NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY 2 TRANSCRIPT

LOREN J. SHRIVER
INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is December 18th, 2002. This oral history is being conducted with Loren Shriver in Houston, Texas, for the NASA Johnson Space Center Oral History Project. Interviewer is Rebecca Wright, assisted by Sandra Johnson and Jennifer Ross-Nazzal.

This is a continuation of the oral history began on December 16th, 2002, and we'd like to start today's session by talking with you about your first mission as a commander, which was STS-31. Tell us how you became part of that crew.

SHRIVER: Actually, it started, I was on a public appearance, one of the many events that we are called upon to do as an astronaut. I was up in Canada, participating in one of the IMAX opening events, and actually ended up getting a call there from John [W.] Young wanting to know if I was interested, and I said most certainly that I was. I, of course, didn't get much information on the phone, other than the basic number, STS-31, and the fact that it was the Hubble [Space Telescope] mission. I think John had been in line to be the commander on that at one time, but then I guess he got busy doing other things, and so they decided to redistribute all of those.

WRIGHT: Your first flight had been a DoD [Department of Defense] mission.

SHRIVER: Right.

WRIGHT: This one was Hubble. Hubble certainly had been in the news, and its expectations, whereas your first mission, you weren't even allowed to talk to your wife and family about it.

Tell us about the differences of your training and looking forward to taking this flight.

SHRIVER: Well, I guess you'd say if there were ever two missions that were completely opposite in terms of the public attention that was given to them, it would be my first and second missions, the first one being a DoD, not that there weren't some people interested in what I was doing, but just couldn't say anything about it.

Now along came the second with the Hubble Space Telescope deployment. Of course, it seems like sometimes everybody in the world was interested in that and what it would be and what it could do. There was a lot of publicity surrounding the mission, just in general terms, again, as to what the anticipation of the astronomy community for years and years to get a space-based telescope that they could use, and finally it was about to happen. So, a lot of good public relations kind of events and a lot of good feeling about becoming part of a very momentous event.

WRIGHT: The crew that you were going to work with had been together for a little while. How did that affect their training schedule, and how were you able to become part of that crew coming in?

SHRIVER: I think coming on to the crew went very well. I didn't notice even any ripples in my training or theirs. There were just five of us. Hubble was a large, big, heavy payload, and we just had the five crewmembers, and [Steven A.] Steve Hawley was there for what I thought was obvious reasons, that he was an astronomer, of course, had intense interest in the telescope.

And then Bruce [McCandless II] and [Kathryn D.] Kathy [Sullivan] were already assigned, and they were going to be the EVA [Extravehicular Activity]-trained people, and various of the other subsystems, of course, on the telescope; then [Charles F.] Charlie Bolden [Jr.], who was the pilot. It really was a joy working, coming in to the crew and beginning to work with them. I think everybody felt they had a definite purpose, and basically got right to the

training, and I thought it all went very well and smooth.

Of course, we were required to do some training, often various other places. We went to Lockheed Martin facility in California and viewed the telescope as it was being—the finishing touches on the assembly and the checkout and all of the things that they were working with, the integration of all of the systems.

We even got to go to Bristol, England, and check out the manufacturing plant of the solar arrays. The first set of solar arrays were made in Bristol, and we went over there and took a look at that and watched how it deployed, what it looked like when it deployed, what we should be looking at, the things of interest to the crew as we went about doing the solar array deployment later on during the mission. It was deemed pretty critical and, indeed, it turned out to be pretty critical to know what the solar array looked like and how the mechanisms functioned as the array was being sort of unrolled simultaneously in both directions. I'm very glad, looking back on the deployment mission, that we had the opportunity to go do that. And there were a lot of other things that we did that were specific to the training on that mission.

WRIGHT: What specific differences did you have from being now a commander than being a pilot?

SHRIVER: Oh, well, of course, quite a few additional items of training and training sessions to go through, as you switch these from being the pilot to the commander. Of course, you're in charge officially for basically the safe conduct of the entire mission and the crew while you're up on orbit. Of course, many, many other people participate directly in the mission and contribute to the safety and the total success of the mission. There's certainly no doubt about that. But for the crew itself, that's your function, and one of your prime functions, of course, you are responsible for knowing how to fly the Shuttle in any phase of flight and what to do about it if it doesn't appear to be doing the right thing, and in general, keeping track of what's going on during the mission and trying to keep everything on schedule and on timeline.

And so you feel somewhat greater added pressure, and you're also concerned about all of the training and the health and well-being of all the crew members before you even get to orbit, trying to make sure that they have all the appropriate training as well. But I think, again, everybody had the sense of what they needed, what they were lacking, and none of this crew was particularly bashful about saying anything where they thought they wanted to see something a little different or a little more or participate in another session or whatever. And, of course, everybody was very helpful to make sure that happened.

Of course, also, there was the added training for now all the approach and landing phase, quite a bit of additional Shuttle training aircraft, approach and landing runs out at [NASA] White Sands [Test Facility, Las Cruces, New Mexico], and KSC [NASA Kennedy Space Center, Florida] and at Edwards [Air Force Base, Edwards, California], and so it was a busy time.

WRIGHT: The mission had been scheduled originally for August of [19]'86 and went through a number of date changes, schedule changes; plus, once you got near the pad, there was a couple of delays as well. How did the varying launch dates and delays affect your crew?

SHRIVER: Well, of course, the original one in '86 would have been interrupted by the *Challenger* [STS-51-L accident, January 28, 1986] and the subsequent reworking of all the program elements. As we got closer to flight, after the schedule settled down, I don't know, I think those of us who were around in the early phases of the Shuttle Program became quite accustomed to fluid schedules and fluid manifests. Let's just put it that way. Things always crop up in this business, and with the intense interest in focus on safety and safety of flight, safety of the crew, the program always takes the time to dig into things to make sure that any questions on technical issues or any of the anomalies on the Shuttles, from previous missions and the ones that crop up during the flow for the one you're going to go fly, those always have to be dealt with in quite detail and always come to closure pretty much on any solution to any problem.

So, slips and changes were sort of the name of the game, at least in those days. Things

settled down a little bit more later on, but I was fairly accustomed to it. Certainly it had happened to me on [STS] 51-C in a very direct way, so I always tell young folks who ask me what it takes to become an astronaut or what are some attributes that are important, I just always tell them patience and perseverance, because those were two things that helped me along, and it just doesn't pay to get too excited about changes like that.

WRIGHT: Well, your mission did launch in April of 1990, and with it had this very large on-orbit observatory. The deployment altitude for the observatory was 330 miles, a distance record for the Shuttle. It required a steeper launch trajectory than previous missions. How did these requirements affect your duties in the flight deck?

SHRIVER: Well, first of all, you could tell at the MECO [Main Engine Cutoff] conditions and the subsequent coast prior to the orbit maneuvering engine burns, you could tell that the trajectory was different than what I recall the first time, and that you were going to end up higher, quite a bit higher on the orbit. It was a record for the Shuttle at that time. Of course, the Hubble Telescope wanted to be put out and deployed at as high an altitude as it could, and still be low enough for the subsequent reservicing missions. The Shuttle with its orbit maneuvering fuel load only has so much capability, so it wouldn't do any good to put it out too high, and we couldn't get that high anyway, because we burned every bit of our OMS propellant, half of it on the way up and the other half to get back. So there wasn't much left over to do any maneuvering at all.

But what it did, of course, was leave the telescope at a high enough altitude to where the drag on the total surface area—as it goes through its orbit, of course, there are some drag effects from various things that will eventually cause it to lose altitude, and the reservicing missions and the upgrade missions on the scientific instruments were only planned for every three, four, or five years or so, and, of course, they were then subsequently adjusted as necessary.

But they wanted to make sure that they could still do science throughout that entire intervening period, and once the telescope gets too low, because it doesn't have any active

control system in terms of attitude jets, you know, the reaction jets, it does have gyros and things like that on board, but they're very sensitive and they're very much limited by the amount of other forces that they can overcome to be able to precisely point the telescope, so it can do science. Again, another reason for going so high.

WRIGHT: Once you reached where you wanted to be, did you have to do additional maneuvers with the Orbiter to get the telescope where it needed to be?

SHRIVER: Well, the only maneuver, we did the OMS burn to circularize at the proper altitude or the proper time, and once that happened, then I think we were pretty much there from then on, and it was mostly resorting then to just using the attitude control system to maintain the appropriate attitude and to get into the right attitudes for deploying the telescope. So, yes, it was a minimum of maneuvering other than the basic OMS burns to get into the right orbit.

WRIGHT: Would you share with us what it was like to watch deployment of this telescope from your view?

SHRIVER: The telescope, first of all, it's a pretty huge device in terms of filling up almost the entire payload bay, and it was covered with nice shiny insulation, and it was just a pretty impressive piece of equipment. Steve Hawley maneuvered it out of the payload bay with the robot arm. We knew it was going to be a pretty fantastic site, but finally seeing it raised up with the big door still closed over the end of it, and then just hanging onto it with the arm for a while, while some of the checkout, the ground was sending commands and things through the Orbiter up to it to start activating some of the systems. And of course, we had some things to do on board in the deployment sequences. The two high-gain antennas were folded up against the side, they had to be deployed downward and outward, and then the solar arrays, of course, had to both be deployed as well.

It was just pretty awesome. By the time everything got sort of undone and unrolled and unfurled, why, it was a pretty impressive sight. Of course, we had spent upwards of a year or more training for all of those events. Until you actually get to see it happen, though, with the real piece of equipment, there is always some, I think, tendency to underestimate what it's going to look like, and I think I would say that was probably the case here.

Even though we had seen a real solar array deploy in the factory in England, when there's two of them on the sides of this big telescope and you're up at 330 miles, it adds quite a bit to the picture. And so it was a pretty amazing process to go through, a sense that, again, you're finally, after all the training, after all the worry about getting there, you're finally there, and you're finally doing this, and you worry a little bit about things going properly and all of the steps working and happening on time.

We had trouble with the second solar array, getting it fully deployed. As a matter of fact, the first one went out just fine. All of the commanding worked fine. As it unrolled and pulled apart in both directions, you could see that the mechanism was functioning normally. The second array, however, we gave it the command to unroll, and it went a little ways, maybe six inches or so, and then it stopped. And we said, "Uh-oh. This is exactly one of the things we didn't want to see happen."

It's also one of the things that we train for, and Bruce and Kathy, of course, had done quite a bit of EVA training, working with the various tools, some of which were designed to—well, when they were outside, if they needed to go outside and do an EVA to help deploy, one of the things they had practiced was to manually unroll a solar array. So we knew we had a backup procedure for it, but we looked at that for a while, and mission control had us try a second time, and each time it would go a little ways and then stop. And I think there was a third time, and it went a little bit and stopped. So they said, "Well, hang on for a while. Let us think about this."

In the meantime, Bruce and Kathy, of course, had gone downstairs, gotten on their spacesuits, and were in the airlock with the appropriate tools, and they had depressed the airlock down to 5 psi [pounds per square inch] from the regular cabin pressure. So in another few

minutes, they were ready to go outside and start to work on this, because there was a time limit. There was a temperature time limit on all of this activity to either have everything unrolled and deploy the telescope so that it could survive on its own, and they had always told us, of course, that you had to have both solar arrays out or the telescope couldn't produce enough electricity to survive on its own. So the worry tends to go up a few notches.

In the meanwhile, they figured out on the ground that there is a little software routine that was designed so that if some of the tension sensors sensed that something was binding up in the mechanism as it unrolled, then that would signal the computer to send a stop signal, and you wouldn't bend anything or break anything. Turns out that software somehow was being invoked erroneously. There really wasn't any binding on the solar array, it's just that the software module was saying, "Hey, stop." So they bypassed that particular little section of software.

And we tried it, I think, a fourth time—it was either the fourth or fifth try, and finally it started unrolling. Of course, it was up to us, then, to act as the safety valve in case we saw this thing starting to bend or buckle. Now, we, the crew, had to be the ones to stop deployment rather than the automatic sensing system. So, once again, the tension factor goes up a little bit. But it did unroll fine.

By that time we were late in the sequence, letting go of the telescope with the arm and backing away from it. So pretty much as soon as we got that second array undone and unrolled and we were about in the right place to release, well, they said, "Let's release at such-and-such a time." Well, we released, and pretty much prior to that time, all of our crew coordination on the release event had at least two people with cameras, one a movie camera, one a still camera, ready to document the moment of release and the backaway and so forth of this momentous occasion of letting go of the Hubble Space Telescope.

They said, "Well, we're ready. Why don't we shoot for this time. Go do it."

There were only three of us on the flight deck. Each one of the three had a specific duty, none of which was to have a camera available to actually document the real event. So after this whole year of training and working out that choreography just right, we were down to the point

where the actual release and the significant amount of the backaway, nobody had a camera to document that. Finally, Steve Hawley said, "Oh no! A camera! Somebody grab a camera!"

And Charlie and he, I think, both did. Bruce and Kathy were still getting undone from the spacesuit. They didn't have to go outside, but they, of course, were in the airlock. They had to repressurize, get out of the suit, get things buttoned up. And so they weren't available to help.

Turns out that the IMAX Company had one of their cameras on board out in the payload bay, and they did get the shot, the actual shot of release and backaway. So we were able to eventually get pictures of the event. But it was kind of a stroke of luck, I guess. So that was the unusual part about the deployment of the Hubble Space Telescope.

WRIGHT: During all of the issues that had to be resolved, how much input were you able to make as commander in that decision?

SHRIVER: Well, anything that has to do, of course, with crew training, training issues, sequence of the flight plan, any of that kind of thing, of course, we were right in the middle of that, and adjusting whatever. Most of the telescope was pretty much already built, put together.

Steve and Bruce and Kathy, more than Charlie and I, kind of kept track of what was going on there, but that was mostly, how are they coming with the finishing touches here and there, and how is it going, and is everything looking okay? That was pretty much what they were—they were more in tune with any of the deployment issues that had to do with actually going through the process of letting the telescope go, getting the things unrolled, and things like that, and practicing the EVA procedures in case something didn't go right. So we had direct input wherever we needed it for anything like that.

WRIGHT: On board when the issue came up about whether or not to manually unfurl or to try one more release, were you able to be a part of that decision, or was that mostly a ground control issue?

SHRIVER: Yes, we were. Of course, we reported what we saw the very first time and what had happened, and they said, "Okay," and they thought a little bit, and they said, "Well, I guess we probably need to have you try it again." So we did. And when it didn't work the second time, then everybody starts thinking about, "Well, the first thing we need to do is get Bruce and Kathy down to get started into the spacesuit, because we may need to actually have them go outside and crank this thing open." Again, there is a total time limit on HST [Hubble Space Telescope] being unhooked from anything in the payload bay to where it would be powered on its own.

And then, in the meantime, again, we didn't have much insight into the actual system, the internal workings of the system on board. We were keypunch operators or key operators and command relayers and things like that, but as being able to get into the software that deployed this module or the array, and actually bypass that module, that had to be done on the ground, so it was a combination of that.

WRIGHT: Then for the next couple of days, you monitored the telescope from about forty miles away.

SHRIVER: Right.

WRIGHT: Can you share with us what else was going on board and what you did during that time period?

SHRIVER: Well, every once in a while, of course, we would take a sighting on a telescope, make sure we were about in the right place and they were still there. We kept getting reports from the ground, of course, during that, that their checkout and the Space Telescope Science Institute, their communication with the telescope was going fine, and the system seemed to be coming up normally on board the telescope. They weren't, of course, doing anything with it. There was an

outgassing period and all this sort of thing that it had to go through before they would even attempt to open the door and look at anything with it.

We, in the meantime, we were watching it, and then we had a few other experiments and things on board that we were working with and trying to make sure we did all the data takes and stuff. So it was just a period where we could follow along and look at it.

I think originally there may have been some idea that if things hadn't been working out, that they could have gone back and gotten it, but they gave up on that concept fairly early on. So I'm not exactly sure why we stuck around for two days, because we weren't going to go back and get it if it wasn't working correctly. They may have had us come back in and take a look at something just visually and take pictures to document, but that would have been about all we could do.

WRIGHT: The Orbiter's approach to Edwards upon reentry was met with high winds, and you had to change your location from the lakebed to the runway.

SHRIVER: Right.

WRIGHT: Plus, you were testing—I use that word very carefully—a new brake system on *Discovery*. Tell us about the landing. Of course, you were commander, and so you were in charge of all of that. So tell us about that experience.

SHRIVER: Well, they had been telling us that the winds were pretty high at Edwards, and I think because of the new brakes they were thinking they would want it to land at Edwards. I'm not sure what the weather would have been at KSC. But anyway, the winds had been real high. My brother and uncle had actually gone out there in my uncle's camper, and stayed out there at the place on Edwards overnight, and they said trying to sleep inside the camper was almost impossible because of the buffeting that was going on with this tremendously high wind. And so

they are all kind of laying there thinking, "Well, this is never going to happen. They're not going to come back and land tomorrow."

Well, sure enough, right at sunrise and a little bit after, when we were due to actually land, the wind died down, the forecast was to be low enough for long enough, and we came back and landed.

Now, there was a significant wind shear that we encountered on final approach. It was of the variety that just kind of chopped the bottom off of our energy level, and so as it finished the pre-flare, Charlie and I had developed the verbal coordination back and forth about what the air speed and altitude was, and I knew what kind of air speed I typically had, which would be a measure of the energy that you have left and how well you're going to be doing on the rest of the approach. Instead of around 310 or 300 knots or so pulling out of that, he reported about 270 knots, and I said, "What?" I think I said, "What?" Anyway, I was thinking, "What? Did he say that right?"

Anyway, I glanced down, and sure enough, it was there. So we clicked a button on the speed brake to make sure it was closed, and from then on it was just kind of a stretch to basically make it to the runway and land and touch down. We had a fairly slow touchdown. It wasn't all that far down the runway, either. And there was a little bit of—still some headwind from just a total wind situation.

But that kind of thing is not so unusual in the conditions that were there. It's just that it really opened your eyes. And in a glider like the Shuttle, you can't add power and compensate for it; you're stuck with what you've got. So you only have a couple options left on what to do. Fortunately, it all worked out. We touched down and made the rollout just fine, but it was interesting. As I say, touchdown was a little slow, but it worked out. But at that point you don't have too much time to think about everything or get too uptight about it. You've just got to kind of react and go do what you need to do and think about it later on, I guess.

WRIGHT: Did you have any concerns about the new brake system?

SHRIVER: No, not really. I had done some brake testing as a F-15 [Eagle] test pilot out at Edwards. As a matter of fact, I was a primary project pilot on the F-15 carbon brake upgrade, and the Orbiter was going to carbon brakes also. So I guess I felt fairly comfortable that things were going to work out just fine, and, of course, they would have tested it significantly also.

It's just that in the F-15 brake tests, I remember several braking rounds where you build up maximum speed and energy, and you just stomp on the brakes, and you get stopped, and then you pull off the runway, and then you just sit there and wait for the tires to go flat because the fuse plugs blow out and because it gets so hot in there. But, of course, with the Orbiter that didn't happen, because that was not the objective. But I wasn't too worried about the brakes.

WRIGHT: What were your final responsibilities with the crew before all of you exited the Orbiter?

SHRIVER: Well, once you stop, there's a series of checklist sections that you go through to make sure all the systems are safed or in a configuration that they can tow back to the deservicing area and get pulled in there and get situated, and then finish the safing there. So basically you run through and make sure OMS RCS [Reentry Control System] and some of the other APU [Auxiliary Power Unit] hydraulics are either shut down or in a safe condition, and then you can start to unstrap and get out, get out of the seat. So it's kind of been standard—that's been standard for pretty much since the beginning.

WRIGHT: After that flight, about a few months later, controllers discovered that there was a flaw in the Hubble's mirror. What were your thoughts when you heard that?

SHRIVER: Well, of course, it's discouraging. You just always come back from the missions on a real high, and especially a space telescope, all the good press they had received and the high

hopes of all of the astronomy community and the Space Telescope Science Institute on what it would be able to do, the pronouncements about seeing ten times further and so many times better and more distinctly.

Of course, the spherical aberration jumped right in the way of all of that. Of course, then the naysayers don't hesitate to come out of the woodwork and criticize anything and everything. As a crew, it was disappointing to have that happen, but, of course, we realized, "Well, we didn't have anything to do with that," but the stuff that we did, we were thinking that we did properly, and, of course, that is absolutely the case. The mirror was ground almost imperceptibly too much, but in a big telescope like that, it's enough, of course, to throw it off.

Almost as soon as it happened, the science community knew what had happened and why. Well, they eventually figured out why. Of course, with that knowledge, then, were able to come back within a relatively short period of time and design the correction instrument, the COSTAR [Corrective Optics Space Telescope Axial Replacement Unit], and get it built, and then carried it up on the first reservicing mission and put it in. Once they did that, then, it's pretty much right back into full swing, and all those things that were said about it in the beginning are still true.

It wasn't like it was totally blind. They could do some things with the telescope and look at some things, and could tell that if it were operating perfectly, they would be able to do a lot of unique things with it. So I don't think there was any worry that it was not going to eventually work. It was just, "Okay. We have got to wait a little while now to get the correction up there." And, indeed, that's exactly what happened.

I don't think there's a day or a week that goes by these days that you don't read something about a new discovery or see a new picture or even a whole new book of pictures that the Hubble Telescope has taken so far during its lifetime. It really has turned out to be everything that everybody said it would be, in spite of that slight error.

WRIGHT: The events that followed this flight were quite different than your first flight. Could

you share some of the other duties that you had after this flight compared to your DoD mission?

SHRIVER: Well, sure. I'm not sure I can remember everything. We tended to stay involved in all of the activities, continuing to attend technical meetings, go to PRCBs [Program Review Control Board], and represent the office in some of the official forums and the design reviews and things like that that go on. Well, they go on continuously in the background while all the other missions are proceeding. So I got involved in a lot of that kind of thing. Continued to do the public appearances, of course. Basically just hoping that you'll be named to another crew as quickly as possible. And at that time, it happened pretty quick, getting named to the third crew.

WRIGHT: That's what we would like to talk about now, is your STS-46 mission.

SHRIVER: Okay.

WRIGHT: The crew had been announced in [19]'89, but in December [19]'90 NASA also announced that you would be replacing [Robert L.] Hoot Gibson as commander. Tell us how that happened, and how did you learn about that decision?

SHRIVER: It wasn't until—you know, your notes prompted me a little bit that I even remembered that that actually did happen. I'm not sure whether—I think Hoot just—they decided it was a better sequence or he fit in somewhere else better. I don't think there was any official reason for it other than they had enough missions going that it just worked out that way.

I think Hoot had picked up—they had assigned him to do something different, and so I came on as commander, and, again, it worked out fine, only this time instead of a single large telescope deployment, we had this thing called a tethered satellite, and then a small European Space Agency satellite, EURECA [European Retrievable Carrier], that were somewhat different objectives, especially—well, EURECA was similar to Space Telescope in that it was a payload

that was grappled by the arm and pulled out of the payload bay and some checkout was done on it, and then we released it and backed away from it. And we left it on orbit. Another crew later on would come back and get it.

So that part of it was pretty similar. Of course, it being a lot smaller payload than the Telescope, was probably easier for the RMS [Remote Manipulator System] operator to handle once they got it out. But still, in all, quite a bit of training involved with it.

The tethered satellite, on the other hand, was a totally new and unique system and concept to anybody with within the human space flight program, and that was a real challenge to train for that.

WRIGHT: Part of the crew were members of the international community. Tell us how the training went with those members as well, and how the crew bonded with these international partners.

SHRIVER: Oh, I think that was—that was, again—it never ceases to amaze me how quickly crews coalesce into a highly functional unit once the commander and in conjunction with the crewmembers and the training leads and all that, it's a kind of a community process, once you get worked out who is going to be doing what, and some of that is due to backgrounds and training anyway, or previous experience. Then the plans start to fall in place, and you go off and start training and everybody, again, knows what they need to do. And as a commander, you just worry about all the things happening on a given timeline.

The international crew, we used to think we were widely international. We had Franco Malerba and Claude Nicollier and Franklin [R.] Chang-Diaz, and then we threw in [Jeffrey A.] Jeff Hoffman's wife into the mix. She wasn't a crewmember, but she was from England, so we thought that counted. But we took great pride, and the crew picture had all of those flags in the background across in the setting of the picture. We never hesitated to mention that during our debriefings and public appearances after the mission.

The thing about training for [STS] 46—again, I keep going back to the tethered satellite. The theory behind the tethered satellite is probably fairly well known and fairly straightforward, although there is just a seemingly endless number of things that they were worried about could happen to the dynamics of the satellite as it went out on the tether. And, of course, the tether full length would have been some twenty kilometers, thirteen and a half miles or so. Some people worried about, "well, as soon as you start to send it off, what if it just kind of falls over to the side and comes back and contacts the Orbiter? And what if it goes over here, up there?" You know, all kinds of things, getting tethers wrapped around control surfaces and tail surfaces. It was just wild.

The community, in general, was worried about this thing we all called slack tether. That meant that the little round satellite that was on the end of the tether that was sort of pulling it out had nitrogen jets in it, and the amount of thrust coming out of those was very small, but in zero-G it's enough to keep the tether tight. And so they worried that during at least the initial part until the gravity gradient forces take over and keep the tether tight, that these jets might not do the job, and if the tether ever went slack, then the dynamics could do most anything, and it could go frontwards and backwards and side to side.

The trouble was finding any computer system that NASA had that could model that. We eventually, with—well, within the last couple of months of going to fly, had some standalone trainers that began to show some of that in a reasonable manner, but we never did have really good training setups in the Shuttle mission simulator. There were some approximations, but they were never that complete or that good.

Of course, in the early part of deployment until the satellite got so many meters away from the Shuttle, they were worried that if it stopped, if you had to stop for some reason in that area, the tethered satellite would be unstable; it wouldn't remain in one place. And they were worried about recontact with the Orbiter.

Well, during the mission, of course, due to a last-minute addition to the reeling mechanism that stayed down in the Shuttle payload bay, the level line mechanism for the tether

contacted a bolt and jammed up. So we couldn't get anything more than about 256 meters on distance for the deployment. Well, that was right in the middle of this so-called unstable zone. So we're sitting there worrying about, "Well, this thing, we're going to have to cut it loose. There's no way we can hang on to it."

Well, we noticed that as soon as we stopped jerking it around and doing things to try to unjam the tether, it would just go to one place and stay there. It was totally stable. And we ended up with about that distance through an entire overnight period that we had somebody up watching it, but it was as stable as anything. So right away, everybody's best theory had been proven wrong.

But I don't know, it was almost correct to say there were no rights and wrongs in anybody's theory or anybody's idea of what might happen. Almost everything that we worried about that could happen during a deployment mission and we might have to respond to actually happened during the mission, and we had to respond to it.

We had slack tethers so many times that I can't remember how many times it happened, and we responded to that with all the techniques that we had learned. We had movement forward and behind the Shuttle that moved out of plane a little bit. We finally unjammed the mechanism and reeled it back in, and that was yet a different set of things. That part worked fine, as a matter of fact. But it was a very, very interesting payload to try to train for, because nobody basically knew how to train for it. There weren't any models or simulators for it, and there was all these ideas of what could happen, most of which did happen, but things turned out fine, and we were able to bring it back.

WRIGHT: Had your lessons that you learned from that mission been transferred on to future missions?

SHRIVER: I think, yes, the tether satellite subsequently flew again on STS-75, I think it was. [Andrew M.] Andy Allen, who was my pilot on [STS] 46, was the commander then of that

mission. So, of course, he had exposure to some of the techniques that we had developed to accommodate various things.

I think Claude was on it. I think Franklin was there. There were a lot of the same crewmembers ended up flying again. Some new ones, of course. And I think the training situation then was a lot better for that second go-round, because they had what was left over from our mission, and then were able, of course, to update that as time went along and learned some of the things that we had seen or noticed.

And I think their deployment went a lot smoother. As a matter of fact, it was going so smoothly, I guess probably because the tether had been wrapped around the spool for so many years in between flights that the Teflon insulation had cold-flowed—it's a thing that Teflon will do, and it created a thin spot in the insulation, and the tethered satellite concept was working so well, it was producing so much electricity in the copper wire that ran the length of the tether, that it arced through the weak place and essentially burned itself through. Of course, they lost the satellite then, but just as it was approaching full deployment.

WRIGHT: During your mission, at any time did you feel like your crew was in danger because of the problems with the tether?

SHRIVER: I didn't feel like we were in danger. I felt like we were seeing all the things that we weren't supposed to see. [Laughs]

WRIGHT: Living those simulations.

SHRIVER: Hopefully wouldn't have to experience. But, on the other hand, I think every one of those was probably some form of lesson learned to pass on to anybody who might be doing it after that. I don't think there was ever any time that we were close to cutting the satellite loose because it posed a threat back to the Shuttle. It never got to that point at all. It did some

interesting things, and its attitude varied a lot, and the tether would slack and all that sort of thing, but we were never—it really was stable after we got it out a certain amount.

WRIGHT: Not only did you have an international crew, you had a full crew. You had seven members aboard, which was more than you had on your other two missions. How was that different for you with so many people on board?

SHRIVER: Well, it was a little more crowded on the flight deck, of course, during the busy periods. But once again, everybody had a specific function for being up there, whether it was doing Shuttle-related stuff, or flying the Shuttle, as I was doing, or operating CRTs [cathode-ray tubes], or operating the systems of the satellite itself. Everybody had a specific purpose, and it worked out fine. In zero-G, you tend not to notice the congestion as much just because you can occupy more of the space than you can on the ground.

WRIGHT: When you returned to land the Orbiter, you had a payload with you. Were you concerned at all how this was going to affect your landing?

SHRIVER: No, we knew the training, all of the weight and C.G.s [center of gravity] always did have the tethered satellite there. That would have been the normal mode anyway. So I wasn't too worried about—as a matter of fact, what we came back with was pretty nominal, as it should have been. So I wasn't worried.

WRIGHT: Was the landing or operating of the Orbiter *Atlantis* any different from what you had done with *Discovery*?

SHRIVER: No, I didn't notice any differences at all. All the vehicles, I think in terms of flying qualities and handling, are very similar to each other. None of my three flights had the drag

chute on board. As a matter of fact, I think [STS] 46 may have been the last flight without a drag chute, and then after that we've been flying drag chutes. So everything is pretty nominal.

WRIGHT: Two months after returning from this mission, you were appointed the Deputy Chief for the Astronaut Office. Did you have any idea when you were on flight that that would be your last mission?

SHRIVER: Well, at that time, no. I don't think—well, I had not given it much thought as to whether it would be my last or not. I guess everybody assumes that you're going to continue what you're doing for a while. Once I did get back, though, I was happy that they were going to make me the deputy chief. I was ready to go and try and do that, and I think it worked out fine. Again, you know, you work on the issues that are important to the Astronaut Office, and among the issues then are some people things as well as technical issues and other general health of the office kind of issues. Nothing out of the ordinary, though, that I can see.

But my family had told me that—well, wondered if it might not be in my thought process that I might want to do something different. [Laughs] Not so subtle a hint as to—you know, they were ready to have me think about different things. And as hugely satisfying and fun and rewarding as space flight is, there's a tremendous amount of personal commitment to the training time and that sort of thing, and the time it takes away from you and your family and all that. I think that's one of the things my family was trying to tell me. So I wondered, "Well, maybe it's time to start thinking about that."

About that time Brewster [H.] Shaw, [Jr.], who was already in Florida as the Manager of Launch Integration, he had a slightly different name to his title, but he came back—he always came back during the missions, and so he came to talk to me, and there were some things in the works within the Shuttle Program Office, and so he asked me if I would be interested in the job he had in Florida. Of course, I asked to think about it, but I'm thinking, "This is maybe not a bad idea. It's a chance to go do something different, but it would be in space operations," and I was

interested in kind of staying in that line of business. Of course, it meant I'd have to move to Florida, but that was fine, too, because there's a lot of really good activity, and all the hardware is down there, so you get to do something different than what you've been doing, but it's still connected with human space ops [operations]. So I did eventually say, "Yeah, I'd like to go do that."

That was in the fall, you know, I guess even a little bit before Christmas season that we first talked, but it wasn't until after the first of the year that we kind of solidified the plan, and I started going to Florida then in a temporary basis, oh, as early as March of [19]'93 that year. Then once school was out, once summertime, then the family moved down, and I had pretty much been there full time by that time for a couple months already and was learning that end of the business.

WRIGHT: What were your duties as they told them to you, and then what were your expectations of yourself in those duties?

SHRIVER: Basically what that position is, it's kind of a Deputy Program Manager in the Space Shuttle Program. The title officially was Manager, Launch Integration. There's Manager for System Integration back here, or Mission Integration, I guess. So there's sort of a couple of Deputy Program Managers. One's in Florida handling all of the integration issues, that is, you've got several huge components that come together to make the Shuttle stack, and there are several program milestones that have to happen on a specific time scale, a template to make it toward each mission.

So a good share of your responsibility has to do with making sure that template process and—we call it the COFR process, the certification of flight readiness process, is happening on the appropriate time scale, and you conduct the reviews that enable the certain milestones to get beyond the place—you know, you watch the boosters being assembled, and then there's a review for the mating of the tank and the boosters, and then there's a subsequent review for rolling out

the Orbiter to get ready to stack to the tank. And then there's a flight readiness review, and this is a sequence of events, and the main responsibilities of that job center around making sure and shepherding and being in charge of all of that part of the process.

So it definitely was hardware oriented, but also closely related to the mission ops back here, because the two have to be tightly coordinated.

WRIGHT: Almost a combination of your prior experiences coming together from those first days working down at the Cape [Canaveral, Florida] and then your experiences—

SHRIVER: Turns out it was a very logical progression of a career path for somebody who had my background, and created for me even a more unique background than most people in our business have. While a lot of people are in space ops or human space ops for a long time, not very many have experience both in Houston in our environment and at Kennedy and their environment, and in the Astronaut Office and the mission and the ground. It's fairly unique. When I went into that job, there were only, I guess, three other people in the world that had ever done the same combination of things in that sort of sequence. So it was a unique experience.

WRIGHT: Did you find your new position allowing you more time with your family, as you had hoped, or did you find responsibilities very busy, very time-consuming?

SHRIVER: Yes, it did. Evenings were, of course, a little more predictable, less travel on weekends. The hours were late enough, but at least the weekends, and a lot of that was a lot more predictable. Eventually I wasn't flying T-38s anymore either, so that probably even made it more so.

There was still quite a bit of travel involved, mostly back here to Houston and to Washington [D. C.] for other official program stuff back here during the missions or the mission phase. But, in general, it steadies things out quite a bit.

WRIGHT: Another change you went through about that same time period is that you retired from the Air Force after thirty years.

SHRIVER: Right.

WRIGHT: That must have been a—

SHRIVER: That was simultaneous with the move to Florida, becoming part of the Space Shuttle program. They and I both thought it would be more appropriate. Since I was at probably a logical place to retire from the Air Force anyway, I went ahead and did that and went into the civil service.

WRIGHT: So, another new change for you.

SHRIVER: A new change, yes.

WRIGHT: You were very much involved and very responsible in being in the position of making some tough decisions during that role, that role as well as when you became the deputy director for launch and payloads processing. Can you share some of those situations that you had to face and how you were able to do that?

SHRIVER: Well, as the Manager of Launch Integration, as I mentioned, you're intimately involved in the entire process leading up to launch. So it's very logical for the Shuttle Program, the NASA government side, to have that person, the Manager of Launch Integration, be the Chairman of the Mission Management Team as you progress past the flight readiness review, which is, again, that person's responsibility to get the process to the point of being ready to have

a flight readiness review. And then it's kind of you who is presenting the flight readiness review to sort of the senior board people within human space flight.

Then, you know, you're basically conducting everything afterwards, including—the mission management team is made up of the senior contractor and government people in each of the elements that have anything to do with the mission, and so being chairman at that point in time, it's part of your responsibility to make sure that any management issues or any out-of-family technical issues have been appropriately dealt with and that the Shuttle really is ready to go fly. And you have the authority to give the final go-for-launch for each mission. That's basically your job. Yes, it can be significant. A huge number of factors all have to come together, including the weather, which you have absolutely no control over.

WRIGHT: Are there some times that you can remember that stand out that you had some decisions that you made that you wish maybe you weren't responsible for?

SHRIVER: I was doing that job for about, I guess, four years, so I would say roughly the first half, the first two years was a huge challenge. The second two years, things seemed to settle down a little bit, and we had quite a string of on-time launches without too many problems. But when I first got there, it seemed like it was maybe—I guess I have told people that it seemed like there was about a fifty-fifty chance that when you went to the end of the firing room to get ready to go launch a vehicle, that it would actually lift off that day or in that attempt. And that's due to a combination of technical issues along with weather issues that, again, you don't have any control over

I think there were some significant things that happened, though, as we went along. The program initiated several things that eventually paid off; one of the most critical being the main engines have several sensors and valves and actuators that all have to work just right in just the right amount of time, and the timing is critical. And it seems like we had our share of problems with just the sensors themselves. The engine project worked on and brought into being a new set

of, I would say, upgraded sensors, and we learned how to deal with the actuators better and some improvements.

To me, along with reworking some of the launch-commit criteria, which we did heavily, in areas like weather, how constraining was weather really going to be, could we push the wind limits a little bit more, we really worked those hard, too. And the combination of all of that eventually, I think, really paid off. As I said, for the last two, two and a half years, we were having good strings of launches that went off precisely, went off in the launch window, and we were able to do our thing a lot more regularly.

WRIGHT: Once the missions were in flight, did your responsibility stop, or did it travel on to on-orbit decisions as well?

SHRIVER: Early on, when I was down there, they didn't stop. I kept coming back here to continue to chair the Mission Management Team during the mission. Eventually, that second position, the Manager of Mission Integration, came into being back here in Houston, and then a little time after that, then the Program Manager said, "Well, since it is a pretty big load, if we fly seven or eight times a year, and the missions are getting to be ten or twelve or some of them longer, sixteen, seventeen, eighteen days, that means you're gone from home and your business back there for that long. Why don't we, once we lift off, when we switch to the Mission Control Center, doing the controlling, that would be a switchover point to the Manager of Mission Integration back here would become the MMT [Mission Management Team] chair." So eventually that's what happened.

Then I still—I didn't travel right away. I usually waited until the end of the mission in the landing phase, which then control transfers back more to the purview of the Manager of Launch Integration. So it was toward the end of the mission that I would travel, but a lot less time away. I think nowadays the Manager of Launch Integration really doesn't even come back here during the mission much at all, including landing anymore.

WRIGHT: You were drawing from such a complete and diverse range of experience, but you knew what it was like to be on that launch pad and be told, "No, not today." Did you ever have those feelings of sometimes knowing what those guys were feeling, of putting yourself back in the position of the astronauts?

SHRIVER: Oh, I think absolutely, every time. Not just sometimes; every time. The particularly frustrating times are when at the Cape you've got good weather, which in and of itself is a unique event, seems like. You've got good weather, you have good vehicle, everything is ready to go on your end, but the TAL [Transatlantic Abort Landing] weather might be bad. We just had that last mission on an STS-113 for, I think, only about the second time in the history. I ran into that once, also.

Other things were, you know, things would seem fine technically, but it was too late, or people were working something too hard and just say, "Hey, something is not quite right here. We don't need to go today, so we're not going to go today." And it's a bit frustrating under those conditions, because it is no small thing for the crew to get up and go through that process. It's emotional, it's physical, it's a draining experience. No doubt about it. Of course, it's draining on the ground crew as well.

WRIGHT: You moved into these positions in the early nineties, when there were lots of discussions and plans for Space Station Freedom, and then, of course, the Shuttle-Mir flights, and the International Space Station [ISS]. When did you first become involved, and what was your role in doing what you were going to be able to do with the ISS plans?

SHRIVER: Actually, when I was still here first, as the Deputy Chief of the Astronaut Office, just before I was tapped to go to Florida, we were starting to—Sergei [K.] Krikalev and—Titov.

WRIGHT: Vladimir Titov?

SHRIVER: Yes, Vladimir. Yes, I couldn't think. Vladimir Titov. They came here just before I left to go to Florida, so that whole sequence was just getting kicked off as I had transferred to Florida. So in terms of watching it unfold in the Astronaut Office, I wasn't very closely connected to it at all, but, of course, the processing of the missions and watching the missions go, I saw all of it. But I had pretty much left the astronaut business by the time we started through that, just only saw the very beginning of it.

Of course, the Space Station has been going through, seems like, several iterations of what it might be or look like prior to that time as well, but I had never been assigned direct jobs to work on, specific inputs to the station. I was usually more on the ops side of the Astronaut Office. There was an operations section, and that was usually where I spent more of my time.

WRIGHT: Another part of your role, you had the opportunity to work with the congressional staff and members. On one occasion I know of at least you addressed a congressional subcommittee. Tell us how it was to work that part of the aspect of your job and what all that entailed in preparation and the results of your work.

SHRIVER: Well, the specific instance I'm thinking of is after I changed jobs in Florida to become the Deputy Center Director for Launch and Payload Processing, which was a very unique opportunity, again. It was a follow-on to everything I had done before. Roy [D.] Bridges, [Jr.], who was relatively new at the time that he asked me to come upstairs, so to speak, and do that job, one of the things he had in mind was to try to promote a certain ability to do technology projects at Kennedy Space Center. Most of NASA thought of Kennedy as being an ops center. You go down there to launch your satellites, either via the Shuttle or other expendable rockets, and Kennedy wasn't necessarily known as a technology or a research center. And that's by design. There are other centers that do that. But we believed that there was a place for what we

referred to as space port technology. This is launch-site technology. If all you do is stand around and hope for the best and never make any upgrades to your thinking or your launch systems or your concepts of how you can get things into orbit, then you're probably not going to make very good progress.

So the idea was to have—since Kennedy does have a lot of people who have been involved in launch-specific operations for years and years, our thought was that that was the right place to begin to develop a capability to look at space port technology, the kind of technologies that would promote the kind of operations in systems and improvements in systems that you would want at the launch site.

We started from nothing. There was no budget, no plan. We developed basically the plan of what we wanted it to look like, the basic technology areas that we thought were appropriate to concentrate on at first, and then kind of some specific projects we started looking at as we went on through that process. The idea was to, if we could, pick up more projects, maybe a more consistent line of funding, if we could, through the years as we went along.

I think good progress has been made, but it suffered some from trying to build that up in a time of level or declining NASA budgets overall. So it was a pretty painful process, but I think we put some real good effort into it.

One of the technology areas that we talked about, though, was range technology, things that the range, which is run by the Air Force, things that could make the launch processes for any kind of launch vehicle a lot easier, a lot simpler, the interfaces to go smoother and cheaper, less expensive. And so we were working some of that and, of course, there was a lot of interest in other areas. The launch service providers, commercial, as well as government were all interested in that. That's the background of the congressional committee that I went to testify to, was various inputs on range technologies and improvements, and why we thought certain things would be good to promote and do. It's basically from the NASA-government side point of view that was my input to that committee.

WRIGHT: Well, speaking of ventures between commercial ventures and NASA, while you were Deputy Director for Launch and Payloads Processing, the relationship with United Space Alliance and NASA began. Could you share with us all those changes affected the processes and how you were able to work with that?

SHRIVER: Actually, that relationship got started just a little bit before I left the program office in Florida and went upstairs, but, yes, it had just come into being, and NASA had a concept that it wanted to—it had eighty-seven different contracts, I think, in the Shuttle business, and they thought surely it has to be cheaper to consolidate a bunch of those into a single contract, and it was. I mean, there is no doubt, I don't think, in anybody's mind, it saved a huge amount of money.

As with anything new, there's always growing pains to get started up, business and contractual issues to work out, and then everybody finding the right place or the right mix of duties and responsibilities as some of the things transition from total government control more to the contractor being responsible for those items. One of the conditions of transition was to develop a plan that everybody could look at, they could monitor, they could tell where at in the process they were, how it was going, and whether to continue or not to continue.

Most of that proceeded on in a fairly smooth manner. There may have been a couple areas where they held on a little bit and then went on. There were maybe a couple areas where things kind of died off and never did start back up again, and everybody just kept going. But, yes, it was a new situation, but I think overall it's worked out fine for NASA.

WRIGHT: Before we go too much further, I would like to stop for just a second and going to change out our tape.

WRIGHT: Can you discuss with us for a few minutes about what you believe the pros and cons are based on your experiences from working, all the processes just via government or including

private sector, and even the military? Because there seems to be lots of concerns in both manners, and you've been in the middle of that, so maybe you could share that with us.

SHRIVER: Well, I think the concept that NASA had—I was in the program office when it was started. I think the concept they had of going to a single prime contractor was exactly the right thing to do, and that has to do with a few things, but basically it's trying to coalesce what would otherwise appear to be a wide-ranging basis of responsibility into more of a focused scheme of responsibility for the various critical processes that have to happen to make a Shuttle launch and the entire mission successful.

Now, maybe a couple words of explanation there. I mentioned the COFR process, the certification of flight readiness. As I was moving to Florida, NASA had just come under some criticism from some independent agencies who had come in to do audits and look at how things were going, for a seemingly highly dispersed system of responsibility and authority for all the different things that had to happen to make a Shuttle flight go off. Some folks might interpret that to say, "Hey, if it's that diverse, if it's unfocused, then what's that do to safety?" So I think it was only natural that they take a look at a way to try to focus more attention on at least a single unit.

Government always stayed firmly involved in what was going on. They always have an oversight mode, and they have an independent safety and quality organization that continues to watch what's going on, and it doesn't hesitate to offer opinions on whether things are, in their opinion, being done correctly or could stand some change.

One of the first jobs I had when I went to Florida in that manager or launch integration job was to completely rewrite that COFR document or the program document that specified what was to be done. That was an agonizing process, and it took a long time to do. But you had to deal with—we coordinated with the entire set of people that have anything to do with human space flight, the Space Shuttle Program, were part of that change, and were critical to it. But what we were trying to do was make sure that those organizations or people or maybe a group of

people who were responsible for a particular thing to happen were actually the ones who were being asked to sign off on it, and we got rid of the extraneous signatures. Those folks who were called upon to sign this thing, they had nothing to do with the quality or the safety of what had been produced; it's just that they were in the signature chain, and these people who had come in to look at this said, "Well, what is this? I can't tell who's in charge or who's responsible for what. You have too many signatures."

So we completely redid the entire system, and I think we focused it a lot more on just "Okay. If you're the one responsible for the final certification of this element that it's ready to go, then you're the last one that signs. We don't need a bunch of other signatures muddying up the water who really haven't had anything to do with the quality or safety of what has gone into that."

So we worked on that, as I say, for a long time. It took over a year to do that, that whole thing. But I think the end result was good, and still forms the basis of the system that's in use today. I know it's been tweaked some, and, of course, it's been tweaked since SFOC [Space Flight Operations Contract], the single prime contractor for Orbiter and several other things came into existence. That would have created a change.

So I think it's healthy. I think it contributes to the appropriate division of responsibility and authority to do it that way. I think NASA is in the proper role for oversight of some of the functions, and I think it's working fine.

WRIGHT: Now, you retired from NASA in 2000.

SHRIVER: Right.

WRIGHT: After twenty-two years with the agency. What were the factors that led you to that decision?

SHRIVER: Okay. Well, they were actually sort of nonconnected to human space flight and the background. My wife, when we were here, when I was an astronaut, she had gone through a course of instruction to become a certified nurse-midwife, and she was in one of the first classes at Baylor [University, Waco, Texas] that graduated, and proceeded to work then first for Baylor and then later for University of Texas at Galveston Medical Branch. After we moved to Florida, she continued to go to school for a while, and got a B.S., and then worked as a midwife.

But her old boss back here kept twisting her arm about a job down in Galveston. So finally she said, "Well, you know, this is really kind of a good offer. I want to go back and see what it's all about." So she came back, and we talked about it for quite awhile, and said, "Well, why don't you go back." And that job turned into even yet, I think, a better, more significant job for her back here. So for the first time in my life, instead of her following me around the country, having to find a new job and new work every place I ended up, I actually ended up following her back here.

But the timing was right as well. I think the timing, you know, everybody—not everybody, but folks often mention that it just seemed like the time to go do something different. And it was kind of like when I went to Florida in the first place, seemed like the time was about right to go do something different. Staying within the civil service system, maybe if I would have stayed on a few more years, I would be doing something different than I was at that time, but maybe not. And I was ready for a change, and I was ready to, after some nine or ten months of us living apart, I was ready to form the family back together again. All of my kids are in this area, and a couple of grandkids, so all of the forces there came together at one time, and I decided it was time to go look for something different.

WRIGHT: And you currently are working with United Space Alliance in a position. Is it similar to the one that you were doing for the Space Center?

SHRIVER: Yes. You kind of caught me there. I said "time to do something different." Actually,

the job I have now is so very similar to that first Florida job, the Manager of Launch Integration, but it's just that I'm doing it as one of NASA's prime contractors now rather than within the government itself. Duties and responsibilities have a lot of similarities. Of course, the experience and background are directly applicable to both jobs. That's probably indeed why United Space Alliance was interested in hiring me in the first place, is that the background and experience I had basically represented something that they had not yet had an opportunity to find and bring into the company. So I guess it worked out for everybody.

WRIGHT: Do you feel this current role will allow you to do even more than you were able to do in your job when you were at Kennedy?

SHRIVER: Well, I think the contractor always—there's always a customer relationship with NASA, so the NASA decision makers are pretty much the final authority on all of the requirements and satisfying the requirements. So you probably don't have as much authority in that respect; but, of course, within the company there's still quite a bit of authority to go around. So I'm not too worried about that.

Again, you alluded to it before in one of your questions. This is a teamwork kind of business. The more people you have thinking about the proper way to do things, the best ways to do things, the new ideas that can make things better, I think the better off you are, and that's one of the functions that we have as a contractor for NASA.

WRIGHT: Have you had to make some adjustment of knowing that you're on the other side now?

SHRIVER: Well, certainly. I think it's very easy for me to do. To go back to the beginning of this interview, to the days when I was a Midwest farm boy, and you don't get too pushy coming along in that kind of a beginning. And I think I'm diplomatic enough to know when it's right to push a little and when it's right to not push.

WRIGHT: Well, you certainly have had a very interesting and challenging career, and we wanted to ask you, is there a time or a point in your life when you feel like you can name as the most significant accomplishment?

SHRIVER: Wow. There's been what I consider to be quite a few of them. There are some key turning points, definitely.

WRIGHT: Well, let's talk about those.

SHRIVER: Being accepted into the Air Force Academy [Colorado Springs, Colorado] has to be the first one of those. Basically, without the Air Force Academy, I think everything else would have been kind of an academic discussion, because it basically got me in the right frame, the right start to the background. Of course, Air Force pilot training is the key part.

I think I need to credit the Air Force Academy and everything I learned in the beginning of a long string of consistent types of work that even though the jobs were different, it ends up there was more of a focus to what I was doing than I even realized in the beginning, and it all came together as I went along. But the Academy is a great place to be from. Sometimes each individual moment there is not the most pleasurable thing, but there was a lot of great experience and a huge, just a fantastic education and leadership training and opportunity to do a whole bunch of things that you would never get anywhere else.

A lot of other things were follow-ons. Air Force Test Pilot School, for example, another very excruciating academic—the flying was fun. The academics were—I had been out of school long enough that it was kind of a shock at the beginning. But that's another key turning point.

NASA didn't seem to be very interested in hiring anybody on as a pilot who had not been a test pilot before. And it's kind of still in that mode, at least for the Shuttle Program; so it's kind of another key event about my career.

WRIGHT: How about some memorable times or some key points as part of your moving from the Air Force into NASA?

SHRIVER: Each of the missions, of course, has some special moments to it. The Hubble Telescope we talked about being almost a name-recognition observatory to almost anybody in the world having something to do with that. If you go somewhere to speak and they introduce you as having deployed the Hubble Space Telescope, there's almost instant, "Oh, yeah, I know what that is."

So that's one of the neat moments. But all of the missions had their neat moments. I mentioned the tethered satellite as kind of hair-pulling at times, but it was fairly unique. Very challenging time, though.

Still, I think I mentioned it the other day, being the casualty assistance officer after *Challenger*. It was very much a different set of challenges than I had ever had in my life.

WRIGHT: That's surely memorable. They won't be ones that will be easily forgotten.

Well, as we start to come to a close today, I'm going to ask Jennifer if she has got any questions or topics for you.

ROSS-NAZZAL: I actually have one question for you. You've been an astronaut for about fourteen years. I'm wondering if you can talk about how the occupation or the job of astronaut changed from 1978 until you left the astronaut corps in [19]'92.

SHRIVER: I'm not sure whether the job changed or whether I changed within the job. Maybe a little of both.

Early in the human space flight program, of course, astronauts were unique individuals. Part of their charisma or their charm or whatever was the fact that each one of them was a hugely

successful individual, and it was focused on that way because that's the way they started off flying, as individuals, one person in a spacecraft, and then eventually it was two, and then eventually it was three. In the Shuttle it was a lot more.

So I think one of the evolutions that we saw or experienced some was the evolution from individuals doing fantastic things, to total teamwork. And today, if you don't have the team and the good of the crew and the team uppermost in your mind, in my opinion, you don't need to apply to be an astronaut, because we don't need the highly individualistic person anymore. We need people who can get along with other Americans and other nationalities for long periods of time on orbit in a confined space. And that is an evolution in the role of an astronaut, I think, from the early beginnings of human space flight to what we have now. Pretty significant change.

ROSS-NAZZAL: Do you think that it's changed at all during the Space Shuttle Program from your own experience?

SHRIVER: Yes, I think in the early days of the Shuttle Program there was still some of the—"We've got small crews, and let's get on about the business," and I think that evolved in just part of a string of evolution, but it happened during the Shuttle Program, and especially when the Station started to come along, and especially then when international partners started to fly with us, even more important.

ROSS-NAZZAL: Thank you. That was all of my questions.

WRIGHT: Is there anything else that you would like to talk about or share with us?

SHRIVER: Gosh, I think we've hit everything. We went through pretty much all the missions and all the phases and all the jobs.

WRIGHT: And some of the challenges. I'm sure there are so many.

SHRIVER: Well, yes, it's impossible to hit everything, and next week I'll remember something that would have been nice to talk about, I suppose, but I think we've got the important stuff.

WRIGHT: Okay. Well, thank you for your time, then.

[End of interview]