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EDITED ORAL HISTORY TRANSCRIPT

JAMES TERSIGNI
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is July 12, 2018. This telephone interview with James Tersigni is being conducted at the Johnson Space Center in Houston, Texas and Albuquerque, New Mexico. The interviewer is Jennifer Ross-Nazzal, assisted by Sandra Johnson. Thanks again for joining us and agreeing to participate, we really appreciate it. I wanted to ask how you became involved with the James Webb Space Telescope.

TERSIGNI: It was back in 2013, so I was kind of a newcomer to the program. One of my colleagues, Ben [Benjamin B.] Gallagher, approached me. It was [actually] Ben Gallagher and Eric Coppock. They needed some software written for the Aft Optics Sub [Subsystem (AOS)]. Basically, they needed someone to create a system that would create stars, for lack of a better term, to simulate stars. We needed something that would create very precise amounts of light, at very precise colors, in very precise locations, for very precise periods of time.

What started out to be just a light source that was controlled by a couple switches and fiber optics, turned into probably the world's most expensive flashlight. It was quite a few years in development. We developed the system, we called it ASPA [AOS Source Plate Assembly]. It was a very sophisticated piece of software and probably one of the prettiest racks of equipment I've ever seen. We were very proud of it. Yes, I remember that's where it all started.

It started with that, and then it shipped off to Houston [to work] with pathfinder at Johnson Space Center. While it was there, I went down a few times to test it out and make sure

that we had it all working fine. We went through the [full] certification [and left it there in preparation for the arrival of JWST].

[I was then needed at the NASA Goddard Space Flight Center, Greenbelt, Maryland to assist with flight integration efforts.] We had a guy up there, Kevin Babcock. He was doing general engineering support for the entire team. That was right when the OTIS [Optical Telescope Element (OTE)/Integrated Science Instrument Module (ISIM)] backplane first showed up at Goddard. He needed some help, and I said, "You know what, I'd be happy to help."

[It] started out as general engineering support and turned into, "Okay, we've got some software that has been written that controls the mirrors. We're going to need you to take over that software." I said, "Okay, that's fine." [The software] was called MATE [Motor Actuator Test Environment]. That was an interesting phase.

It was different software. It was older software, but it was really interesting. It did some [pretty] amazing things, [but it] needed some upgrades. It needed some tweaks and additions, so I took over that. My background is actually in optics. I have a degree in laser electrooptics, and I have a second degree in photonics engineering, no software degree. So, it was kind of ironic that I fell into this role.

[Next], they said, "Well, you've got an optics background, how would you like to do some mirror integration?" I said, "Absolutely." I started working with the team in the SSDIF [Space Systems Development and Integration Facility] clean room at Goddard. We integrated all 18 [primary] mirrors plus the secondary mirror. [What an amazing experience!]

I also have a background in electronics, so they said, "Well, we've got to do some flight electronics integrations." I said, "All right, let's do it." So, I got into working with the flight electronics team, and we integrated all of the different components that control the mirrors.

Then, using the software that I had taken over, we started testing out the entire system. Each one of the mirrors has seven actuators in the back. This software controls all seven of those actuators [for each mirror], to tip or tilt, clock, or actually bow some of the mirrors so that we can do what's called phasing of the entire primary mirror segment. What that is is basically adjusting the location of each one of those 18 primary mirrors so that they all function as one large mirror.

That was a really good time, going through, working with those teams. We spent some long, long days in the clean room. Sixteen hours was not unusual to be spending in that clean room. But you got to know the team really well. I worked with people from Harris, I worked with people from Northrop [Grumman], all of Ball [Aerospace & Technologies], and NASA, of course. Just really an amazing team.

It was funny because you think about when you're working with a group of people like that, you've got a lot of people that are from different locations and different cultures. You're working long hours, and you're tired. You would expect that there would be some tension. Things are going to go wrong, but not once was there ever any tension. It was just a great group of guys and girls working together.

There were times when you had to [just] be in the clean room, because we had to have a lot of eyes on the system just paying attention to what was going on. [Occasionally], you [would have] some downtime, and one thing in the clean room is—it was kind of funny. There's never any place to sit, so [after a while], your back starts hurting. Despite all of these different things, everybody worked together. It was really a great team, I loved it.

ROSS-NAZZAL: What do you attribute that to?

TERSIGNI: [I think it was because we all had a great deal of pride in what we were doing and a tremendous level of respect for each member of the team. When things went wrong, and they did, no one ever placed blame. Instead, what you heard was "how can we help."]

The next role that I took was a position where we had to take all of these different pieces [of hardware, that each of the individual teams built, and get them to work together. This included hardware and software and it had never been done before.] Once OTIS [was] assembled, they decided, "Okay, we've got Northrop, we've got Harris, we've got Ball, we've got NASA. We've got all these different people from all over the country, and all over the world really. They've all got a different piece to the puzzle. They've all got a different piece of hardware that needs to be connected to OTIS, and it all has to work nicely together. But not only that, the different people [from different cultures with] different personalities [also] need to play well together.

Our program leader came up to me and said, "You like people. So, we're going to put you in the middle of this, and we're going to have you pull everybody together." I got into that role, where it was much less developing software and much more using software. Flight software, we had to [exercise and] shake out [any problems]. We had to connect all the different pieces together. We had to make sure the ground systems were working and communicating. We had scripts that needed to be debugged and shaken out. When something went wrong, we had to identify where the problem was [and how to fix it]. Was it with the [software, the] script, or the hardware?

This goes back to your question of "what do you attribute that to." A lot of times when you get groups of people like that together and things go wrong, you get a lot of finger pointing.

…

I think it was a general understanding that, "Things are going to go wrong, and we're going to work together and get this resolved. We're going to fix it together." When something would go wrong, I never heard any accusations. [Not even once, as I said earlier, all] I heard [was], "How can we help?" It was just a really great team of people. I don't know how to really explain it, truly.

One thing I really pride myself in is the fact that I like creating an environment where people enjoy coming to work. I think it takes a certain personality. When you're around people that are positive, when you're around people that have that energy, it's easy for that energy to spread. It takes just one person or two people to have that kind of energy to create an environment where everybody works together.

I think that's what I attribute it to. I don't attribute it to myself. I just think that there were a lot of people on that team that were very positive. The management was fantastic; all the program managers were extremely talented, just patient, I think. In a nutshell, yes, it was just a fantastic team.

That was just at Goddard, and then we moved the whole team down to Johnson. It was the same thing. We couldn't get people to leave their shifts. We were working around the clock, and you didn't want to leave. We actually had to force people to leave because they needed to be rested so that they could come to their shift the next day. It was that excitement of the next thing. If we ran into an issue, how were we going to solve it? It was really exciting. I was one of those people that refused to leave my shift. But yes, that's a long-winded story of how I got started with OTIS.

ROSS-NAZZAL: How do you start coming up with software? You mentioned the ASPA, that it was very sophisticated. But how do you come up with a plan to create stars to simulate that environment for a very small space? It's a large chamber, but it's not as infinite as space itself. How did you work that?

TERSIGNI: Yes, it was interesting. I start off with an idea. "Okay, we've got equipment that we're going to have to control." We have a concept of what we want to do, "Here's what it is." We put it all on paper. We have these requirements where we need very precise amounts of light for very short durations, milliseconds, and they have to be very precise colors.

We put all this equipment together. We know we can do it. Now all we have to do is create some kind of software that has the timing, that has the flexibility, that has the user interface that will allow us to do all these things. Not only that, [it] also has [to have] the hooks in place that will allow what we use—[Raytheon] ECLIPSE is the ground software—to command it.

It starts evolving. You start looking at documentation. You start talking to the different engineers that are going to be using the software. You start asking them questions about what they need. Because basically what software is, it's the eyes into the system. The people that are using it need to have all the knobs and controls and indicators right at their fingertips so that they can get detailed information regarding how the system is performing.

As far as controlling the system goes, creating software that will provide us with the correct amount of light in the correct locations—that's under the hood. That's easy to do. What's difficult is providing a user interface that is very intuitive and clear to the user. I think

that's where most of the work really goes, creating something that when you look at it you don't have to read a 100-page document to try and figure out how to use it.

It's a ball of clay; it's a blank canvas. You start talking to people, and you start thinking about it. You start creating something, and then you have a number of iterations. People say, "Oh, that's a neat idea. What about this?" And you start building on it. Before you know it, it evolves into this really nice package. I have a great sense of pride in creating these user interfaces because it really is parts of the people that are using it. It's their ideas. They come up with things they want, and I provide them with things that they need. It's very fulfilling.

ROSS-NAZZAL: Can you talk about the mirror integration? You mentioned some of the work that you were doing there and the long hours, but I wonder if you can elaborate a little bit more on that and what that entailed and involved.

TERSIGNI: That was a lot of fun. I don't know how much you know about this, but each one of the mirrors was shipped to Goddard in these huge stainless-steel containers, one [mirror per container]. They were purged with nitrogen and very secured. Each one of these 18 mirrors—actually 19 with the secondary mirror—were up on a mezzanine in the SSDIF clean room, and we would crane them down one by one.

We'd have a team of engineers, and we'd [also] have the NASA engineers there to run the crane. Very slowly, they would grab one of the mirrors. They'd crane it down over to this—it's like a little dolly. … Once we uncovered the stainless-steel container and exposed the mirror, we used—I forget what they call [the] big jaws [that we would use to lift the mirror]. It

was this apparatus where we would grab on to the mirror and very gently lift it up and put it on this kind of a carrier.

We'd go through and inspect each one of the mirrors. Everything was zip-tied underneath, and everything had to be very very carefully maneuvered. We had I don't know how many engineers. Engineers from Harris unbolting each one of the mirrors from their—they come shipped with a frame on the back. They very carefully [unbolted] them and then [bolted] them down to this frame.

Everything had to be torqued just right. Every zip tie that was holding the connector wires underneath had to be cut. Each one—it was amazing to watch, because you had a team of engineers watching the one engineer that was doing the cutting of one zip tie at a time. It was a very slow process. Because you can imagine, if you cut one of the wires, the process involved in getting that fixed is astronomical in cost. It would set us [way] back, so everything was done very very delicately [and carefully].

Then, once we were done unpacking each one of the mirrors, we would crane it up to the AOAS [Ambient OTE Assembly Stand]. It's one of the larger platforms. At the time we had the backplane of OTIS sitting between these two stages in the SSDIF, and it was cup-up. So, it would be, once integrated, shiny-side up. We craned each one of these mirrors up to the AOAS platform, dropped it down, and again we had a team of engineers watching every move.

When you move these things, nothing was careless. Safety was a huge emphasis on every move you made. When you're walking, we all have ground straps. The potential of tripping on something—there are things up there that if you damage, or anything touches that mirror, it would be a tremendous setback.

We all had such a sense of pride in the mirrors and an appreciation for their beauty. If you've ever been up close to one of those mirrors, which most people never have, it's the most reflective gold surface [you've ever seen]. When you look at it, it's almost dizzying. It's an awe-[inspiring] feeling, really it's glorious. I don't know how else to explain it. We handled these [mirrors] like a watchmaker, with kid gloves.

Once we got [the mirror] up on that platform, [we would attach it to] another arm called the PAIF [PMSA (Primary Mirror Segment Assembly) Alignment and Integration Fixture] arm. It was this robotic arm that hung from a crane at the top of the SSDIF ceiling. It would come down, and we would bolt [the mirror to] it. It was kind of like a claw sort of, that bolted onto the mirror. It would lift it up, and it was on its own little hexapod. It could tip and tilt, and we had coordinates for each one of the mirrors.

The location of the mirror corresponded to coordinates of its tip and tilt location, and we would very carefully drop it down one millimeter at a time until we got down and actually touched the surface of the location where it needed to go inside the backplane of OTIS. There were accelerometers [on the mirrors]—they were strain gauges—that told us how much pressure we were pushing down. We knew how much each one of the mirrors weighed, so [based on the gauge reading], we knew when we were down solid.

Then they would go in there, and they would put shims. They would put epoxy, and then they would lower the mirror and bolt it in. Then we would be done for I think 24 hours, where no one could go in the SSDIF. We could not, obviously, disturb the curing process of the epoxy once one mirror was down. You can imagine how long this took. It would take us about a day I think to get one mirror inspected, craned up, bolted, moved into location, and then epoxied in. It would take another day [for the epoxy] to cure.

We [used] laser trackers [to measure the mirror position both before and after it was integrated to the backplane]. Once bolted in, we would measure the exact location of where the mirror was sitting. The epoxy would cure, and the next day we would do more laser tracking measurements [to] make sure that nothing moved during the curing process.

It was an amazingly slow process, but it was [very] exciting. Yes, 16 hours in the clean room seems like a tremendous amount of time, and at times it could be. But there was so much going on, and there was so much excitement, that that 16 hours went by quickly. We would take breaks to go grab something to eat, and we couldn't wait to get back.

I know it sounds funny, but it [is] hard to explain to a lot of people, some of my friends, how my job really isn't [so much] a job. It's a hobby. It's that way for everyone who I was working with, the entire group, where people are excited about what they do. We get into work at 6:00 in the morning because we want to be there. It sounds insane, but it's true. That's really what we did.

We did it for all 18 mirrors and then the secondary mirror. I actually have pictures of myself with my head poking out of the location for segment 17. It looks kind of funny, looks kind of like a Whac-A-Mole. Just got my head poking out. All the other mirrors are in there, and they got me poking my head out of the location of mirror segment number 17. That's kind of a classic picture.

Yes, we were so proud when we got that done. Then it turned into, "Okay, now does it work?" You can imagine.

ROSS-NAZZAL: You mentioned you got pulled in to group people together. Why do you think that was the case?

TERSIGNI: I think it was because they needed somebody who really enjoyed working with people and knew how to navigate different types of personalities. Someone who understands that everybody wears a different hat.

I typically am probably one of the most upbeat people you're going to meet. My glass is always half-full, and I like people. It's a blessing and a curse sometimes. I think that was what our program manager saw, and she said, "We need somebody who's willing to be there, first, and somebody who can bring people together." I think that was it. I'd like to believe that I had a hand in creating an environment where people woke up in the morning and wanted to come to work.

I think she needed somebody who was going to approach it from a software perspective, too. We're trying out new flight software that had never been tested before. We're using hardware that had never been used before. We're connecting them all together, which has never been done before.

We had a lot of people that [had experience] scripting software. We didn't have somebody who was really a software engineer, and I think she needed somebody who approached things from a software process perspective. I think that had a hand in it, too. Yes, I think the combination of those two things.

I really enjoy getting people excited and approaching things from the standpoint and with the attitude of, "You know what, we've got a ton of work to do, but we're going to have a hell of a [good] time doing it." When you're in a position where you're the lead and you've got that kind of energy and you've got that kind of attitude, people tend to follow you. That energy rubs off. It does. It spreads quickly. When I'm excited, they're excited.

It's funny, when I was managing some of the guys from my group, a few people had come up to me and asked me, "How do you do it?" I don't like talking about myself like this. I did tell him, "It's a conscious choice. You get up in the morning, and you can either go one direction, or you can go the other. I choose to go the other. I can choose to either be miserable and make everyone around me miserable, or I can be excited and happy and make everyone else around me happy." That's what I do.

What makes me happy is making other people happy. That can be a compliment, it can be a joke, it could be just a smile. It could be anything, just a conversation. It doesn't take long before you find yourself surrounded by a bunch of happy people. It's the way I ran things while I was working with the group at Goddard. It was great. Everybody was happy. I can't take credit for that, but I think I had a hand. It makes me feel good.

ROSS-NAZZAL: How did the software end up working? Were there any major malfunctions or bugs that you had to really work hard at fixing?

TERSIGNI: There were some challenges. Nothing crazy though, nothing major. I think with any software, you write the software based on design and requirements. When it comes time for testing the software, you're going to have a phase of testing, which is an integration and test phase, and you're going to find issues. It's expected. It's normal.

We did find some little issues where, "Oh, we didn't think of that," or, "That was something that we didn't plan on." "Oh, okay." So, we had to make some modifications. There were other times when there are just flat, "Oh, that was a one, and it should have been a zero," or

something like that but nothing major. We had some surprises where, "Oh, we didn't handle these fault flags. Oh, okay."

It's very simple—when you get everyone together and start running the test. We see things that are happening [that shouldn't be, but] we don't quite understand [why. That's where the troubleshooting starts.] "Oh, it turns out there's a divide by zero [error]," because we didn't anticipate something happening. [With] a divide by zero, obviously everything detonates. But again, everybody came together. [When] things went wrong, we stopped. As soon as something goes wrong, everything comes to a complete halt, we all come together, and we put our heads together and figure it out.

That was flight software with the Actuator Drive Unit [ADU]. A guy named Jess Murphy [ADU flight software engineer] is the one who wrote it. What a fantastic guy. I've worked with him quite a bit, just an outstanding guy. He's very calm and very collected, very well thought out, and just really, really nice guy, and brilliant on top of it. Those things are hard to find in one package. He wrote the flight software, and Eric Coppock took over writing the flight software that's controlling the mirrors, MCS, which is the Mirror Control Software. Between those two, MCS would command the ADU software. We had times when we were commanding it improperly, or we were supposed to get responses back and the telemetry that we received was not formatted the way we thought it was going to be.

These are the different pieces that we had to deal with, and it's expected. We completely anticipated that we would see issues like this. Yes, we ran into some problems but nothing catastrophic.

ROSS-NAZZAL: What did you work on between this time and the time you came to Houston? When did you make your way down here for the testing that was going on? Did you work on OGSE [Optical Ground Support Equipment], for instance?

TERSIGNI: After Goddard, I remember flying back—there was an awful lot of documentation that had to be wrapped up. I had documentation that I wanted to finalize for the ASPA code that I had created. I wanted to make sure that we followed all the processes, and dotted our i's and crossed our t's, and got everything put into [Oracle Corp.] Agile [product lifecycle management software].

There was about, I don't know, maybe a month or so of that. That's when we started getting prepared for flying out to Houston and getting ready for the [cryogenic] test. I can't say exactly how long it was between the time I finished at Goddard and the time I started at Johnson, but it was no more than a month or so.

I remember the day that OTIS showed up at Johnson. I was watching it online, and it was quite an exciting time. We all had so much ownership in OTIS. It's our baby. We want to make sure nothing happens to her. When OTIS did arrive, it was a big news release. Of course, nobody knew when it was going to arrive. They kept that very secret; very few people knew when.

I watched the unpacking. It showed up in this huge STTARS [Space Telescope Transporter for Air, Road and Sea] container, they call it. Maybe Conrad [Wells] knows—I remember both of us laughing—what STTARS stands for. It's a big container that OTIS flies in. When they cracked that open, it was just such a good feeling. They put her onto the rollover stage, the erson stage, and it felt good. "She's there safe. Okay, now we can start our work."

Then all the teams started flying into Houston. It's like we got the band back together. For so long we were together, day in and day out. These people become your family. Then we were gone for a few months, so you missed everybody. Then the day came when we flew into Houston and were scattered about Clear Lake in different hotels, and it was just a bunch of high fives and, "All right, let's get to work." We started testing the systems and making sure that everything was working properly.

I did go down to Houston before OTIS arrived to make sure that the ASPA system was being commanded properly from ECLIPSE and all the scripts were running properly. There was quite a bit of work that had to be done there just to make sure that all the systems were working. So that was one thing I did before OTIS showed up.

But yes, when OTIS did show up it was an exciting time. Everybody hit the ground running. We started running the tests, and during pump down—when I say pump down, when we got OTIS in the chamber and close the door, we start evacuating all the air. That's pump down. Once it gets down to pressure, or down to I forget how many torr, then we start cooling down to space-like conditions. You can imagine that takes an awful long time.

During that time, we had all kinds of different things that we could do. We could run tests provided they didn't impact OTIS, didn't touch OTIS. We could run these tests, and we could test out our systems. We had a good month or so of pump down and cooldown that we could run different tests and make sure that the ground systems were talking to the EGSE [electrical ground support equipment] and the telemetry was properly represented on all the screens.

Once we were down at temperature and pressure, the fun began. We got to see if we could phase the mirrors in space-like conditions, and we could. It was the first time we saw

these things under those conditions, it was amazing. We were getting images from ASPA. It was great.

ROSS-NAZZAL: Were you here the whole time at the test, or did you come and go as the test was ongoing?

TERSIGNI: I was there pretty much for the whole test. I was actually running the MCS system, I was on the team that ran the MCS system. They call it the WSS (Wavefront Sensing System). We had a group of people that could run that software. I ran that, and we would run three shifts around the clock. Occasionally I would fly back to Denver [Colorado], but I was there [in Houston] for primarily the whole test.

ROSS-NAZZAL: Would you talk about running that system? In which part of the facility were you situated, were you with the ops [operations] team? I understand that there were three different teams, and then there was also a team over in [JSC] Building 30.

TERSIGNI: Yes, there was a team in Building 30. I think that was the analysis team. I was on the WSS team, so that was the wavefront sensing team. We had a group of people that ran the system, and we had a group of people that did the analysis on the images coming back.

Basically, the way it works is we have the wavefront sensing engineers or scientists. They come up with, "Okay, based on the images that we're getting back from ISIM, we need to move the mirrors in this way. This many microradians, this many millimeters." Clock, tilt, all

different types of directions. They come back with a recipe, if you will, "This is where we have to move the mirrors."

The MCS (Mirror Control Software) is part of the WSS software. Using the MCS we create this file, it's basically a mirror move file. It's a recipe of all the different actuators, how many steps they have to move in order to move any particular mirror in the direction and the amount that the wavefront sensing team told us we had to move it.

We create this. It's our Wavefront Control File. I think that's correct. It's funny, it's been a while. All these different acronyms, I'm trying to remember [to] use words instead of the acronyms for you so it's a little bit [clearer].

ROSS-NAZZAL: Sure, I appreciate that.

TERSIGNI: It would either spit out a SESL [Space Environment Simulation Laboratory] script or a Wavefront Control File. That file would get sent over to the ground system. They would take that, and they would crunch through it. It would send out commands to the Actuator Drive Unit on OTIS. At this time, [the ADU] was actually outside of the chamber, so commands would be sent to the Actuator Drive Unit.

The Actuator Drive Unit basically distributes those commands to the appropriate actuators on the backplane of the mirrors. It would take quite a bit of time. You're moving millimeters at a time, and depending on how many actuators you're moving, it could take either 20 minutes or hours while these actuators are moving and while we're chunking through all this script. If it's a big move, if we're moving a number of millimeters, it could take some time.

The telemetry would then get sent back [from the ADU] to the ground system, the MCS system would ingest [it] and compare it to what it thinks it should be. If it matches, we get a green light, a thumbs-up. If it doesn't match—in other words if the telemetry says the mirrors didn't move in the manner in which we commanded them—all work stops, and we have to figure out why. Then it becomes a numbers game.

You can imagine, there are thousands and thousands of numbers that we're sifting through. We built tools that would go through and help us figure out exactly what the telemetry was saying and what actually happened. Sometimes that could be a dance, because if the telemetry didn't match, we would basically call a meeting with all the board members and say, "Okay, let's put our heads together and figure out what went wrong." Then we would figure it out. We had some very talented engineers that were from the Space Telescope Science Institute [Baltimore, Maryland] that we pulled on board. We all put our heads together. We were able to figure out, "Oh okay, so this is what's happening. This is how it's behaving, this is how it's performing."

Once we understood what the telemetry was saying and how to interpret it, there were very few times when something would come up where we would scratch our heads and say, "What in the world just happened?" Once we had enough time behind the wheel, looking at how things were behaving, it became second nature. You could look at the numbers, and you knew exactly where to look and say, "Ah okay, I understand exactly what's going on."

Very complicated systems, these actuators, extremely complicated. I hope I'm not babbling too much.

ROSS-NAZZAL: No, you're not at all. Like I said, all these details are important. I know there are going to be technical papers that come out, but most people who are members of the public aren't going to download a scientific paper. So, I think these oral histories will give people a real sense of the challenges you guys faced and that things weren't just like, "Oh, real quick we just designed this space hardware and we did a quick test." That it was multiple years that it took to do all this sort of stuff. Yes, this is great.

TERSIGNI: It was years, it was years. You can imagine summers in Houston. That was a challenge in itself, the summers in Houston. Hurricane [Harvey], oh boy.

ROSS-NAZZAL: I did want to ask you about that because Conrad had sent me an article that he authored, and you seemed to be front and center in that article. I wondered if you wanted to talk about that, your pickup truck, and your role during Harvey. What happened there?

TERSIGNI: Yes, that was an interesting time. It was a scary time. It was funny because I flew to Nashville [Tennessee]. I wanted to watch the [solar] eclipse, and Nashville was going to be a perfect spot for it. I went there, and the eclipse was beautiful, unlike anything I've ever seen. I had my head in the sky. I was not [paying attention to] the weather [in Houston]. I was looking up. I had no idea there was a storm in the Gulf [of Mexico].

I flew [to Houston] out of Nashville kind of late. Whenever you fly late into Houston's [William P.] Hobby Airport you wind up with a crummy car. I knew I was going to get it. They had nothing but a [Toyota] Prius. You don't want to drive a Prius for a month in Houston, you'd get run off the road. At least that's been my experience.

I bargained with the attendant there. I said, "Is there anything you can do? Can I come back tomorrow?" He said, "No, I don't think so." I looked around, and I see this huge pickup truck. I thought, "You know what, what are the chances." He hemmed and hawed a little bit, but eventually he got me that truck. I took off in that pickup truck, not knowing what I was running into.

Went and checked into my hotel and went into work. I look up on the screen. In the control room we have all these big monitors that display all the telemetry, but one of them had the radar of the Gulf of Mexico. I looked up there, [there's a] big storm in the middle. I thought, "Well, we're going to get some rain. That's not unusual in Houston." So, I ignored it. I didn't pay any attention to it, just went on with work.

Then a few days went by and our [test] director came in and he said, "Here are some emergency procedures that we need to go over. What do we do if we lose power? How do we secure and maintain the safety and ensure the safety of OTIS if we lose power? Here are some procedures." I looked at him and I thought, "Wow."

It was Carl [A.] Reis, another amazing guy. It was Carl Reis, and it was Lee [D.] Feinberg. So, I started taking notice. I said, "Oh, okay." Before I knew it, it turned into a Category 3 hurricane and then shortly after that a Category 4 hurricane. It's headed straight for us. Everybody had their job, and everything laid out as far as safety procedures go.

Everything was laid out and organized, whose role was to do what. We had to maintain our stations. If we lost power, "This is what you do." NASA was fantastic, even when it came to providing food and air mattresses and places for people to sleep. They locked the place down. They basically said, "No, we're going to lock it down. Those of you who want to stay, stay."

I thought, "Oh, it's not going to be [that bad]." It made landfall on Saturday, I believe, down south of Galveston [Texas]. I walked out after my shift, and it was like around 8:00 at night. A little bit of rain, a little wind. I thought, "Oh, come on, this is just a bunch of news hype. No big deal, it's going to be fine. Harvey made landfall. We're not getting anything. Let's just keep working." I went back to my hotel.

About 4:30 in the morning my phone rings. One of my systems, actually ASPA, went down. ASPA actually controls some critical heaters, and we were in the process of cooling down. In cooldown, different materials cool at different rates. When you have that, you wind up with these temperature gradients. It could damage the hardware, so we have heaters on certain pieces of instrumentation so that we can control how it cools down and we don't get these temperature gradients. Those heaters went down, so I had to get in. There was no question.

I get up, and I look out the window. The rain's coming down sideways, and the trees are bending. I thought, "Oh boy, this is going to be something. Well, good thing I [have] this truck." I made a mad dash for my truck. Jump in soaking wet, laughing to myself. I had no idea what I was in for, laughing to myself thinking, "All right, well let's go fix ASPA, and then I can get back here and get to sleep."

I couldn't have been further from the truth. I take off, and there was a little bit of water on the roads. They had warned us where not to go, areas that were prone to flooding. So, I went where they said it was not prone to flooding, and apparently, they were wrong. I came over the top of this one hill, and I just plunged into this river. I thought, "Oh my Lord, I'm dead." Literally. The things that go through your head.

It's dark, my [windshield] wipers are going as fast as they can. I'm tired, I don't know the roads. Then all of a sudden, I find myself in this river, and the truck is skipping sideways. I

thought, "Oh my gosh, 'Turn around, don't drown.' Do I roll the windows down? What do I do?" I'm just panicking. I thought, "Well, I'm just going to stand on the gas and hope that I don't stall out." I managed to creep out to higher ground. I sat there. I stopped the truck, and I had to catch my breath and say, "What in the world just happened?" I gathered my thoughts a little bit and caught my breath, and then continued on down towards NASA [Road] 1.

I went to Gate 1, which is the main entrance to Johnson, and again the rain is coming down in buckets. I look, and I see something in front of me and I stop. It's a car, it's the roof of a car sticking up. Long story short, I see the roof of this car, and so I stop. It was a good thing because I would have been in the water, too. I look closer, and there's these two women walking towards me in waist-deep water. I'm thinking, "Okay, it's 5:00 in the morning. Now what in the world are these women doing?" I pull the truck as far as I could in, I helped them get some stuff out of their car. I throw it in the back of the truck and get them in the truck.

I said, "What in the world are you guys doing?" Turns out they had driven here from someplace, because there were no planes flying. They were just trying to get to their hotel, and they sunk their car, so I took them to their hotel. That was exciting. I felt like, "All right, so good thing I have this truck," again.

Then security from NASA is calling me. They're wondering if I'm safe, it's taking me too long to get to base. I said, "Gate 1's flooded." They said, "All right, go to Gate 4." It was this dance of, "Okay, how do I get to Gate 4?" Because there was so much water on all the roads. I came around, Gate 4 was jammed.

They said, "All right, go to Gate 3." To get to Gate 3 I had to drive on the wrong side of the road because [the right side] was even too deep for the truck. Oncoming traffic, that was

interesting. I think people finally realized that I knew I didn't belong on their side of the road, but I had to be.

Took me two and a half hours to get on base. Fixed ASPA, and then I went up to the control room. Lee Feinberg is up there, and of course I'm joking with him saying, "Hey, how's everybody doing? What are you guys up to? What was it like sleeping here in a bunkroom with a bunch of guys?" One of our thermal girls was telling me it was like a symphony of snoring, that was the funniest part. I thought, "Oh, you poor thing."

He said, "We've got people that have been working here double shifts. They're exhausted, can you get them out of here?" I said, "Yes, I'll get them to their hotel. Why not?" That was the thing I said, "I've got this big truck, why not?" So that turned into my job. They called me Uber Jim, I shuttled people around.

I realized these people, they need food. I would just scour the streets until I found someplace that was open, and I'd bring them food. Then people were running out of supplies. Stranded on base—you don't think when you go to work in the morning to bring a toothbrush or to bring shampoo or soap. They needed people to go shopping. When the grocery stores started opening up, I would go stand in line in the rain and wait. I'd take lists from people, and I would just go and go shopping. Then I'd go back and deliver it to everybody. There was that, there were all kinds of different things.

Lee came to me one time and he said, "Okay, so we're cooling down. We have two LN2 [liquid nitrogen] 18-wheelers that usually come in"—I think once or twice a week—"in order to keep this cooldown process going. And if we run out of LN2, then all of a sudden, it's an uncontrolled warmup, which is damaging. It can damage the hardware, so we can't have that.

We need to find a driver, we need to find a truck, and we need to find LN2. We need to see if we can get it to us, because none of the trucks are driving."

So, I went out and I would scout roads—a primary and a backup route from where the truck was located at the plant—and how we could get them to Johnson. Lee went on a mission to try and get a police escort to get a driver to the truck from Dallas [Texas]. That was exciting, it's all this stuff that was happening.

I don't think I slept at all. I would sleep for maybe an hour, and I'd get a phone call. Somebody would need a ride to or from Johnson. Lee [said], "We need to go find out if we can get people in or out of the airports, if they open." I would go find clear routes and see if I could get through with the truck. It was an adventure.

The STTARS shipping container that we shipped OTIS in was stored over at Ellington [Airport, Houston] in a hangar. We didn't know if it was damaged, I had to go find out. [A few others and] I [were] the only [people] that NASA cleared [to drive on base]. There were a few people that were doing some shuffling, people that had big trucks, that NASA cleared and said, "Okay, you're allowed to drive on base. But everyone else, if you're [here], you're going to stay [here]. If you're not here, you're not coming in, except for these few people. You're allowed to drive."

We had a lot of different things that we did. It was a very exciting time. It got to a point where the hotels around town that everyone was staying in were starting to shut down the water. No toilets, no showers, no laundry, no nothing. It was interesting, because my parent company is Ball Aerospace. As soon as corporate in Broomfield [Colorado] heard about that, that was it. They said, "That's it, you're getting out of there."

There were no planes flying, no [public] airport was open. Ellington Field [Joint Reserve Base] was open. It's an active military base, and they decided that they were going to fly the corporate jet in and get us out of there. When word got out that Ball was flying the corporate jet in and getting its engineers out because it's unsafe, everyone took notice and said, "Oh, wait a minute. We need our company to get us out of here, too." It turned into this mad dash with people trying to charter planes and get out. That was an exciting time.

I remember the day came when we were leaving. This was [shortly] after the hurricane. It was pretty much over. There was all kinds of damage everywhere. We're standing right on the tarmac waiting for the jet to taxi up to us, and it did. They open the doors, and this team of relief engineers [came] out with their arms in the air and hugs and high fives. I'm like, "Wow, this is really [incredible] that I work for a company like this."

I saw something else that I couldn't believe, and I was so proud. There was a forklift that started going towards the plane. The back door opened, and they started lifting box after box after box of supplies. Food, water, canned goods, fruit that Ball had sent. Not for Ball employees, but for everybody at NASA that was still stranded there. I just felt so proud to be working for a company that would do that.

I remember talking to everybody on the plane as we took off. We're looking down and feeling very humble. Yes, it's nice to know that we work for a company that is willing to do this, to fly us out of there and rescue us. To look down and see rooftops of houses and levees that are broken, and water just gushing over these levees—a feeling of "wow."

It was a very humbling experience. Yes, we were excited to go home, but those people down below us—we were quiet for quite some time realizing that they don't get a rescue like we

do. We're very thankful for the company that we work for that's willing to do that. The entire experience was a very humbling experience.

To go through it, it was a team-building experience. Everyone came together. It was a time when we weren't doing any work, we were just manning our stations. Somebody would have a deck of cards. I brought in a Rubik's Cube, of all things. You got to bond with people at a time when, if we were buried in work, we normally wouldn't have had the time to do that.

We bond anyway because that's just what you do when you're working with people 24 [hours a day]/7 [days a week], but it was different. We had to make sure that our systems were safe; we had to make sure that OTIS was in a safe state and protected. Other than that, we had time to talk. We had time to connect.

I think Lee mentioned in the article that we found out things about people that we normally wouldn't find out about them. Things like how someone knew how to make some kind of sauce. You could just learn more about people; you learn who they are. It's funny because it's one thing to be working 16 hours in the clean room with your coworkers, it's another thing to start living with your coworkers, if you're in lockdown basically.

Despite that, despite the enormous amount of time that people were spending elbow-to-elbow, it was a bonding experience. It was a happy experience. People were not feeling stressed out like, "Oh, get me out of here." Yes, people were tired. They wanted to get back to their hotel and get to sleep. And yes, you wanted to get home and see your kids. But all the while it was a very happy experience of being together like that. It was a bonding experience, a team-building experience. That's my long-winded story about the hurricane.

ROSS-NAZZAL: That's great. How long were you in Boulder [Colorado] before you came back to Houston?

TERSIGNI: About three days.

ROSS-NAZZAL: Three days, not much of a respite there.

TERSIGNI: No. I went back and was there for about three or four days, and then flew back into Houston. It was a challenge trying to find a hotel, because most of the hotels either were damaged, or they were filling up with people who'd lost their homes. Finding a hotel was very difficult.

I was lucky. I found [one] down in Kemah [Texas] a hotel called the Boardwalk Inn that was kind of set off by itself. Nobody knew about it. I managed to find the Boardwalk Inn, and I booked it for 40 days straight because I knew how difficult it was going to be to find a room. I had that room for 40 days. It was beautiful, right on the water.

ROSS-NAZZAL: How was your system working once you finally got to that cryogenic temperature, and you were back? How were things operating once you got back and where you needed to be to run that test?

TERSIGNI: Everything operated perfectly. It was funny, I would go down periodically to check the system and make sure [everything was okay].

Johnson is prone to leaks in the roof [of Building 32]. I don't know if you've seen pictures of the control room, but we had plastic over all the computers, and we built these tents and hoods. It was kind of a comical thing. We decorated them with all kinds of different things. Leaks were a big concern. We thought, "We can build a spacecraft that's going to see 13.5 billion light-years into the past, but we can't keep the roof from leaking," which is kind of funny.

It looked like some kind of a *MacGyver* apparatus that was over the top of ASPA. It's this Plexiglas with trenches and little metal guides. If it did leak, it was this gutter system that would direct the water someplace else. I thought, "Okay, worst case we're going to have maybe a few leaks." But the system ran just like it should.

We came back, and we hit the ground running. There were no issues. The hurricane came and went. The surrounding areas obviously were damaged, but we didn't sustain any damage at all to the systems. Everything functioned as normal. We never lost power, but we were certainly prepared if we did.

ROSS-NAZZAL: You guys were prepared. You described that system that was surrounding your hardware. Was that something that you had thought of, that there might potentially be a leak in the roof so, "We have to think about these things"?

TERSIGNI: Oh, yes. There were many different things.

Power issues were the main concern, "What happens if we lose power?" Obviously, we had backup systems and generators and UPS's [uninterruptible power supplies]. But [that] was our [main] concern, if we lost power. Water. We said, "Okay, let's make sure that we protect just in the event of any kind of a water leak," because we'd had them in the past.

It was very minor. I don't think there was much concern that we weren't prepared for any kind of event. The only thing that I—I'm sure they had something in place, but earthquake was the one thing that I wasn't concerned about. We knew hurricanes were a possibility.

ROSS-NAZZAL: Especially that time of year, for sure.

TERSIGNI: Yes.

ROSS-NAZZAL: You said things went well, there really weren't any major challenges with your system.

TERSIGNI: No, there were no major challenges. Obviously, the way telemetry would present itself might be a little bit different than what we had originally expected, but other than that—in fact that's actually something that's expected. So, there was nothing really truly unexpected, and it performed the way it was supposed to. It was a very satisfying feeling when we started getting images back and they looked correct. Everything looked great. I still have those images on my screen.

ROSS-NAZZAL: What are your memories of that last day of the test and rolling out OTIS? Were you there for those days?

TERSIGNI: I was not there when they rolled OTIS out. I actually flew out the same day OTIS flew out. I didn't watch them roll it, but that was in January of this year. Yes, it was January of this year. End of January, I think.

I remember I had flown down there. I was there for three weeks going through some different ADU [testing]. I was there with Jess Murphy, and we did some ADU testing (ADU meaning Actuator Drive Unit). We had some upgrades we had to do to the flight software before it hit the ground at Northrop in Redondo Beach [California]. We were there working for a solid three weeks getting everything done, and I remember the day we left. You walk up, when they packed OTIS into the STTARS shipping container where they covered it up, and you said your goodbyes. I knew that was the last [day] I would be working on OTIS. It was a sad time, it really was.

It was somewhat sad when we flew OTIS to Johnson. I remember taking my last walk past OTIS in the clean room [at Goddard]. I have a picture of it in fact, of me standing in front. It's only me in the clean room, and I'm standing in front of OTIS. And it's upright. So, the mirrors are pointing at me, and I'm just looking up. I remember thinking, "This is just such an amazing opportunity just to be part of the team alone, let alone to be standing next to this beautiful piece of hardware." I took one last look, and I walked away. It was a sad feeling.

I knew I was going to be back at Johnson, but the day they covered up [OTIS], it's like saying goodbye to a loved one. That STTARS container looks kind of like a coffin, too. I thought, "Oh all right, well goodbye OTIS." I knew once it gets to Northrop, we wouldn't have public access to it. There are no webcams, you won't see it.

Yes, that was a sad day. I remember flying home knowing that OTIS was flying kind of the same direction I was, northwest.

ROSS-NAZZAL: You seem like a very congenial person, very friendly. Did you have an opportunity to interact with people when OTIS was there? I know that there were many tour opportunities, lots of people at Johnson were very excited that the telescope was there.

TERSIGNI: Oh, yes. I did a bunch of tours, brought a bunch of people through. Family members, friends, especially kids. I would talk to some friends of mine back in Colorado, and I'd say, "If you have the opportunity, please come down to Houston. Bring your kids, I want to bring them through and show them."

Sometimes we forget how cool our job really is. You're doing it day in and day out, and you forget that this is pretty amazing. We get to see some things in our day that most people don't get to see in a lifetime. If there's an opportunity for me to create a spark in a kid's eyes and show them, "if this is a dream of yours, this is attainable. You can do this." And I did. A number of friends of mine would fly down with their kids, and I'd bring them through.

At Goddard they've got a huge overlook window where they bring tours through. They bring all the middle school kids through. They look down, and we're all in our clean room bunny suits. I tend to be more animated than most, which I'm sure you can probably tell by my voice. I wouldn't just stand there, I'd look up at them. They'd wave at me, and I'd wave back. I'd dance and make it fun for them. They would laugh.

A lot of times I had the opportunity to answer questions, do question and answer in these tours. They would have questions about OTIS, how it works, what it's going to do, and where it's going to go. These kids are so interested and excited. They would pull me into the tour, and I'd start answering questions.

I actually had the opportunity, after OTIS already was at Redondo Beach—I was at Goddard, because my girlfriend actually works for Goddard. There was a tour going through, and they had some questions that they didn't know how to answer. So, I stepped in, and I started answering questions. I brought them through a tour of all of Building 29, Building 7, and showed them all the different things.

It's these young college kids, and they were asking me questions: "Is it possible for someone who's a foreigner to get involved with NASA?"

I said, "Absolutely."

"Even a girl?"

"Yes, absolutely. Have you seen *Hidden Figures*?" They invited me and my girlfriend both to go do a presentation at one of the local colleges, to be an inspirational speaker to these students.

I think it's almost an obligation that we have, working at NASA facilities, to provide people with the opportunity to see some of the things that we see. To create opportunities, to say it's possible. "If this is a dream of yours, reach down, tighten your sneakers, and run like the wind. Don't let anybody stand in your way. You can do it! All you have to do is decide, and you can do it."

The look in their eyes is just this look of "Oh my gosh, yes. I guess you're right, it is possible."

I'm like, "You're darn right it's possible." My girlfriend is a success story, she's an incredible success story. She's an optical engineer. She came from a very small town in France by herself, and she worked her way up and she did it.

It is nice to be able to bring people through, interact with the different tours that come through and be that voice. I like that.

ROSS-NAZZAL: I can see where a lot of kids would be very excited after hearing from you and your girlfriend.

TERSIGNI: Yes.

ROSS-NAZZAL: Looking back, were there any lessons learned that you think are important? Especially related to software and optics, these big projects or programs?

TERSIGNI: Oh yes, there's a number of lessons learned. Some very technical lessons learned when it comes to analyzing telemetry when it comes back.

When you think you've got it figured out, think again. Make sure you double check. One thing that we would do is we would always have two people. When you're running a system, you don't have one person. You have two people. Always have two sets of eyes on everything.

When you are trying to analyze a problem, and you're looking through data and you're making calculations, you triple-check your calculations. Obviously, that's common sense. But a lot of times when you're in the middle of things and something goes wrong, you have to step back and breathe and think before you take any steps.

The lessons learned are in how we go about documenting. When something does go wrong, how do we clearly document it? So that if and when this same problem occurs, we can

identify it and react quickly and efficiently and accurately to that situation. It's the ways we go about writing up and documenting what exactly is happening. Capturing pictures, making sure that when we do revisit this, we understand fully what's going on. Because every minute counts when things go wrong. For instance, if we're moving mirrors and everything's going smoothly—it could just be a very smooth shift. Everything happens [as it should], no problems, no failed movements, everything confirms. That's great. Everybody's happy. But when something goes wrong, we have to stop work. Minutes turn into hours very quickly.

When we analyze, we [must] make absolutely certain that what we're looking at, the conclusions that we're coming up with, are indeed the correct conclusions. We have a number of people on our Failure Review Board that get involved, the scientists that created the systems get involved. We put everybody's brains in the room, and we pick through the data very methodically and make sure that what we're doing is correct. That process takes time.

Luckily, we had very few times when we lost too much time. In the very beginning there were times when we scratched our ears going, "Hmm, I'm confused." But we figured it out. Some amazing people on that team, some amazing minds. Now it's such a good feeling, because so many new friends, people that you'll know for a lifetime.

ROSS-NAZZAL: You've described some memorable moments or events. Are there any others that stand out to you that you would like to share, while you were working on the test? Obviously, Harvey—it's kind of hard to top that story—but I wondered if there were any other anecdotes.

TERSIGNI: Yes, I remember at Goddard I got stranded in one of the biggest blizzards. We had blizzards that shut down NASA, people got stranded on base. I got stranded in my hotel, and that was kind of an exciting time. I have to make the joke—and they did it twice. They did it during the blizzard, and they did it at the hurricane. The staple food product that they brought in for the people that were stranded there was chili, just Wolf Chili. I thought, "Of all things—." But it was funny.

The challenges that we had to face during those lockdown periods were bathrooms. We had one shower, and we had a sign on the door that was it's a girls' room or it's a guys' room at any particular time. You just flipped the sign, there were no locks on the doors. You had to be very considerate of who might be in there. That was kind of comical.

We made the best of it. We made the best of a very challenging situation. The blizzard was fun. I, of course, got stuck in the hotel. Power went out, stuck in the hotel for two days. I don't know about you, but I park my car, and if I don't go to my car for two days, you walk out of the hotel and you forget where you parked your car.

All the cars are covered, I mean buried, in snow. I couldn't find my car, and I don't know about you, but I don't typically travel with a shovel to dig my car out. I went to the front desk, and they gave me a little handheld whisk broom. They said, "Good luck." First the challenge was finding my car, so I'm walking around this waist-deep snow pushing the button trying to find my car, the lock button. Finally found my car, and it took me a good two or three hours to [dig it] out. That was exciting, that was fun.

There were many times we had some exciting things that we could see. I encourage anyone, if they can, get down to Space Center Houston [JSC visitor center]. Go, bring your kids, take the tours through NASA. Go visit the different astronaut training facilities, the neutral

buoyancy pool. Go learn, go take a walk through the [replica] Space Shuttle [*Independence*] that's mounted on top of the big 747 [aircraft]. They've converted that into a museum, and they've really done a phenomenal job.

I think if there's one thing I can say—and in fact I did say this. Actually [United States Senator] Ted [Rafael E.] Cruz came through one time when I was at Johnson. He came through, and everybody was looking around, afraid to talk to him. I'm not afraid to talk to anybody, so I walked right up to him. I struck up a conversation, and he started asking me about the telescope. I gave him a full dissertation. I told him how important it is that we expose our younger generations to this, our students, and we create opportunities for them to get involved in the space program. I said, "These kids are our future." I laid it on thick with Ted.

ROSS-NAZZAL: Good for you. If you looked back over your time working with Webb, was there one thing that you would point to that was your most significant challenge that you had to overcome?

TERSIGNI: Significant challenge. During the entire [time] the most significant challenge really wasn't with James Webb. It was probably the hurricane. Keeping everybody's spirits high, or at least helping keep everybody's spirits high. Challenges with OTIS—there were times we'd be working third shift. I don't know if you've ever worked third shift, or through the middle of the night, all night.

ROSS-NAZZAL: No.

TERSIGNI: Eventually you get used to it, but the first couple days it's really difficult. Me and some friends of mine, we were working in Building 29 in the control room. This was actually at Goddard. It's a 10-story building. We would run the steps to try and keep ourselves active and awake. Sometimes we would go out, and there were times when Wallops [Flight Facility, Wallops Island, Virginia] would be doing launches. We'd go out, a group of people, and we'd watch the launches.

But a challenge—gosh, the most significant challenge. I can't think of anything—the entire journey was so enjoyable. Every single day was a new adventure. We would have issues and challenges, but it's like solving a puzzle. Every day something is going to come up, whether it's facilities-related or whether it's something to do with the systems. Whether that's the ground systems or whether it's the EGSE.

We had temperature diodes that were doing some funny things, trying to figure out why. So really using your engineering skills to figure out what is going on. Looked like they were shorting, we didn't know. They were showing 10 or 15 [degrees] Kelvin high. We couldn't understand why. We knew it was wrong. That's where the engineering comes into play, we knew it was not correct. So, we're seeing inaccurate data, "How can this be?" It's going back to the manufacturer of these diodes. Going through, seeing how they're built, how they're made, doing mock-ups in a lab in Boulder. Having people try and come up and simulate or reproduce the failure mechanism that we're seeing.

And we did. It's, again, so satisfying when you figure it out. We're putting our heads together. It's a puzzle. It's a problem. "Oh my gosh, we've got to figure this out," and we did. We worked together. We put our heads together. We used the skill sets that we all have, and we figured it out. It's so gratifying when you do.

I can't really say there's any one particular challenge that was really the worst. It was a whole bunch of little things, and it was a constant exercise of your skill set. That ranged from engineering to communication. I loved it.

ROSS-NAZZAL: I have one last question for you. What do you think was your most significant contribution to the test program?

TERSIGNI: I'd have to say ASPA. ASPA would be my most significant contribution. It was something tangible. It was something that I built from the ground up, the software at least. It was a very solid piece of software. We had some issues, but I'm very proud of it. Yes, I'd have to say that the software that controlled ASPA was my most significant contribution to OTIS.

Aside from, obviously, the time that I put in with all the people and building relationships and establishing that trust between everybody. Obviously, that's a contribution. But as far as a tangible contribution, I'd have to say ASPA.

ROSS-NAZZAL: I know I sent you these questions earlier. I wanted to know is there anything else that you may have jotted down that you think we haven't covered today that you wanted to talk about?

TERSIGNI: No, I don't think so. No, I think we've covered pretty much everything.

It was one of the most iconic moments and programs I've worked on to date. Such a spectacular team, amazing piece of engineering hardware. To be part of that is a life experience. It's one of the most amazing things that we've done in our generation. To be part of that, to

think about what we're really going to be using Webb for—looking for first light, working with people that are Nobel Prize winners. John [C.] Mather—oh my gosh, what an amazing guy. To have him know me on a first-name basis is an incredible feeling.

ROSS-NAZZAL: Yes, that's cool.

TERSIGNI: The friends that I've made. It's a life experience, it's one of the most amazing things I've done.

ROSS-NAZZAL: Yes, I have to say it was pretty cool seeing it when I had the opportunity to take my family to see it. Knowing where it was going and what it would be doing, yes, it's very exciting. Kind of cool, you don't see much hardware here.

TERSIGNI: Yes, yes. You had an opportunity to bring your kids through?

ROSS-NAZZAL: Yes, I think it took us about three hours. He's five, so he was like, "Oh." I'm like, "No, trust me. It's going to be so cool, it's going to be so cool, it's going to be so worth it." I think when he's probably 10 or 11 he'll get it. But as a five-year-old it was a challenge to keep him excited about what we were going to see.

TERSIGNI: That's exactly right. "Oh look, shiny mirrors. Okay, what's next?"

ROSS-NAZZAL: Exactly, yes.

TERSIGNI: I think Space Center Houston is really good for the younger kids, to get them excited about it. Space camp, as they start getting towards the 10, 11, 12 years old. Get them into space camp, get them interested in it. It's just such an opportunity for them. I get so excited about it, I'm very passionate about doing that.

ROSS-NAZZAL: Yes, it sounds like you are. You may decide to change your career and go into more of that field at some point.

TERSIGNI: Yes, I've got some big plans for Ball Aerospace moving forward. My next program is working on the next big telescope which is coming through, which is WFIRST (Wide Field Infrared [Survey] Telescope). That's going to be at Goddard. Right now, I believe it's up in Rochester, New York. I'm not sure when it's going to be down at Goddard, believe it's going to be sometime next year it's going to get underway. That's my next program.

I'm going to be working software, but I'm also going to be working with the teams. I really enjoy working with people. I enjoy building teams. It's going to be more tours. I really enjoy working at Goddard. I love being in the middle of things; I love the excitement. I work very well under pressure. It's just exciting to me.

ROSS-NAZZAL: Thank you so much for your time today. I'm glad we were able to get some time to talk. Really appreciate it, especially since you're here and there and everywhere else.

TERSIGNI: You're welcome.

ROSS-NAZZAL: Like I said, I'll send you a copy of the transcript once it's ready, probably take about eight weeks. But if we're running later I'll let you know.

TERSIGNI: Okay, that sounds great.

ROSS-NAZZAL: All right. Good luck with it.

TERSIGNI: All right, Jen. Thank you, it was very nice talking with you.

ROSS-NAZZAL: Yes, absolutely. Have a good day, and I'll be in touch soon.

TERSIGNI: All right, sounds good, Jen. You take care.

ROSS-NAZZAL: All right, you too. Thank you, bye-bye.

TERSIGNI: Yes, you bet. Bye-bye.

[End of interview]