

NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT

EDITED ORAL HISTORY TRANSCRIPT

EDWARD L. SHADE
INTERVIEWED BY JENNIFER ROSS-NAZZAL
HOUSTON, TEXAS, AND GREENBELT, MARYLAND – 22 AUGUST 2018

ROSS-NAZZAL: Today is August 22nd, 2018. This telephone interview with Ed Shade is being conducted in Houston, Texas, and Greenbelt, Maryland, for the JSC Oral History Project. The interviewer is Jennifer Ross-Nazzal, assisted by Sandra Johnson. Thank you again for taking some time to talk with me today. I really appreciate it. I wanted to ask how you became involved with the James Webb Space Telescope.

SHADE: Back in 2009, right after the last servicing mission for Hubble, I was contacted to help out a group that was building a large optical piece of test equipment they called OSIM [Optical Simulator], which was the optical stimulus for the instruments in their cryo [cryogenic] test that were performed here at [NASA] Goddard Space Flight Center [Greenbelt, Maryland]. That was supposed to be a rather short-term assignment, but it led into other assignments with the project. Once we got through that test program—the fabrication, assembly, and test program for OSIM—I moved on to the Integrated Science [Instrument] Module [ISIM] team and worked with them to do cryo testing of that Integrated Module called ISIM.

After doing two large cryo tests with the ISIM team, I was asked if I would like to get involved with OTIS, which is the [Optical] Telescope and Instrument Module assembly, and be the Integration and Test Manager for that flow. So I did; I jumped at the chance to do that. That was probably at the end of the year in 2014, so I've been filling the role as the Integration and Test Manager for OTIS since that time. So I guess about four years now, almost four years.

ROSS-NAZZAL: Are you an engineer by training? What is your background?

SHADE: I'm a mechanical engineer by training. Most of my career I've been doing integration and test, I&T we call it, for spacecraft assembly.

ROSS-NAZZAL: You work primarily out of Goddard. Were you still working [at] Goddard in 2014? Or did you have a chance to come down here and work with the folks at JSC?

SHADE: Yes, I've been at Goddard for 20 years now, as a contractor. Then at the end of 2014 when I transitioned to the OTIS I&T Manager role, I did start traveling quite extensively to JSC to support a lot of the setup and the preliminary tests and then the final tests that we did with the OTIS assembly there. I think my first trip down there was in January of 2015 and probably I was there about close to half-time for the next three years.

ROSS-NAZZAL: Which company do you work for, if you don't mind me asking?

SHADE: I work for a small company right now called G&N Corporation.

ROSS-NAZZAL: That is one company I have not heard about in terms of their role in the test. Can you talk a little bit about that? I've heard about Ball [Aerospace] and—

SHADE: We're a very small company. I think we have about five people supporting this project but in various roles. We're more of a contracting support company I guess you'd say. We don't have a specific hardware role on the project. I'm the only one that works integration and test. We have several other people in systems engineering with James Webb Project.

ROSS-NAZZAL: This morning I was looking at your e-mail, so I thought, "Oh, I'm curious about that." I've talked to a number of people from Harris and Ball and some of the other contractors but not your company, so I wanted to check with you on that. When you first came down to JSC what was the status of Building 32 at that point? Was the building ready for testing, or was there still a lot of work that still needed to be done?

SHADE: When I came down a lot of the prep work on the facility was done. The clean room was assembled. The chamber was modified and operational. The new cryo system was installed in the chamber. When I came down, we were bringing test hardware down to check out all the work they had done. I came down [in January of '15], right when we had a full-scale simulated test unit we called pathfinder. We ran several tests with it to verify both that we could test something that was very similar to James Webb Telescope at those temperatures and then secondly that the facility that we were using was capable of doing those tests. That's what happened for probably the next two years, a series of pathfinder tests that we conducted down in the JSC facility.

ROSS-NAZZAL: What was your role in preparing for OGSE [Optical Ground Support Equipment]-1 and 2 and also the thermal test that was done? You said you do integration and testing. What does that involve?

SHADE: My role was mainly leading the team that was down there to perform the test. It started out with planning all of the tests required to get the test article and the facility ready for each of the tests: doing final assembly of the hardware, doing checkouts of the hardware at ambient temperature and pressure, configuring the chamber itself to receive the hardware, and all the operations in between.

We would lay out a plan and a detailed schedule. The real tough part or interesting part of the job is we work with people from so many different organizations. Like you mentioned, there was Ball, there was Harris, there was Northrop Grumman. [We] had Goddard folks—both direct Goddard folks and contractor Goddard team members. Everyone had their role [in the effort]. Sometimes we had to work together with teams we hadn't worked together with before. Coordinating [many] of these parallel tasks into a logical flow that efficiently led to the performance of these tests, leading that effort is what I was responsible for doing.

ROSS-NAZZAL: How closely were you working with the JSC side of the house? I can see where you would work more with the people who were running the tests of the [optical and science] equipment. But were you working closely with people who were working on the Building 32 equipment and the chamber itself?

SHADE: Absolutely, very closely with those folks. Jacobs Engineering is the name of the contractor support team that worked the facility side of the house down there. Worked a lot with them to get the chamber set up how we needed it. A lot of our hardware had to interface directly with the chamber hardware and test equipment, so there was a lot of coordination that happened on a daily basis.

We had a meeting every day to lay out our plans for the day, and [there was] a lot of coordination back and forth between all of the groups. That was the biggest challenge, to get many different groups working together towards this common goal. Sometimes groups had different priorities and drivers, and we had to piece everything together so that we could efficiently get there and share the resources that were somewhat limited at times to get the job done as efficiently as possible.

Often we would run into problems. We'd meet in the morning. "We're held up in this area. What else can we do to keep things moving while we bring in the people that are needed to resolve that issue?" Sometimes we had to fly people in from the West Coast [or] from Goddard. Sometimes the facility folks at Johnson had to go get people from other facilities. There were a lot of challenges that we came across that we had to work around. Even though we had a detailed plan laying out where we're going day to day, we would often have to make adjustments to work around issues as they came up.

ROSS-NAZZAL: Can you talk about some of those challenges and doing that work on the fly? Can you give a couple of examples?

SHADE: Let me see.

ROSS-NAZZAL: I know it's been a while.

SHADE: It has been a little while. One of the bigger challenges we had was between OGSE-2 and the thermal pathfinder test. We had to replace some mirrors—or install, I guess, two new mirrors in the top of the chamber. We had some lift equipment that was purchased to get people and the hardware up to the top of the chamber to perform that task. When that lift hardware came in, it was not compliant with a lot of specifications that it was required to meet in order to get in the facility and to meet certain NASA guidelines, so we had to retest the hardware. We had to make some modifications to the hardware. The vendor where the hardware was purchased was in Ohio I believe. We did lose quite a bit of time on getting the mirrors in place. While they were doing that we did redirect some folks to get the test article further along, so that once the mirrors were in place we had a shorter turnaround to get to the test. That was one big effort.

I'm trying to think of some other examples of issues we encountered. Nothing's coming to me right off the top of my head here. There were a lot of daily problems with harnesses and sensors that we worked through. I'm trying to think of a bigger issue. It's not coming to me right now.

ROSS-NAZZAL: It sounds like you guys had planned things out so well that things tended to go fairly smoothly for you, even in the [preliminary] test phase before the actual test itself.

SHADE: Right. Having a good plan enabled us to be able to make changes more quickly. If we didn't have a path on how we were going to get there, it would be hard to execute changes without knowing what you would impact. We knew a lot of the dependencies from one task to another, so that when something changed we knew what we could possibly move forward on and what we had to wait on to complete certain phases of the activities.

Like you said, we had a very detailed plan, and we weren't always able to follow it step by step because of situations that came up, but by having that plan we knew what our flexibilities were and what they weren't when we had to make changes.

ROSS-NAZZAL: What were your hours like as you were working on the three tests prior to the actual test of OTIS?

SHADE: We were always working, a lot. Pretty much the whole time we were working six-day weeks there at JSC, probably roughly averaging 10 hours a day for the workforce. Then there would be planning before and after each shift to get things in order for the next shift to come. They were long days and six days a week most of the time. It made it easier in some ways that a lot of us were away from home on travel, so we didn't have a lot of other outside influences to take our time. We could concentrate, focus on that work solely, as opposed to if we were in our home office, and there'd be other things pulling at us for time. That helped.

Once we got to the point where the flight hardware showed up at Johnson, we did switch to two shifts a day for the setup and the teardown of that test to meet some schedule commitments we had on delivering the flight hardware to Northrop Grumman in California. There were two 10-hour shifts six days a week during [most] of those peak times.

ROSS-NAZZAL: Sounds like you were working a little longer though with planning before those shifts started, and probably afterwards doing handovers to folks.

SHADE: Correct, right. There was a lot of prework. At the end of the shift when we'd know how things went on that shift, we would try to make adjustments and changes to accommodate whatever new information we had so that we could keep things moving, try to be as efficient as possible. It was often difficult to juggle a lot of issues and people, when those changes came up. I think looking back at it all, I think it went pretty smoothly. In the heat of the moment, it was often frustrating. As is usually the case when you look back when these things are over you realize, "Wow, we did something pretty good there."

ROSS-NAZZAL: What's amazing to me is how long the test took to just prepare and all the equipment changes that were needed to the facility here.

SHADE: Each of the preliminary tests had very unique objectives. The setup for each one was very unique and challenging. All in all, I think looking back it went well. In the middle of it there were some trying times.

ROSS-NAZZAL: Can you give some examples of those trying times? You also mentioned that in the middle of it it was kind of frustrating. I'm curious if you could explain a little bit more about that.

SHADE: There were times when we would be putting hardware together and things wouldn't fit the way we wanted. There was an assembly called the spacecraft thermal simulator, it had an acronym that escapes me right now. We had the telescope assembly there with the Instrument Module. As part of the cryo test to create the right boundary conditions there was a thermal simulator for the spacecraft that it would eventually be mated [with] at Northrop. We put this thermal simulator on one end of the telescope as it would be in flight, to simulate the environment it would see once it was in space. This simulator had several fit issues when we first tried to install it. There were harnesses on the telescope side that were different than what was modeled when they designed the simulator. There was mechanical support test equipment that was interfering with the simulator. So that one-day planned assembly and integration took probably close to two weeks to get through all the issues and hardware changes that were needed.

That was at the time in the schedule when we had the flight hardware there, we were working two shifts, and we were working really hard to get OTIS into the chamber and get the test started. We would solve one problem and go off, rework say the mechanical hardware, come back in a couple days, have all that fixed, and try to integrate. Then we'd find an issue with say cables or thermal sensors that were interfering. It got very frustrating. We were taking two steps forward, one step back there for a couple weeks until we finally got through that. It was a very complicated three-dimensional integration task. We ran into several problems with [that hardware] over about a two-week period that was a very frustrating time for all of us. For the most part everyone maintained their cool and composure and we got through it, but it was very frustrating.

ROSS-NAZZAL: You're managing the integration and testing. How much time were you spending on the floor watching over things as they were happening and then helping to come up with these kind of solutions? Or were you primarily managing a bunch of people, having them report to you, "Hey, this is the plan. This is the solution"? Or were you in the middle of these teams?

SHADE: I was not in the middle. There might be say four different tasks going on any given shift in parallel with each other, different pieces of activity. I was not directly on the floor overseeing the performance of those tasks. There was a lead person for each part of it.

I would however, go on the floor often to make sure that the tasks [had] the right priorities—if there was a conflict of space or who was using the crane or who was using [other equipment resources], make sure that everyone knew which task had priority if there was any conflicts. When there were problems, I went in to help understand what was going on so I could be part of the troubleshooting and coming up with the resolution plan. I did not directly perform each of the tasks or lead each of the tasks on the floor. I was more the traffic cop if you will, making sure that everyone got through the lanes when they were needed, and then when there were issues helping with the resolution of them.

ROSS-NAZZAL: You mentioned that you were traveling back and forth between JSC and Goddard. Were there things that popped up while you were at Goddard that were a challenge because you were so far away to manage?

SHADE: There often were. One thing I guess I didn't mention earlier is that I had an assistant or deputy, if you will. His name was Raul Martinez. We usually planned it out that one of us would be at Johnson at any given time, and he was very good at handling a lot of the issues as well. We would talk multiple times a day, compare notes.

[For] some tasks he was much more familiar with than I, and other tasks I was more familiar with. We would keep each other up to date, so we would consult each other [often] when something came up [to determine] the right path forward. It was more than just him and I. It was a big team effort. We were leading it, but there was a lot of input from [many] people. It took a [team] of really smart and talented people to get through that. It went well.

When there were challenges and I wasn't there, Raul was there and helped coordinate things for me. With Web meetings and telephone calls, things generally worked out pretty well.

ROSS-NAZZAL: How many people were involved overall in the test once OTIS arrived? How many people were involved in that effort?

SHADE: The performance of the tests I was involved with but not necessarily overall lead. I was more the lead of getting the test article and the facility ready to perform the test and then after the test deconfiguring the test article and the facility. In that part where I was more directly leading there was—oh, boy, it's hard to say how many people. People would fly out. A team from Ball would fly in. They would configure their hardware or their mirrors, and then they would leave. Another team would come in.

There was teams coming in and going for their little pieces all the time. The Harris team was there for the facility and the test hardware setup. They stayed the whole time. If you add up

all the folks that were involved it was 200 or 300 probably. At any given time, there could have been 50 to 60 on site, at our peak time.

ROSS-NAZZAL: You were preparing to get OTIS into the chamber. Were you here when she arrived?

SHADE: I was.

ROSS-NAZZAL: What are your memories of that day?

SHADE: That was one of the more challenging days I had when I was there. I'm trying to remember what all happened, but it was quite a—coordinating the transportation team, our integration and test team, and facility teams, I remember it being a real challenge and a very long day. Probably one of the longest more challenging days I had when I was down there.

I guess just the pressure of the fact that we [completed] two years of preparation. Here it is. I think everyone was a little on edge and tense. We ran into some pretty small problems, but people reacted, I guess, in a way that was unexpected. I guess everyone was a little bit nervous and excited at the same time.

ROSS-NAZZAL: Do you recall what happened? You mentioned it was relatively small potatoes.

SHADE: Moving the container into the clean room, the air bearings that were floating it got hung up at one point. It required just a few adjustments. The fact that this container with the flight

hardware in it was stuck for maybe 15 minutes, wasn't long, but people got really excited about that. The team worked through it. It was a long day. Some of the folks that were responsible for lifting the flight telescope out of the container and getting it onto the turnover fixture where we did a lot of the integration activity, those folks were coming up on the end of a long day, where they had to be relieved. We were debating whether we'd continue that day or come back the next day. There was a lot of negotiating between different groups: the transportation group, the mechanical handling group, [the facility team], and the ground support equipment group.

It doesn't sound like a big deal now, but it was a very stressful day, one of my more stressful days there as I recall. It got better. It got much better.

ROSS-NAZZAL: Things can be stressful. When you look back sometimes you think, "Oh, that really wasn't a big deal." I wasn't in your shoes, but I can imagine it must have been stressful.

SHADE: Yes, you feel the sense of responsibility on something that's that expensive, that important, but things got much better. If every day had been like that it would have been a tough road.

ROSS-NAZZAL: How long did it take your group to prepare Webb to actually get ready to be put into the chamber? How long did that process take?

SHADE: Once Webb arrived, I don't remember the date, I believe it was late April early May but don't quote me on that. It probably only took us six weeks to roll it in the chamber and then another two or three weeks to make all the connections and checkouts once inside the chamber to

be in a position where they could shut the door and pump down and start the test. It was a relatively short cycle time for the flight hardware [to complete] that [task]. It may not sound short, but it seemed short to me.

We had done a lot of prep work and testing with the pathfinder assembly, so the team knew what they had to do. We had practiced all these operations with the pathfinder several times, with the one exception being that spacecraft thermal simulator I mentioned [earlier]. We had never really fit [checked] completely on a flightlike article.

Most things went relatively smoothly, with some obvious exceptions. It was maybe six weeks till we rolled in the chamber, six weeks at six days a week two shifts a day. To me, looking back now that seems short. That was because we had so much practice and review before with the pathfinder assembly.

ROSS-NAZZAL: I understand that the clearance was pretty tight putting her in. Was there any concern on the part of your team like, "Oh, no, it may not fit," or having to work that issue on the fly?

SHADE: The tightest area was probably the secondary mirror, which sticks well up above the primary mirror and getting that in under the rim of the chamber. Our pathfinder assembly had an almost identical secondary mirror [on] it, and so that nervousness was cleared with putting the pathfinder in two or three times already. The fit problems weren't as big a worry when we got the flight article there. The fit problems, that much we worked through earlier. It was just a matter of there were more mirrors, and these were flight mirrors. The contamination concerns

and the electrical concerns were a bit higher with the flight one, but no major issues were discovered there.

ROSS-NAZZAL: Can you talk about those contamination concerns and electrical concerns you just raised?

SHADE: Contamination, the telescope by design needs to be very very clean. The clean room that was built around the outside of the chamber and the chamber itself were extensively cleaned and extensively maintained to be very clean so that when we delivered this telescope to Northrop and when it gets launched, it's clean on orbit. The optics are very very sensitive, and some of the mechanisms are very very sensitive to contamination.

We maintained that cleanliness level all through the pathfinder flow in preparation for flight, but there was definitely a heightened awareness once the flight unit arrived. The chamber was a very old chamber that had been totally refurbished. It took a lot of cleaning over and over again and some discoveries in the pathfinder flow [led to] improvements that [were] made. The cleanliness levels performed very well with the flight hardware there, but there was concern and extra care taken at every step to make sure that the room was operating correctly. We had proper procedures in place if the air handling systems went down to try to protect as best we could from any contamination event.

Electrically, the issues were with just cabling up. The pathfinder assembly, other than thermal sensors, did not have any electronics if you will on it. So [this was our] first time cabling up and performing safe-to-mates with flight hardware and procedures at JSC. Some of the unique challenges with having your test equipment outside the chamber and the flight

hardware inside the chamber and communication. Everything went pretty much according to plan, but they were somewhat unique to the flight flow, different from the pathfinder flow.

ROSS-NAZZAL: Once she was in, you went back to Goddard for the 100 days? Were you monitoring what was going on? Just keeping track of what was happening at JSC?

SHADE: Yes, I was. I was originally going to be part of the test team. I had been part of the test team for the pathfinder test as on-shift test director. It had been quite a long flow, and I took the time to take a break during the test because I knew that we would be picking up again with a pretty heavy activity afterward. I was not part of the test team that ran the test. I did monitor remotely what I could. At the same time I was starting to plan for the deintegration flow at JSC and our flow after arrival at Northrop Grumman. A lot of planning was done at that time.

ROSS-NAZZAL: Were you watching the weather? Any concerns about the hurricane that showed up?

SHADE: Oh, yes. I was watching a lot. I had originally been asked to be part of the rideout team if the hurricane came, so I had gone through some of the training and some of the medical screening required to be on that team. So always an interest, and kept a close eye, and [I] was fascinated with what happened and how everything worked out so well.

ROSS-NAZZAL: Yes, it's a pretty amazing story, I think, that things worked out and everything went well in spite of the weather, in spite of Mother Nature.

SHADE: Right, it is incredible. Incredible. We had done so much planning for what we would do, and it was good that we did that planning. What actually happened in reality was a little different than anyone predicted. It wasn't the classic ramping up at the levels of alert and then the facility being closed. It happened in a very different fashion than I think is normal for hurricanes. Right?

ROSS-NAZZAL: I think so. I don't even remember the Center telling us to start preparing for the hurricane, it just sort of came up and then we were closed. Were you here for the last couple of days of the test? Or when did you come back to Houston?

SHADE: I came back when the door opened, and we could start preparing to deconfigure in the chamber for the rollout. There was some troubleshooting on a couple issues that had to happen for a few days before we could actually deconfigure. I was there, and we were laying out a plan for the teams on what we were going to do once we got clearance to go in and break the configuration. I don't remember the date I got there. The chamber was back at ambient pressure and temperature, [however] the door wasn't open yet.

ROSS-NAZZAL: Was that a momentous occasion for the team? Was there any sort of event to mark that moment or that day?

SHADE: I don't think there was an event really. I think the bigger event in my mind was when we put it in the container to leave JSC, because that was really the sense of this is over. It was

done. All that planning and it's done. It's just hard to imagine. It was three years, but it seemed like it was much less than that because it was nonstop for quite a while.

ROSS-NAZZAL: How long did it take you guys to take her out and get her ready to go out to California?

SHADE: I'm trying to think back. There was some issues identified during the test that had to be investigated to make sure they weren't real issues and things that needed to be reworked. Once we were given the go-ahead to move on that, everything was clear and good to go, it was about six weeks. I think it was about six weeks. That included the teardown in the chamber. It went, I think, a little quicker coming out. The shifts weren't quite as long and second shift [wasn't always used] either. We turned it around. I know it was late January when we were ready to put it in the shipping container. I believe it was in early/mid December when we got the clear to start deconfiguring, getting ready to go.

ROSS-NAZZAL: How was she brought to JSC and then also returned back out to Ellington [Field, Houston, Texas]? Is there a special convoy or truck?

SHADE: Right, there's a large shipping container used to transport it. The shipping container is designed to be pulled down the road by a large tractor. It is a convoy to Ellington. They go basically—I forget the names of the roads down there. They go to the NBL [Neutral Buoyancy Laboratory] facility in the back of Ellington Airfield, and they go across the airfield from there. There's convoy support personnel, and there was police escorts as well.

ROSS-NAZZAL: Were you part of that convoy?

SHADE: I was not part of that convoy. We have a separate transportation team that did the moves. I was there that night just to see it off, and I was at Ellington Airfield and watched it get loaded onto the plane, but I was not a direct part of the convoy.

ROSS-NAZZAL: What are your memories of her leaving? Was there any sort of relief that you had, like this stage has been complete, things went well, and happy?

SHADE: Very relieved, the sense of responsibility and the sense of ownership was overwhelming at times. It was very relieving to see it on to the next phase. It was somewhat bittersweet as well.

I had worked pretty closely with a lot of folks down there for three years, and some of those folks I wasn't going to see a lot or at least on an everyday basis if ever again in some cases. Working that long and that many hours with making an accomplishment like that, you develop some really close working relationships. A lot of people were saying goodbye that you may not see again or work with again, so it was very bittersweet.

ROSS-NAZZAL: Looking back, what do you think was your most significant contribution to this effort?

SHADE: I guess I'd like to say that my most significant contribution was my ability to work with all of the different people that were needed to accomplish those tasks, coordinate activities and set priorities, and guide the events towards the logical conclusion. I feel like that's my biggest contribution.

There was a lot of very detailed complex technical parts that had to come together, and there's subject matter experts for every one of these areas that dedicated a lot of time to their piece of hardware or to their piece of software or to their test design or procedure. Getting everyone working together as a team and keeping the process flowing and resolving conflicts, resolving issues, I guess that was my biggest role and biggest sense of accomplishment I got was the fact that we were able to all get this done together. None of us could have done it on our own, obviously. It was probably several hundred people that were involved at one point or another to get it done. I guess I was kind of a choreographer in some ways.

ROSS-NAZZAL: That's a good description of things. Was there any one significant challenge that you could point to while you were working on this effort?

SHADE: No, I guess I can't. Not one specific. I've told Mark [F.] Voyton a couple times that the biggest challenges were often getting the people working together and working toward the same end. The people issues and some of the corporate culture issues, getting different corporate cultures with one set of paperwork and another set of paperwork and different management systems—getting everyone working on the same page was the biggest challenge overall in my mind. We had a lot of smart people that could solve technical problems. It was just more getting

the team working together with each other or doing their separate parts and making sure the parts came together at the right time. That was by far the biggest challenge in my mind.

ROSS-NAZZAL: That's a good point. All these different contractors working together and then also civil servants.

SHADE: Right, and everyone coming from a different perspective on what's the most important thing, what's not the most important, or what we need to do first, or whose way of doing it [is best]. Everyone's way works, but whose way is better and whose way is not? In some ways, "This is the 'OTIS way,'" and we're going to all try to work around that.

ROSS-NAZZAL: How would you describe the "OTIS way"? I'm just curious since you mention that. Is there a way you would characterize that?

SHADE: Don't know how I would describe it. I guess we developed a way of working that worked for us. I don't know how to say [it]. We tried to use a modified Goddard system, if you will, of doing things that included, as best we could, the best practices and the requirements of everyone's individual company or organization. Certain organizations have contractual requirements to do things a certain way, and others have best practices and safety requirements. We tried to meld them all together. I guess there's really no way to describe the "OTIS way" other than it was a meld of a lot of different organizations.

ROSS-NAZZAL: That brings to mind another question. There's always competition between Centers. You're from Goddard, working at Johnson. Was there any tension between the two Centers over the test, who was in control?

SHADE: I think there was a little. I tried to stay below all that if you will and more working the real-time issues on the floor, but I think those issues worked themselves out. In some cases I believe a lot of that happened before I was involved. The chamber modification and the clean room assembly was done when I got there. A lot of those, I guess, agreements were made. I sensed some tension at times, but I think it definitely waned. I think at least at my level close to the floor and down it all melded together pretty well in the end.

ROSS-NAZZAL: I think that's all the questions I had today, but I wondered if there was anything that you wanted to talk about or any anecdotes that you wanted to share about your involvement.

SHADE: No, I guess I don't have anything to add. It was a very enjoyable part of my career, and I'm glad I did it. It was a challenge being on the road so much. I had never traveled much throughout my career. That was a challenge. But it was very rewarding, and I'm glad I did it.

ROSS-NAZZAL: You go out to California now and then and still working on the telescope?

SHADE: I do. I'm working on finishing up some tests at OTIS level before it gets mated to the spacecraft and becomes the James Webb Telescope Observatory [which] is what they call it at

the end. We're finishing up work we have to do at the OTIS level, so I'm there one or two weeks a month right now until they integrate with the spacecraft.

ROSS-NAZZAL: That's exciting.

SHADE: Yes. Still traveling, but getting a little more used to it.

ROSS-NAZZAL: Thank you so much for your time today.

SHADE: Thank you, Jennifer.

[End of interview]