot of help from them.

BUTLER: Certainly very important to have that connection.

SHELLEY: It is because Gene, in particular, and I think Glynn Lunney to a major extent, always felt that the simulation exercise was really a development tool. It wasn't really just a training thing. It was a development tool.

BUTLER: Sure.

SHELLEY: To help them develop their processes and procedures and then validate them so a major component of the simulation planning associated with that.

In fact, if you look at the Shuttle in those days, the Shuttle simulator was really the first opportunity for the crew to interact with the onboard software. That's where the crew really first saw the software and, more importantly, where the software first saw the crew. A lot of problems were found in the Shuttle simulator in the flight software that got reported back and were worked out because they were able to do that. So that's an example of how the environment really is a developmental environment.

BUTLER: Absolutely.

SHELLEY: It helps in that regard. A lot of that went on. Probably still does. Maybe not to the extent that it did in those days, because I don't think the simulators are as good. I don't think the Space Station simulator, for example, represents as much of the Space Station as the Shuttle simulator did of the Shuttle, if you know what I'm saying. It's not as hi-fi [high fidelity].

BUTLER: Having mentioned—sorry, go ahead.

SHELLEY: I was just going to say I'm sure those guys are over there trying to do the best they can with it, though.

BUTLER: Oh, yes.

Having mentioned the crew and talking about all the various simulations, as you said, there was a role of astro sim, but there were times that the actual flight crew participated in the simulations.

SHELLEY: Oh, all the time when we ran with the simulators.

BUTLER: Okay.

SHELLEY: With the mission simulators. See, the mission simulators for Gemini or for Apollo, we used the actual trainers that had been developed for crew training. These things were electronically tied into the control center. They simulated a telemetry data stream. They

responded to commands from the control center. So we tried our best to develop a complete closed-loop environment between the flight control team and the crew.

So we always used the flight crew where we could. It was only if we couldn't find one that we—in fact, I don't know that they ever ran—we may have once or twice, but in general we didn't run without a crew. We didn't really have that much trouble, because the crewmen are always doing their best jockeying to get into the simulators, you know.

BUTLER: Sure.

SHELLEY: They like to fly simulators. We never had a lot of time. I don't know. Simulators, I don't remember what the numbers were on Gemini, but I know even on Apollo and certainly in the early days of Shuttle, thirty hours a week of total time out of a facility like that was pretty good.

I'm sure they're doing twice that now, but in the early days, those things didn't work that well, and we still had all sorts of development problems. Sometimes development had to occur in the trainer, and you wouldn't be able to use it for training because they had to use it for software development or something.

But thirty, forty hours a week for a long period there was about what you could expect. Then you had to share that across four or five crews. The near crew always got first dibs on it.

BUTLER: Sure.

SHELLEY: So the guys who were a couple of flights downstream were always more than anxious to volunteer for any simulator time they could find. You really couldn't justify letting somebody who wasn't going to fly go spend time in there flying this simulator because of that.

BUTLER: Sure.

SHELLEY: So we always had crewmen.

BUTLER: Okay.

SHELLEY: In those days also we also always had a backup crew. They don't always have backup crews nowadays so much, but in those days there were always two crew per flight. So we had plenty of crewmen.

BUTLER: Looking also at differences between Gemini and Apollo, if there were some, again, you had mentioned the network simulations. Well, on Apollo, the network was very different than on Gemini.

SHELLEY: Oh, yeah. What happened was we implemented a wideband data capability out to—later we implemented it even before we got to TDRS. We had a wideband data system, which 40.8 kilobits sticks in my mind, that we were able to ship back from those remote sites, and that made a world of difference, because that allowed us not to have to deploy

teams of people out the remote sites. So the flight control team was contracted to the local control center. The data still cycled until we got TDRS, but there was enough of it so that you could see what was going on.

That made a difference mostly in that we no longer had to just deploy people out to the remote sites, and it was a big deal, incidentally, deploying these people. You'd spend a few days traveling halfway around the world, and even after the flight was over, you'd take a few days to get back. Then it's time to go again, so it was a big deal.

So the implementation of ultimately TDRS was really a step forward. TDRS, of course, gives you full-time, basically, access. Today people don't have to worry too much about cycling their communications with the crew or cycling their analysis to coincide with when the data is going to be available. They just go look at it. It's there.

But in those earlier days, it was really difficult. I don't know how difficult it was, but it required some planning on the part of a CapCom [capsule communicator], for example, to make sure that he got everything said that the crew needed to have told to him. Actually, that's a major reason those cyclic periods of contact. In the early days, we didn't want anybody to talk to a crewman other than this capsule communicator, which was another astronaut. The reason for that was because it required very precise, very crisp, very cryptic language from someone who understood what the crew was doing. That was done.

I don't know. When we got to Skylab, I think we finally agreed to let some non-astronauts talk to the crew like once a week on some payload stuff. Today, they may not be fully there yet, but the intention is to allow the payload people to routinely just get on the line and talk with crew. In fact, the crew picks up, they dial people on the telephone.

BUTLER: Yes.

SHELLEY: Call up Joe and ask him what he thinks about something. It's a different world.

BUTLER: Very different.

SHELLEY: It's different now. Much more relaxed and much better. It's much better this way.

But in the early days it was difficult. One of the things you had to do with the training and the simulation was to try to discipline that or instill that kind of discipline in the communications that were going on with the crew. But TDRS did away with all that.

BUTLER: Well, you had to make do with what you had have available, though—

SHELLEY: You had to make do with what you had to do.

BUTLER: —and did good with that.

SHELLEY: Yeah. That's why the sim net sims had pretty good value. We could practice that, and we'd just turn the data on and off based on the orbital computation as to whether it said this thing should be in acquisition or should not be in acquisition. More than one conversation got cut off in the middle. People missed updates that they should have read up and things of that type. In the training, not so much in the mission.

BUTLER: Sure. Well, that's what the training's for, is to learn how to do it right for the mission.

SHELLEY: That's what it was for. Yeah.

BUTLER: Okay. Well, looking back over your entire career with NASA, what would you consider your biggest challenge, and what you consider your most significant accomplishment?

SHELLEY: The toughest problem I had to deal with was to define what a space station is in a user sense. I had the job of trying to make some sense out of this user environment, these users that were going to use the Space Station. What did they want in the way of a space station and what should it be?

So my job was to interview all those people, extract from them what they thought they wanted in the way what a space station should be capable of doing, and then integrate that into some sort of a set of requirements that could be given to the engineering community to go design a space station to them. That was pretty tough.

We had a lot of discussion in the early days of the Phase B studies on Space Station as to just exactly what it should be. Of course, the engineers had their own solution as to what they wanted a space station to be. I remember we had lots of debates on things like power systems and cabin pressures and things like that.

Ended up, the Space Station looks a lot like we asked it to be today. I mean, the laboratory module is exactly what we defined it to be. It's one atmosphere cabin pressure. It's on DC power. If it had been left up to the engineering community, the systems engineers, you would have had 400-cycle aircraft power in the station. There are major problems why you don't want that from a user perspective, mostly related around the impact on the external plasma environment around the station. Because in those days, they wanted to study that.

BUTLER: Sure.

SHELLEY: And 400 cycle AC power put beat frequencies throughout the plasma, in particularly the 13 kilohertz region, which was a region they were interested in at the time, so they didn't want that. The Shuttle people wanted 10.2 pounds per square inch cabin pressure. That's good for EVA preparation and lack of prebreathing preparation, stuff like that. It's terrible from medical analysis point of view.

You may or may not be aware, but there are humongous medical databases, as you could imagine, throughout the country. We even went so far as to try to calculate what the average altitude was of the data that was gathered in a database. Turned out it's like 400 feet. Well, 10.2 psi cabin pressure is more like 8- or 9,000 feet. So you have to worry, any data that you would gather under those pressure conditions, how do you extrapolate that back down to 400 feet and stuff like that.

So we argued, well, we don't want that. We want one atmospheric pressure, sea level pressure. We finally won that. That's what the Space Station is.

There were about forty or fifty major issues on system design in those days that we ended up having to build we called them white papers, but what it was was it was to interact with the using community and try to derive what would be best for them and try to get the system then to respond to that, accommodate it the way we wanted it.

We were able to get most of that in, so I think that was the toughest thing I had to do. It's also probably the biggest contribution that we made. Space Station, when I look at it, I see a lot of stuff that the issues are still the same as we were talking about then in those days. But the modules, the U.S. laboratories at the center of pressure, the sweet spot for the microgravity environment is inside the U.S. module. That was a big deal. I mean, it may not seem so today, but, of course, you wanted your module to have the best micro G environment. Japan kind of wanted theirs to be that. We juggled module positions around a lot.

Today they make a big deal out of the centrifuge. You've heard about the centrifuge on the Space Station?

BUTLER: Yes.

SHELLEY: When we started, centrifuge was kind of an afterthought. It wasn't even a big deal. It was like a $10 million item. It was a relatively minor experiment. Today it's $500 million.

But, anyway, we did a lot of work on the utilization. I guess one of the tougher things we had to do was to try to—how do you go out? Who do you talk to? Who is the user? What is this guy? We ended up breaking the scope of the activity into three major pieces on

Space Station. There was a science piece, a commercial piece, and a technology piece, is the way we broke it up. You could probably do it other ways, but those seemed to fit pretty well.

So we ended up setting up advisory groups in each those areas. We had a group of scientists who advised us on the pure science, what they wanted. Then we had a different group on commercial people, involving private industry people, what do you have to do to make this thing commercially appealing. And a similar group for the technological type, technology really meaning structures. How do you build big structures in space? We were going to build a lot of big antennas and things like that.

We had servicing bays on the station in the beginning. Hubble [Space Telescope] was going to be brought down to the Station, put into this big servicing bay—hangar, if you will. We were going to refurbish the Hubble, and then we were going to take it back to 300 miles up. Budget did away with all that.

But it was tough working on all that in those early days, because nobody had done it before. We didn't know what we were doing half the time. We struggled through it.

Space Station *Freedom* won't get much credit for it, but the fact of the matter is, most of the hardware they're flying up there now was really conceived on the *Freedom*, in fact, was initiated building, development, on the *Freedom*. So we feel pretty good about that.

BUTLER: Well, it certainly is a very important role. If you're going to put that much time and effort and money into building something, it better be able to be used well and with purpose.

SHELLEY: I tell you, I think we had like eight major activities that we wanted to support utilization-wise on Space Station. I think they're down to like one of those left now. So Space Station has really shrunk in terms of what it was expected to be.

For example, when we initially conceptualized it, drug manufacture was to be a big deal. In fact, we had one study performed that said that by the year 2000 — remember, we were going to fly in 1992 — by the year 2000 that drug manufacture or the drug industry, based on space manufacture, would be like $50 billion a year.

BUTLER: Wow.

SHELLEY: By the year 2000. That was the study that was performed in '85, '86, somewhere in there. Most of that was based on a process called electrophoresis. You may remember that.

BUTLER: Yes.

SHELLEY: Johnson & Johnson was involved in it, along with McDonnell Douglas. That turned out not to pan out too well, because what really happened is genetic engineering and a few other ground-based processes kind of overtook it. It's still better, but it's not that much better. So it turned out not to be such a good deal.

The other thing that happened was, after we did the Phase B definition, the Space Station and the prime emphasis became development, hardware development. I think people forgot all about why they were building it. The utilization people sort of got shuffled off to

the back, and all those advisory committees pretty much went by the by. They're just now beginning to realize again that, hey, this thing really is—I don't know if you've read the Young Committee report. Have you been following that?

BUTLER: No, not directly.

SHELLEY: You need to do that. There was an ISS [International Space Station] Management and Cost Evaluation [IMCE] team that just completed their report and turned it in to the NASA Advisory Council just last week.

BUTLER: Okay.

SHELLEY: It was chaired by Tom [A. Thomas] Young. It has recommended some major changes in NASA and in the Johnson Space Center and the Space Station Program, one of which is this thing is a science program, give it to the scientists. That's basically what it says. So if you haven't read that—do you ever read a thing called *NASA Watch*?

BUTLER: Yes.

SHELLEY: It must be on *NASA Watc*h. Look on *NASA Watch*, and you'll find a copy of the report.

BUTLER: Absolutely.

SHELLEY: The other thing that would be very worthwhile reading for you if you want to know what's going on in the space business, this report in particular, there's a guy by the name of Sean O'Keefe, who's deputy manager of the OMB [Office of Management and Budget]. He and Tom Young testified just yesterday, in fact, to the House Science Committee. You should read those statements, O'Keefe's in particular, because that reflects the administration's view of what they want to do with Space Station. So it's interesting.

BUTLER: Absolutely. Especially since we're in the process now of trying to find a new administrator and a new center director.

SHELLEY: That's part of the problem. Not only administrator, but you need an associate administrator, and I guess we need a center director. Tommy [W.] Holloway, I guess, is the ranking Space Station guy.

BUTLER: I believe so.

SHELLEY: But there are three vacancies above him, so that's going to be interesting.

BUTLER: It will be.

SHELLEY: It be will interesting.

BUTLER: I think NASA is in for a little bit of change here for the future.

SHELLEY: Well, they are. I sat through three of those Tom Young committee meetings, task force meetings, supporting Japanese people. It's fair what they've concluded. I mean, I think they did a pretty good job. At the same time I think the Space Station program did a pretty good job of presenting their situation to them as well. It's just there are honest disagreements about where you should be and what you should be doing. Tom Young's view, very clearly, is that this program is a science support program and should be orchestrated by scientists, not by a manned space flight infrastructure, and that's what he's recommended.

BUTLER: Very interesting.

SHELLEY: So it will be interesting to see what happens out of that.

BUTLER: Very much so. Very much so.

SHELLEY: You may have some new history you can write on JSC.

BUTLER: Well, we are always looking for new history and ongoing history.

SHELLEY: It will change the flavor of how JSC will support the program.

BUTLER: Right.

SHELLEY: It's not going to move the program anywhere else, I don't think, but they'll have to adopt a different view, JSC. The problems that we had, even when I was working utilization, in the early days of Space Station, there were big arguments even in those days about JSC did not have high enough ranking advocates for science. Most people are arguing that, well, you ought to do this at some other center. You ought to operate the station somewhere else because JSC doesn't attribute a lot of importance to the science community.

It was true that you could go to Marshall and you could find someone who reported directly to the center director was a scientist. JSC, you'd find him about four levels down. That's another thing Tom Young's recommended. He wants a program scientist put on as a deputy manager of the program here. Plus he wants them both to report to the associate administrator for Space Station, who will be a scientist.

BUTLER: Very interesting.

SHELLEY: Yeah.

BUTLER: I will definitely have to check that out.

SHELLEY: Check it out and read those.

BUTLER: Thank you for—

SHELLEY: Read those articles. You'll enjoy it.

BUTLER: Absolutely.

SHELLEY: You'll enjoy it. I try to read those things. I'm still interested.

BUTLER: Oh sure.

SHELLEY: You can't work in a place for thirty-five years. We all love this place.

BUTLER: Right.

SHELLEY: Not much we can do, other than kibbutz from the sideline, though.

BUTLER: True.

SHELLEY: Nowadays.

BUTLER: Well, one last quick question. Looking back again over your career at NASA, were there any particular individuals that really either impacted your career or that you think were very significant to the program as a whole?

SHELLEY: I had two guys that I really admired, more so than the other guys. The first one was [Christopher C.] Kraft [Jr.]. Kraft is what I would call a real leader. He's very personable—demanding, but very personable. Seemed to have this uncanny ability for figuring out where is the wheat in all this chaff, what are we trying to do, and keeping people focused and headed in the right direction. He's very good at doing that. I always admired him very much for that.

The other guy was Kranz. Kranz had a work ethic and integrity that went with it that I haven't seen in other people around here. Gene was this—we called him straight arrow. You know what I mean by that.

BUTLER: Yes.

SHELLEY: He was very much a straight arrow individual. He had a flag by his desk, and he believed it. That was important to him. He's the kind of a fellow who plays military marches on his CD player coming in every morning, or his tape deck, to charge himself up for the day.

But the thing I always admired about Gene, you could argue with Gene. He expected you to argue with him, incidentally, if you had a thought about something. He wanted you to. But you could debate and shout and yell and argue about things all day long, but at five o'clock—and Gene usually went home about five o'clock—he didn't work late like everybody else wanted to, unless he needed to be there. But the next morning, it's a clean table. It's a new day. All that stuff yesterday was behind us. We worked on it, and what are

we going to deal with today. No personal grudges or anything like that. He was always an issues guy. I always admired that in him, and a lot of other people did, too.

The other thing Gene would do, he might send you off to a meeting, and you might go over there and screw things up, which we did, but he always stood by you. "Nope, we're going to defend what you said here, but let's go back to the office and let's fix it and see what we can do." [Laughter]

But in public, Gene was always with you. He'd never desert you in the heat of battle, if you will. He's very much that kind of a guy. I guess that maybe comes from his military background or something. I don't know. Gene believed in his people, and he did everything he could for them, and people responded to that. So I always admired him for that.

I worked with a lot of people who were sharp people. I learned a lot from a lot of different people, I'm sure, but Kranz probably in terms of just the work ethic that he applied and the way he dealt with his people and Kraft in the way he led those people around, all of us around, very good.

But there were a lot of other people who influenced me here. I think I mentioned to you a guy who never gets much credit, a guy named Harold [G.] Miller. Miller was here. He's the first branch chief I worked for down here. Miller was a thinking fellow, very much a deep-type thinking fellow in terms of what was good for the space business and what it was all about. In fact, he and a guy named Jim [James A.] Miller pretty much conceptualized this closed-loop simulation system. They had done that work before I got here. They don't get a lot of credit, because they were never in the operations side of it, they were always in the support side. But those are very good people. Very good people.

There are a lot of other people who contributed a lot. You could name all the branch chiefs that were in Flight Control Division in those days: Arnie [Arnold D.] Aldrich, Jerry [C.] Bostick, Chuck [Charles R.] Lewis, Don [Donald R.] Puddy, Neil [B.] Hutchinson. I learned a lot from all those guys.

BUTLER: It was certainly a big team effort.

SHELLEY: Very much so. But Kranz and Kraft were probably the ones that I dealt with the most. I think you can ask anybody who was in MOD [Mission Operations Directorate] and they'll probably give you that same answer.

BUTLER: We've gotten similar responses from quite a few people.

SHELLEY: If they were here when Kraft was here, he was clearly the man who was in charge, and everybody knew it. But he carried that off very well. Very well.

Glynn Lunney. I shouldn't leave out. Glynn is one of my favorite people. But it was always kind of interesting when we had Kranz and Lunney and Charlesworth and later Pete Frank and Milt Windler were all flight directors, I guess, in those days, and later on Puddy and Hutchinson and those guys. But Kranz was a different kind of flight director from Lunney, who was different from Charlesworth, but in their own way, they got the job done.

Lunney was very much a people person. He was a lot like Kraft in terms of how he managed things, a very personable fellow. He'd let you go work the problem, and that was

it. Gene is more of a hands-on manager. "Let's sit down here and see what you're doing here. Let's go through this in detail."

They'd ultimately get to the same point. You'd be pulling your hair with Kranz. "Get out of my hair." And you'd wonder whether Lunney was even interested in what you were doing because he was so aloof from it at times. Actually, Charlesworth was more aloof than Lunney. He would be even further removed than Glynn from it.

But they were all good people, very competent people. Well, they had to be. The way MOD was managed, it was inherently a process of weeding out, if you know what I mean by that. It wasn't exactly a sink or swim, but the cream came to the top the way things worked, because it was who's working this problem and who knows the most about it. As a group, everybody agreed, I guess, on what the ultimate solution was, and the guy who was leading that charge became the expert, so that's the way it worked.

Have you had any dealings with Bill [Howard W.] Tindall [Jr.] ? Have people talked about Bill Tindall?

BUTLER: Yes. Definitely.

SHELLEY: Tindall probably contributed more to going to the Moon than probably anybody. Bill Tindall was very influential, a very good guy. He used to write, we called them Tindallgrams. You've heard of that?

BUTLER: Yes.

SHELLEY: But it was nothing more than he was documenting the discussions that were going on, and he would express his opinion about some of those things. But he was keeping the minutes. That's what it boiled down to. But those minutes and those discussions were evolving the techniques for going to the Moon. Tindall made a major contribution in that arena.

BUTLER: We're fortunate enough to have copies of a lot of those Tindallgrams.

SHELLEY: John [W.] Aaron has got a whole set of them, if you're missing some of them.

BUTLER: Oh, okay.

SHELLEY: Have you talked to John Aaron?

BUTLER: We have.

SHELLEY: Tell him to send you the Tindallgrams.

BUTLER: Definitely.

SHELLEY: I'm pretty sure he's got them all. There may be some other people that have them. I don't know, but John's got them. John's got them.

BUTLER: We'll check on that. Because, unfortunately, he's one of the people that we obviously haven't been able to talk to about the project, Bill Tindall, but we have talked to a lot of people about him and certainly—

SHELLEY: Phil [Philip C.] Shaffer, have you ever talked to Phil Shaffer?

BUTLER: Yes, we have.

SHELLEY: He would know all about Bill Tindall, too.

BUTLER: Yes.

SHELLEY: He might be one of the first guys I'd talk to, Shaffer, about him. He can tell you all about Tindall. John can tell you about lots of things.

BUTLER: Yes.

SHELLEY: Shuttle, Station, Skylab.

BUTLER: We were able to do a couple sessions with him.

SHELLEY: John has been in a lot of—you probably know this already, but he was the power guy when the lightning struck Apollo 12, for example. He was really instrumental in the power management on Skylab. Of course, you saw the movie *Apollo 13*, so he was in the middle of that. John's been in the middle of everything. He was in the middle of developing the Shuttle flight software. Then he got work on Station with the rest of us. That was his downfall. [Laughs] Station killed a lot of us. But anyway, you should spend a couple of sessions with John.

BUTLER: Yes.

SHELLEY: If you can get him to talk. In particular if you can get him to—some of his West Texas similes and metaphors and things.

BUTLER: Yes. [Laughter]

SHELLEY: I can never remember all of them now, but he used to have—when he'd get through talking, we'd say, "What did he say?" [Laughter] "He'd got that doggie roped and tied." What did that mean? Stuff like that. Yeah, John's a good fellow to talk to about that.

Actually, Neil Hutchinson would be an interesting fellow to talk to a little bit too.

BUTLER: Yes.

SHELLEY: If you haven't talked to him.

BUTLER: We're in the middle of talking with Mr. Hutchinson. He comes to Houston on travel frequently, and so we try and catch up when we can. We've talked to him, I think twice but would like to again.

SHELLEY: Neil could give you a good Space Station early day history. Have you talked to Clarke Covington?

BUTLER: No, not yet.

SHELLEY: Clarke Covington would be a good guy for you to talk to in terms of program formulation, if you will, how Space Station got started here and how things evolved the way they did. He will have all that in spades.

Neil inherited the Space Station. It was already in place and pretty much all the conceptualization had been done when he was made the program manager. But he could certainly relate for you what the relationships were between Johnson and Headquarters people in those early days. Neil, he only stayed there about a year and a half, though. I believe it's about a year and a half.

BUTLER: Well, before we close, I'd like to ask Kevin and Sandra if they had any questions on what we covered today.

RUSNAK: I guess I just have one sort of anecdotal question that you may or may not have any comments on. I was just thinking of something that one of the flight controllers had told us about simulations. We were talking about Bob [Robert L.] Carlton.

SHELLEY: Oh, yeah.

RUSNAK: And he was saying that sometimes during simulations when things got a little slow for some of the controllers, the astronauts—and he was speaking particularly of Neil Armstrong—used to like to make things more interesting for them by flipping a switch here or pulling a circuit breaker there.

SHELLEY: Oh, yeah.

RUSNAK: Just sort of—

SHELLEY: They'd do things like that.

RUSNAK: — on the fly. I was wondering if you had any comments about that kind of thing.

SHELLEY: It went on. It happened. It was kind of "Let's flip this and see if those guys can figure out what happening down there." It was their test for the flight control team. But they would do things like that.

Sometimes they'd do that in the middle of our major exercises that we'd gone to great lengths to plan out and they'd mess up things by throwing some switch that they weren't supposed to flip. But, yeah, that happened. Not a lot. They were a pretty disciplined group of people. Didn't do a lot have that, but things like that would happen.

There are other things that would happen over there. I remember one day, there are only so many things you can do to a flight controller environment over there, his consoles and everything, but we ran a string to one guy's master power switch under his console. They went in there and pulled a string all the way back into the control center and yanked the thing to pop his console. That really fouled him up one day. I've forgotten now exactly how it happened, but it seems like we knocked the power off to the building one day, too. I can't remember now.

Anyway, you didn't do too much of that. Kraft and Kranz those guys didn't like that. We never did that intentionally. But sometimes things like that would get out of hand. But you find when you run these simulations, it's sort of like the crew flipping these circuit breakers because the whole support team—remember, there's a flight support team that's over there keeping the facility on-line, and they get into the act too. "Why don't we do this? Let's do this thing over here."

You've got all these brilliant ideas from all these guys who've got things that you can do that would exercise the team. So you have to be careful there, because you can't control all those guys. I mean, you don't even know them. They're sitting in the background somewhere, and they get third-hand that "Yeah, it's okay to do this" from somebody. First thing you know, something's happened and you don't know what it is and yet it was a simulation problem. A lot of that stuff went on. All you can do is you talk to them and say,

"Guys, we've got to control. You've got to keep this thing under control so we know what's going on." And once they realize that maybe they shouldn't have done it, they don't do that one again, but it'll be something else next week. There was a lot of that, a lot of that stuff.

Voice loops were always a prime example of that sort of stuff, because they didn't work right anyway half the time, and people were always playing games with the voice loops. Because it's so common and you're so dependent on it, and you just assume it's always there and right and everything. Guys used to try to dream up ways to screw that up, and you can do it. You could do it.

Bob Carlton, he was a LM flight controller, lunar module flight controller. I think he was GNC [Guidance, Navigation, and Control]-type guy. I don't remember exactly what he did now. Did you guys talk to him recently?

RUSNAK: Yes. He came in for a couple of interviews with us. One was just recently, and earlier in the spring he was in, too.

SHELLEY: One fellow you really need to talk to and maybe you don't want to wait till he retires, do you know Bob [Robert D.] Legler?

BUTLER: Yes.

SHELLEY: Legler is the trivia king. He knows everything there is to know about the space program, I mean in terms of trivia-type stuff. But he knows which crewman did what, when, where and etc.

BUTLER: Okay.

SHELLEY: But he's, I don't know, Legler's probably seventy years old. He's still working over here, I think.

BUTLER: We've been trying to set up a session with him, and unfortunately, his work schedule hasn't panned out.

SHELLEY: You really need to talk to him. You need to talk to him.

BUTLER: Okay.

SHELLEY: Anything else?

BUTLER: Sandra?

Is there anything else that you can think of that we haven't touched on?

SHELLEY: Oh, nothing that's worth mentioning. I suppose if we'd sat down and had a couple of beers, we could probably remember a lot of this stuff. You have to understand, it's been fifteen years or so since I worked on the training stuff.

BUTLER: Sure.

SHELLEY: Well, it's actually been longer than that. It's about twenty years. Apollo 12 was the last time—well, we were training a flight control, and then we were crew training for the Shuttle up through 1982. '81, '82, somewhere along in there.

BUTLER: Well, I think you certainly remembered quite a bit, and we appreciate you sharing it with us.

SHELLEY: Well, if you have any further questions, by all means, let me know what they are and I'll give you a reaction to them.

BUTLER: All right. Thank you.

SHELLEY: If you talk to some of those guys we mentioned, I'm sure they remember more than I do.

BUTLER: Well, we find that everybody remembers things because everybody had a different focus, a slightly different focus, so we do get all different pieces from everybody, which helps put together the whole picture.

SHELLEY: For old training, this guy [Gordon M.] Ferguson would be a good fellow for you to talk to. And for later day training, [Robert K.] Holkan managed the training division over there for several years.

BUTLER: Great.

SHELLEY: Would be a good guy to talk to. Frank [E.] Hughes, of course, has been involved in there too. You've still got a lot of a folks around you can get some good data out of.

BUTLER: So absolutely. Absolutely. We look forward to it.

SHELLEY: Very good.

[End of interview]