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TONY L. WHITMAN
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is July 5, 2018. This telephone interview with Tony Whitman is being conducted at the Johnson Space Center for the JSC Oral History Project and in Rochester, New York. The interviewer is Jennifer Ross-Nazzal. Thank you again for taking some time to talk with me this morning about the test. I wanted to start by asking how you became involved in the Jim [James] Webb Space Telescope [JWST] Program.

WHITMAN: First of all, it's a pleasure to be asked to do this interview. I'm honored to do it.

I started on JWST back in 2003, with the development of answers to early questions like "What should be tested, how can we test it, how good does the test need to be," basic questions like that. That led to continuing as a lead systems engineer for the mechanical and optical test equipment to be designed and built for the optical part of the test. This naturally led to the role of optical test director for this test down at Johnson.

ROSS-NAZZAL: How knowledgeable were you about the problems with the Hubble Space Telescope, and how did that impact designs for James Webb and then also the test?

WHITMAN: I was definitely knowledgeable of the issues with the Hubble Telescope. One of the main lessons learned was that a system-level optical test was not done with Hubble, which would have caught the problem that existed with Hubble. From my point of view, it made the whole process of justifying the test and the amount of effort needed to do the test, because we had the Hubble experience. It was easier to justify that we needed a system-level test at Johnson to make sure that optically we would not have the same problem that Hubble had.

ROSS-NAZZAL: Originally the test was supposed to be done up in Ohio at Plum Brook [Station at NASA Glenn Research Center, Cleveland]. Why did it get moved to JSC?

WHITMAN: I wasn't really involved in that decision process as far as switching locations or trading between locations. Our role was figuring out a way to make it work at Johnson, as well as Plum Brook, so that NASA could make that trade. Originally, at the time that trade was being made, the project required that the primary mirror be pointed downward for contamination reasons.

We actually came up with an elaborate elevator scheme to make Johnson work [with the primary mirror facing downward]. The telescope was originally going to roll into the chamber with the primary mirror pointed down and then lifted up on an elevator inside the chamber so that we could test the primary mirror with equipment at the bottom of the chamber. Fortunately, later, the project was able to figure out a way to make it work with the primary mirror pointing up, which made the configuration at Johnson much easier.

ROSS-NAZZAL: Were you involved in the decision to move from a cup-down to a cup-up configuration?

WHITMAN: I was only involved in the way that we illustrated the obviousness that the test configuration was far more complicated with the mirror pointing down versus mirror pointing up. That incentivized the contamination control team to assess the risk of testing with the primary mirror up versus down and also looking at installing a clean-air utility in the facility down at Johnson to make that work.

ROSS-NAZZAL: What was the potential contamination risk for having it faceup?

WHITMAN: Just the simple principle that gravity acts on particles; particles tend to fall down towards the ground. If you have the mirror surface facing up, particles from above are more likely to come down and fall on top of the mirror surface. Whereas if you have the mirror surface facing downward, then particles will have a tendency to move away from the mirror.

ROSS-NAZZAL: Would you be able to clean the mirrors easily if particles had fallen on them?

WHITMAN: The project had developed a means to clean the mirror if necessary, but in general you want to minimize operations on the mirror as much as possible so you don't risk any damage that would affect the imaging capability of the mirror.

ROSS-NAZZAL: Didn't want a second potential Hubble, I suppose.

WHITMAN: You try and design the process so that the mirror doesn't get dirty to begin with.

ROSS-NAZZAL: You work for Harris [Corp.]. Can you talk about the role that Harris played in the test?

WHITMAN: Harris had a fairly large role in the test. We were responsible for the optical test equipment. We were the lead role in the optical test equipment, as well as the mechanical equipment to hold the telescope for the optical test. We also designed and built the sunshield thermal simulator in the test and built a lot of the thermal test equipment that was in the test.

I was the optical test director. A colleague of mine, Mark Waldman, and I were the day-to-day test planners throughout the main part of the test. We supplied a lot of the people who ran the test in the control room. We supplied most of the people and processes to integrate the telescope into the mechanical test equipment, to install it in the chamber for the test, and the thermal test equipment. We covered the logistics of items going in and out of that Johnson building for the test.

So we played a fairly large role in that test. We also generated the drawing that Johnson used to understand what they needed to renovate in the chamber for the test.

ROSS-NAZZAL: I understand there hadn't been a 3D [three-dimensional] model for the SESL [Space Environment Simulation Laboratory] before.

WHITMAN: That's correct, because it was built in the early '60s. Computer models weren't available back then. It was all done by drawings. The drawings didn't match or didn't keep up with all the changes over the years, so we had to go through and check everything getting ready for the test to make sure the chamber represented what we thought it represented.

A big part of that was making sure that our platform and the telescope would fit through the door. Johnson surveyed the door location and size for us a couple times to make double sure that we knew where the door was and how big it was, so we could make sure that the telescope and the platform could fit through the door. That was a big worry later on when the telescope was about to roll into the chamber, because with the human eye down low, with such a large telescope you could not get a good perspective to see that the telescope would clear the door.

I remember getting lots of phone calls the week before the telescope was about to roll into the door with worry that it wasn't going to fit. I had to assure them, "Yes, it will fit. Yes we only have inches to spare, but it will fit." Part of my confidence was that we had a pathfinder telescope that we rolled through the door earlier and it cleared, so we had confidence it would work. And it did.

ROSS-NAZZAL: Yes, I think I've seen the video on the website, and the clearance looks very, very tight there at the end as you roll things in. You talked about modifying the SESL for the test. What changes were made to ensure that you could test the optics here in Houston?

WHITMAN: There were a lot of changes made. One big one was the helium system. [It] was installed in order to get the temperature down to 20 Kelvin, so that we could operate the telescope at its planned on-orbit operating temperature. We replaced the chamber crane system with our own lift system suited for lifting sensitive optical test equipment to the top of the chamber. As I mentioned, we added clean-room systems to keep the optics clean throughout the test, and Johnson scrubbed the chamber several times to get the inside of that chamber clean enough for an optical test.

We added custom vibration isolators between the chamber and the telescope to minimize the optical image movement and blur during the test. You can't quite simulate the vibration-free environment of space here on Earth. You have traffic traveling outside and heavy trucks adding to vibration that feeds all the way into the chamber. We had to isolate that as best we could. [The isolators were] custom because of the amount of weight involved in the mechanical platform, the optical test equipment, and the telescope. We had to basically scale up isolators to be able to hold that amount of weight and also isolate the vibration.

We added cameras on windmills that rotated inside the chamber from the walls, using a technique called photogrammetry to measure the [change in shape] of the telescope between room temperature and cryogenic temperature. We innovated and patented an optical instrument [and software] to measure the [optical quality of the] segmented primary mirror. That's just a sample of all the custom equipment that needed to be done and renovated for the test.

ROSS-NAZZAL: Talk about your role in coming up with that patented optical instrument. What was that specifically?

WHITMAN: My role personally was coming up with what the instrument had to do and how it had to do it. One of the people at Harris had to come up with the technology to do it. The effort was shared with a small company in Arizona that made an interferometer for a segmented mirror. The reason that a segmented mirror is tricky is that most interferometry instruments are looking at a monolithic mirror, so the phase [of the reflected light] changes gradually as you look across that mirror. With interferometry, you're looking at interference fringes in the image to understand the optical quality of that mirror. But with a segment, you have two mirrors that can be spaced apart from each other with a very abrupt change in phase across the edge, and you need to be able to understand the phase to well under a single wavelength of light.

Typically, we use well under a single wavelength of visible light [across a monolithic mirror]. It also has to be coherent light, so you have to use a laser to do that. The problem is that when you go across a segmented edge with an abrupt change between the two segments, you can be multiple wavelengths apart. As you know, light is a wave. If you're two waves apart between the two segments, that can look the same as only one wave apart between the two segments, because the wave repeats itself. You have to come up with a scheme of using more than one laser and using the [beat] frequency between those two laser [wavelengths] to be able to effectively come up with a longer wavelength. In other words, using one laser you can only tell if the spacing is less than one wavelength apart.

But if you have two lasers, then you're looking at the combination of the phase between those two lasers. You can set the wavelength such that there's only one spacing that can show the same phase between both lasers, that's how you get an effective longer wavelength. We can add one laser that adjusts its wavelength, so we can check at multiple different wavelengths to see exactly what the spacing is across that edge.

Traditionally the optics in front of the interferometer is designed for a single wavelength, so we had to come up with a design that was just as precise over multiple wavelengths. That was the part that was patented. One of my colleagues here at Harris came up with an optical design where the quality was just as good over multiple wavelengths.

What the optics do in front of the interferometer is convert the parabolic [primary] mirror into a spherical shape, which an interferometer can then measure. We call it a null lens. This null lens had low distortion across multiple wavelengths and low color aberrations across multiple wavelengths.

There were a lot of other challenges that we had to deal with. Typically, interferometer systems are in a lab environment, room-temperature environment. The glass mirrors and components of an interferometer system are designed to be warm, and we had to stick this inside of a chamber that was at cryogenic temperatures.

We actually had a very elaborate thermal cocoon, if you will, around the interferometer system, with an opening at the bottom looking down onto the primary mirror. We put a thermal shutter over that opening so we could isolate the room-temperature heat coming out of that opening when [necessary] during the test and also open up the shutter to take measurements during the test. And still meet the precision that room-temperature interferometers typically perform.

ROSS-NAZZAL: How long did it take to come up with this single instrument? I know it took many years to prep for this test, but this single instrument, how long did it take?

WHITMAN: I would say it started in early 2000s, late ’90s, because when I came on board NASA was already doing technology development with the small company in Arizona to come up with an interferometer that can use multiple wavelengths. When I came on board we had to figure out how to do the null lens. We also had to take the work that was done and make it far more reliable so it could last through multiple practice tests and multiple months during the Webb test.

We also pushed the company to come up with a fiber-optic solution, because the lasers that were being used didn’t have the reliability needed for such a long test. We wanted to be able to swap out spare lasers if necessary from outside the chamber, so we worked with them to come up with a fiber-optic method to deliver the laser light down into the interferometer for the chamber.

How long? It started before I started in ’03 coming up with the technology for the interferometer itself, and we worked on the lens and had that design done by something like 2007. I would have to look up the dates, but I want to say we started integrating the interferometer system around 2011 and going through all kinds of tests to make sure that all the new ideas worked. Then we had to have it installed for all the early practice tests.

ROSS-NAZZAL: Did you relocate to Houston for a time as the SESL was being refurbished? Or were you monitoring all of these changes from Rochester?

WHITMAN: I relocated to Houston for all the practice tests and for the Webb test itself. Leading up to that it was mostly monitoring from afar, with many visits down at Johnson to work with integrating [the test equipment] into the chamber and building it up.

ROSS-NAZZAL: You mentioned the importance of the pathfinder. I wonder if you can talk about your role in the optical tests that were done with the pathfinder. I understand that there were two, and then there was a thermal test, but there were also some optical tests during that run. Can you talk about those and your involvement?

WHITMAN: Yes, it actually even started earlier than that. There were a couple of functional tests on the chamber itself after the renovations were done. I wasn’t very involved in those, other than monitoring and understanding how the chamber was responding to the renovations. After that we installed our mechanical hardware that was holding this interferometer system, as well as [the first of three] large test mirrors that were going to be held at the top of the chamber over the Webb. We did a qualification test with that at cryo [cryogenic temperatures] early on.

Then, after that test, we completed installation of all the optical and mechanical test equipment and ran what we called the commissioning test. We had a chance to run through the motions of our optical and mechanical test equipment to make sure they worked at cryo temperatures and also that they moved to the right position going from room temperature to cryogenic vacuum.

Then we brought the pathfinder in and tested with that, qualified that. Because our intention was to follow that with putting the actual flight tertiary mirror, otherwise known as the Aft Optics [Subsystem] module, onto the pathfinder and run the full gamut of optical tests with that.

My role was organizing the optical test team to get ready for all those tests and also organize the team for running the [optical] test equipment for those tests. Getting everyone to think through how the test was going to be done, think through the procedures, writing all the plans [and procedures] down, organizing the logistics of running the [optical] tests, organizing the control room [for the optical test support]. I had a lead role in all that effort. Also planning the tests and doing the day-to-day planning of those tests, leading up to the Webb test itself.

ROSS-NAZZAL: Was there anything unusual about your role or this type of test, compared to say other telescope tests that you may have been involved in? Or was this pretty standard? "These are the steps we need to take, and we need to make sure we check these boxes before we have the actual test of the Jim Webb Telescope?"

WHITMAN: This definitely had an aspect of—or at least to me it felt like a type of test that had never been done before. We certainly borrowed as many aspects as we could from previous tests and methodologies, but there were many differences, one being that we hadn't tested a segmented telescope. Very few of us had had any cryogenic experience. We were also working with a team of people that were new to testing, new to the experience.

We were working with a team that was spread across not only our nation but working with Canadians and Europeans as well for this test. There are federal restrictions working with our international partners that we had to work our way through to make that work. We had people from different companies as well as different parts of NASA; we had people from academia. It was a process of coordinating a very diverse group, leading them all into one direction, and getting us all working on the same plan and having a broad distribution of expertise scheduled throughout the test so we were always prepared if there were any issues.

ROSS-NAZZAL: Were there any challenges working with such a diverse group of people that you recall that you really had to think outside the box?

WHITMAN: We certainly had to think outside the box to [accomplish the goal while meeting] the [federal] restrictions [working] with international people. The rest of the challenges I think are typical of working with a broad group of smart, innovative people. I don't think that was unusual compared to any large group of engineers and scientists and technicians.

ROSS-NAZZAL: Do you have any recollections of the day the Webb finally arrived here in Houston?

WHITMAN: I wasn't actually in Houston when it arrived. I had been working with the hardware at [NASA] Goddard [Space Flight Center, Greenbelt, Maryland] previously. But when the hardware arrived at Johnson, I knew the clock started ticking on when everything had to be set for the test. We were very busy putting the final touches on our plans for the test at that point, but it was definitely a thrill to see years and years of development and planning end up with actual hardware showing up onsite. Basically a feeling of, "Here we go!"

ROSS-NAZZAL: When did you finally get a chance to make it down to Houston?

WHITMAN: The whole process of transitioning the telescope from shipping to getting it installed in the chamber was about two months long, so I was down there for the second month. By that point, the integration team needed to coordinate with the test team. We needed to start checking out test equipment as it was getting installed. I was down there coordinating with that and getting the final procedures in place.

ROSS-NAZZAL: Would you talk about the test itself? What were your hours like, what shifts did you normally work? Were there any memorable moments or events that took place over the course of the test? [Hurricane] Harvey obviously being one of them, but I wonder if there are others.

WHITMAN: As I said, there were two of us whose responsibility was the day-to-day planning. There were plenty of chiefs, if you will, during the day shift. So I had my colleague do the day shift with them, and I did the late-night shift when there were less chiefs around to make sure things went smoothly through the night.

Typically, we had a tagup meeting with all the leads at roughly 3:30 every afternoon. I would get in for that, or call in as I was getting in around that time, and then I would end up staying there till typically about 2:00 in the morning, but sometimes it went longer than that. It was definitely my 40 days and 40 nights, because I was there at least that long every single day without a day off. It was very challenging from that aspect, from a personal fatigue aspect, but it was also a thrill working with that team. There was a very strong enthusiastic team atmosphere, and it was great to work with a bunch of very knowledgeable people who were experts in their areas and coordinating working with lots of experts together to make it all happen. It was definitely exciting and thrilling and exhausting all at the same time.

The test itself went very well. I was very pleasantly surprised. You, of course, go into these things planning for the worst and hoping for the best. The test went extremely well, so that was a huge relief. There were challenges of course.

We talked about getting the interferometer system, developing that for this test. This test was the first time that we had operated in this particular configuration over 18 mirrors and getting all 18 mirrors stacked up in such a precise fashion. The pathfinder only had two mirrors. We worked on an 18-segmented mirror system in the lab before that, but those mirrors were not polished and controlled as precisely as the Webb was.

We had to do it for real this time. There were still some processes, data analyses, creativity involved in making all of that work in the time needed. We anticipated this, and planned to do as much practicing while we were waiting for the telescope to cool down. Which we did, but it was still interesting to make it all work and be confident that what we were seeing was correct in the end. So there was that fun challenge.

It was also great watching the hardware work in this environment. We of course went into the test with our expectations—or I should say perfect locations or perfect outcomes for various test measurements and images that we were taking, knowing full well that tests are never perfect. There were many times over when we took our first image or took a first measurement and it was very close to exactly matching what we expected. That was amazing in and of itself, that with this huge telescope and all the uncertainties that we knew about, given all our analysis coming into the test on where we think things should be, but also how far off they might be, and turning out that everything was very close to right where we expected. That was great; it was great seeing that.

There was always a crowd. I remember the crowd waiting for the first image to come across in an instrument. There was a whole chain of events [across multiple teams] that had to work to [get that image]. You had to make sure that the optical source was working. You had to make sure the source was lined up correctly relative to where the instrument was located. The telescope alignment relative to the instrument had to be correct, the timing of the signals had to be correct.

The whole processing of the image data, that whole process had to work. We had the people there to make it work if we had issues. We quickly had that first image, and it was great to see that everything was working the first time. Everybody was thrilled to see an actual image through the whole hardware system finally, after all these years of thinking through it.

ROSS-NAZZAL: I imagine that was very exciting for everyone to see that happen.

WHITMAN: That experience carried throughout the test whenever we were doing something for the first time and knew all the things that had to happen correctly to make that happen. Having that feeling of excitement and relief that it actually happened as planned and the hardware was in really good shape.

ROSS-NAZZAL: You mentioned something I wanted to go back to. You said that there was some creativity involved in making all this work. Was there any creativity on your part as the test was ongoing, and an issue came up that you had to come up with a new plan on the fly?

WHITMAN: We were constantly optimizing. We had many things happening in parallel in order to meet the schedule of the test and get as much testing done as we could in the amount of time we had. There was a lot of time spent talking to the various experts there. As we found issues, you had to work around them and figure out alternative ways to make the test progress efficiently. But at the same time, you couldn’t be overly creative because there was a lot of thought going into the test. There was a lot of careful thought going into the test. You wanted to make sure you didn’t forget something or take any shortcuts. You had to maintain the integrity of the test, while also coming up with ways to either work around issues or ways to make things more efficient.

ROSS-NAZZAL: How many people were on the operations team as you were doing the test?

WHITMAN: Let's see. In the test room there were I would say easily 20 people in there, three shifts a day. That was just our test room. The facility [room] had about another five people, the instruments' [room] had about another six or seven people. Plus some other experts just there in the background to help out, although the experts wouldn't need to do three shifts. Let's say 30 per shift, three shifts. It was about 90 people, plus some other managers and experts that were in the background, so about 100 people a day involved. There were more people than that involved, because we were rotating people on location to help keep bodies and minds fresh throughout the test.

ROSS-NAZZAL: Except for you, you got to stay for a very long time, you said.

WHITMAN: Yes, my colleague Mark Waldman and I—he and I had the best grasp of all the details across all the disciplines, so we had to be there for a good chunk of the test to make sure things went smoothly and efficiently. We didn't have to be there for the whole three months fortunately, but I know I was there over 40 days anyway.

ROSS-NAZZAL: I wanted to ask you about Hurricane Harvey, which hit as I understand it really when you hit the cryogenic temperatures that you were looking for. Can you talk about the impact of Harvey on the test and your personal experience?

WHITMAN: From a test efficiency point of view, we actually only lost one day. The first day was tough. I happened to be on shift when it struck and ended up doing close to a 24-hour shift that day. We spent a lot of time running around, kind of like plugging holes in the dikes in the Netherlands. We were running around, running triage on water leaks in the old building, protecting the equipment outside of the chamber that was running the test.

We needed the first day to think through organizing the people and organizing how we were going to operate during the hurricane. Lee [D.] Feinberg led that whole effort, and he was excellent at that effort, leading all of us. We had to shift gears. We first went into basically safety mode, just make sure the hardware was safe, reorganizing personnel because it was too dangerous to travel at night, so we changed to 12-hours shifts.

We had the Johnson meteorologists involved, who would give us a forecast of when there would be a break in the bands of rain passing through, and then we'd set up a shift change time. People would carpool in trucks and SUVs [sport-utility vehicles] and come in for the shift change. Once people arrived, then the people who were already there could then leave and go back to their place of sleep.

We definitely shifted to a mode of monitoring. But after we realized things were stable, the building was shored up at that point, we could resume some optical testing. We ran some tests that could be run given the situation, so that started up again in a fairly quick manner.

We got to the point where food became scarce. We knew Johnson had MREs [Meals Ready to Eat], so we weren't in any kind of starvation danger, but we were told that the MREs weren't all that appetizing, so another guy and I went out scouting for food. All the restaurants had closed except for the Waffle House, we discovered, and all the grocery stores had closed except for a small one that we found that was still open. A bunch of us went in there. The only thing that was left was expensive food. Gourmet tuna, glass jars of fruit that were like $6 apiece, bacon-wrapped pork, stuff like that. At that point we wanted to make sure we had some good food to eat, so we bought it and stocked up. That was one of the challenges.

Many of the people worked 12-hour shifts for seven days straight, so we had to be careful with fatiguing people. We had to rearrange tests to take advantage of the time we had until operations were back to more normal [when] we could get back to three shifts a day and having the full team travel in, instead of just essential team members.

ROSS-NAZZAL: Did you spend the entire time of the hurricane in Building 32, or did you have the opportunity to go back and forth between your hotel?

WHITMAN: I had the opportunity to go back and forth. Actually, personally, I was not critical for running the safety of the hardware since I was more involved in the optical testing, which was more optional from a safety point of view. I was staying at a hotel during that time. I could do what I can from the hotel, which is why I was one of the ones who was available to go scouting for food and road conditions for the people who did have to get into Building 32 to keep the hardware safe during the hurricane.

ROSS-NAZZAL: Quite a memorable event in the midst of this unique test, I'm sure.

WHITMAN: Yes, I was in a hotel that served breakfast. After a while they had to get creative with the breakfast, I remember one breakfast was just a bowl of salad for us to eat.

ROSS-NAZZAL: A bowl of salad? Oh, wow.

WHITMAN: Yes.

ROSS-NAZZAL: Just what you wanted for breakfast, that's funny. You stayed until the last day of the test? Or when did you end up leaving Houston?

WHITMAN: Where we had breaks was when we were waiting for things to happen, when we were waiting for the telescope to evolve thermally to the point where we could run optical tests. I was there for most of the first six weeks of the test, I'll say. I guess it was longer than that, I guess the first two months of the test. By then we were done with most of the optical testing. We were in a thermal balance mode, so at that point the telescope was just sitting and waiting to reach the point where it stopped changing thermally. The planning was not so complex day-to-day anymore. We weren't doing things in parallel. We weren't running both a thermal team and an optical team and other teams simultaneously at that point.

It was mainly the thermal team running the show at that point, and the procedure was fairly straightforward. We were able to leave and just help out from the planning remotely. After that thermal balance was the warmup. We had basically just one optical test to run during the warmup, and a few other mechanisms tests, which was well-procedurized and somewhat simple, so we could [organize] that remotely as well. We also had test directors well-trained in the tools that we used to do the day-to-day planning, so other people could run the local day-to-day operations with confidence at that point. That helped us not have to be there for the full three-month duration of the test.

ROSS-NAZZAL: Did you have to go back down to Houston at all? Have you been back?

WHITMAN: No, actually not. Because the data reviews that we had following the test were not at Houston. So no, I didn't need to go back. I actually moved on to another project as soon as I returned to Harris. I had a whole weekend off before I had to hit the ground running on another project.

ROSS-NAZZAL: Another telescope project?

WHITMAN: Another NASA telescope project, yes.

ROSS-NAZZAL: That's exciting. I wonder, if you could look back over the time you were working on this test—even before there was a pathfinder or a telescope at the SESL—what your biggest challenge was.

WHITMAN: I don't think there was a single challenge. I think there were many challenges over the years. Early on when we came up with what the test had to do and how well it had to test, the numbers we came up with were very challenging, and we had to figure out how to meet those numbers. There was a lot of effort to come up with a test that we knew could succeed. A lot of effort convincing others that the test could succeed, the constant challenge of meeting cost and schedule.

Even though I'd been on the program for 15 years—most of those years getting ready for the test—throughout the years I don't think there was a single day that went by where I didn't feel behind, or felt like the test was coming faster than we felt comfortable with. Each phase had its different challenges. The early-on phases were coming up with the plan for the test, convincing the community that it was the right way to do the test, and that we would be able to meet the numbers that we came up with that the test had to meet. Then the big chunk of the phase after that [was] designing and developing and building the test equipment for the test. How good the test equipment had to be, and how the test equipment had to meet what it needed to do, while also being inside a chamber that we had no access for three months [during the Webb test].

One of the big challenges is that it was a three-month test, and there's no way you could stop in the middle of the test and just open the door to go in and fix something. We had to be very careful with our plans leading up to the test to make sure everything was put together in such a way that we had high confidence that it would work at the environment that we couldn't easily test at room temperature and also work for three months without any reliability issues.

There was a lot of paperwork involved. Paperwork is probably the least favorite thing for engineers to do. It was a challenge providing incentive to get that paperwork done before the test started. I would say there were constant challenges throughout the program. It would be hard to come up with one single one.

ROSS-NAZZAL: Sure, it sounds like it. Do you think that you could define or explain your most significant contribution to the test?

WHITMAN: I would guess my most significant was organizing the technical team to be ready by the time the test started and also to be prepared so that everyone was comfortable and efficient while we ran the test. I think my contribution was my organizational capabilities leading up to the test.

ROSS-NAZZAL: Are there any important lessons learned from the test that you think would be important for others to consider when they are working on tests of future space telescopes?

WHITMAN: It was definitely noticeable, the advantage we had of being well-planned for the test. Never underestimate the value of being well-planned heading into the test and also well practiced heading into the test. It was clear that the test was a success because of all the practice that we had and all the planning that we had.

ROSS-NAZZAL: Is there anything else that you wanted to talk about? Any of your experiences, things that we might have not covered or overlooked?

WHITMAN: I can't think of anything big to add on.

ROSS-NAZZAL: Before we go, I did want to ask you—are there other people you think that we should consider talking to?

WHITMAN: Mark Waldman would be a good one if he wasn't on your list.

ROSS-NAZZAL: I don't think his name is on the list, no.

WHITMAN: I was more involved with the test side. I certainly put the [very] early conceptual [order of events] together for integrating the telescope into the chamber and de-integrating the telescope coming out of the chamber. But there [was a large team that organized and detailed that operation. There are] people much closer to that day-to-day effort, which was also a very—I won't say heroic effort, but it was a lot of hard work as well.

One person you could talk to is Tom [Thomas R.] Scorse, who's also here at Harris. Ed [Edward L.] Shade may be another person, who's at Goddard. I don't know if Carl [A.] Reis was on your list, I'm sure he has stories.

ROSS-NAZZAL: His name doesn't sound familiar. Tom Scorse, we have invited him.

WHITMAN: Carl Reis was the lead test director for the test. He works for Goddard now, but he used to work for Johnson.

ROSS-NAZZAL: All right, thank you very much for your time today. I appreciate you letting us run over a little bit this morning.

WHITMAN: You're welcome.

ROSS-NAZZAL: Have a great weekend and thank you again. Enjoy your next telescope project.

WHITMAN: All right, thank you again for this opportunity. Have a good weekend.

ROSS-NAZZAL: You too.

[End of interview]