JOHNSON SPACE CENTER ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

LISA M. REED
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is August 7, 2015. This interview with Lisa Reed is being conducted in Houston, Texas, for the JSC Oral History Project. The interviewer is Jennifer Ross-Nazzal. Thanks again for battling potholes and traffic to come down here.

REED: That was something. That was a first.

ROSS-NAZZAL: I thought potholes around here were bad; that's really bad. So, we wanted to talk a little bit about how your work on the CAIB [*Columbia* Accident Investigation Board] changed things on the NASA side for crews and other folks.

REED: Well, I think there were effects of what I did, and then just overall how that whole event changed, in my opinion, the Shuttle program. One of the big things in doing the training investigation that I recommended, because obviously in an investigation you're there to document what happened, analyze it, and then make recommendations or findings. One of the findings that came out of that was that the training, number one, was really good for the operators, for the folks actually sitting on console or technicians that needed to be preparing the vehicles or launch controllers. The crews were trained, and in the case of [STS]-107, more than trained, because they had several slips that extended their training period for years. So everyone was trained well.

What came to light in the investigation that I discovered was that the mission management team didn't really follow the same process for doing their mission management team simulations. If anything, they were doing them, which is a good thing. You have to realize the mission management team has the managers from NASA and the Shuttle program, various managers from the contractors that are involved, so they are called in if something happens outside of the flight rules or outside of the normal procedures that would be handled inside of the Mission Control Center [MCC] by the flight director and his team, working with the crew onboard. What happened on *Columbia* qualified, because we couldn't quite identify what needed to be done with that foam hit or anything like that.

In looking at the training records for the mission management team, I noticed that they actually drove their own training, determined what it was they needed to sim, and in some cases the actual simulation objectives and the malfunctions that were going to be thrown at them were sent around prior to actually doing the sim, and that's almost like having the script and knowing what's coming. So that was one of the things that they changed afterwards. They were a little more robust with the mission management team training. That recommendation was obviously handed to the folks in the training division, and they began to run more, I guess what I would call normal sims, where you come in and you know the scenario, for example an on-orbit case. Here's what's going on, but you don't know what they're going to throw at you, because that shows your hand. In other words, and they would have time to prepare how they would act instead of just reacting. That was one of the things that changed.

The effect of the *Columbia* accident and the CAIB report in general, when I look back on it now, signaled the end for the Shuttle program. We did return to flight, and it was very successful. NASA met the recommendations, but when you look at it, it forced the hand of

President [George W.] Bush at the time. One of the recommendations and one of the findings was, what is your future, NASA? The Shuttle is going to end someday, but continuing to rely on it without having another program in place to pick up where it leaves [off], you need to start developing that now. You need to know where we're going next.

That began a series of, I guess, studies and working groups, and the first thing that came out was that President Bush, I think in January of 2004, came out with his plan, and one of those things was to retire the Shuttle by, I believe at 2010. That's probably in the documentation somewhere; I'm going purely by memory. It put a mark in the sand, where the Shuttle was going to end, complete the Space Station build, and then let's retire the Shuttle. [It] started what ultimately became the Constellation program.

So in looking back, the Shuttle, I think, could have gone on longer. I have mixed emotions both ways. It was sad to see it go, but when I look now, where we're at, here in 2015, we don't have American access to space for our humans. I think that's sad. I really wish that they had been able to continue on with that and build Constellation. I know they're working on Orion; I happened to be down for the first test launch back last December, that was so exciting, and wishing them very well. I hope we get some access to space very soon for our American and international partners.

ROSS-NAZZAL: Yes, especially given what was just announced the other day.

REED: Yes, yesterday Charlie [Charles F.] Bolden, his hand was forced. He had to sign an agreement, again, to pay for our folks to go up on Russian vehicles. It just takes away some of the flexibility we have, and I'd just really like to see America get back in space from the human

perspective. I know we've got people in the Space Station, don't get me wrong. I know we have Americans in space, but from Earth to space I'd like to see us have that capability real soon, sooner rather than later.

ROSS-NAZZAL: The launch capability.

REED: The launch capability, yes. Access to space is what the DoD [Department of Defense] calls it. I'd like to see assured access to space, from the civil side.

ROSS-NAZZAL: You mentioned you were down in Florida, you got to see that Exploration flight test.

REED: Yes, and it was like old home week. You just run into so many people that you knew from various programs all through the career, and it's interesting to realize that however many people are working in the space program, it's still a small community, if you will. It's really a very small community, of thousands, but it's amazing the number of people you run into that you've known for decades that are doing this. I think there's another one next year, in 2016, 2017. Depending on how it goes, the second flight test will be coming, so that was exciting.

I'll tell you what that told me, though. I was so proud of that team, because leading up to it, there had been a couple of high-profile launch failures of some of what they're calling the commercial crew partners. We've always worked with commercial businesses, they're as much part of the space program as NASA, because they've been the industry engines behind building all those pieces, putting them together, testing them along with NASA. NASA still knows how

to do this, in my opinion, better than most people because we have a lot of experience. So it's not easy, and I think, on some account, NASA did so well at it that it seems easier. Launching rockets will never be easy. And it just shows that the rigor behind the process and what the people in the human spaceflight industry do, they're very good at that, and we've got some of the best in the world doing this. So, onward and upward. I hope those guys do well next time.

ROSS-NAZZAL: I think we're all hoping for that. Last time we talked, you were working for that company in Colorado, and then I read on your resume that you did some work for Constellation. Were you still working for that company?

REED: It was a large strategy technology consulting firm, and their headquarters is based in Washington, DC, but they were in Colorado Springs because they supported the DoD side of space. The DoD launches unmanned vehicles and satellites and all these other things, so it was a similar fit. They were also looking to grow some of their NASA business at the time, because it was understood that things would be coming down the pike as far as new programs and whatnot. So there was a hope there, and it's one of the reasons that they hired me, because of my human spaceflight background. I went in there initially working some of the DoD missions that were starting up; this company had a lot of systems engineering contracts that were let by the Department of Defense.

The professional organization ICSE [International Council on Systems Engineering] for systems engineering, they have training as part of the specialty engineering class, or processes. So I was typically tagged to help them determine training requirements for operators that would sit in their control rooms, helping to design, or give the requirements for simulators working with

those DoD counterparts, very similar to what I did over here. There were no humans on their vehicles.

After *Columbia*, then there was a contract let a couple of years later from NASA for the Constellation program, and that company that I was working for won the systems engineering contract for that. It was headquartered here at JSC, for obvious reasons, because it was a human program, a manned program. So I continued to work mostly DoD, but being a consultant you can get assigned different things. From Colorado Springs I began to help the company's office [in Houston], because that was the company I worked for, here in Houston. If they needed a particular expertise for some of the things that they were developing in Mission Operations, they might call me. So I would work remotely from Colorado Springs and fly down here if I needed to. That's how I got back to NASA [work], if you will.

After a few years in Colorado Springs, I started thinking about coming home, because my folks were getting older and I wanted to be here. My dad was sick, so I just wanted to move closer. So I asked if they had a full-time position, if you will, for me to come back down here. As it turned out, things were really heating up from the Mission Operations perspective, as far as planning and writing some of the planning documents that they were supporting NASA in doing that had to do with training. So they said, "Absolutely, come on down." So in 2007 I ended up moving back to Houston, back down here to Clear Lake, and working over at NASA on the Constellation program.

I was specifically focused on working with the Mission Operations folks on their test and verification plans for Mission Operations product deliverables. Some of those would be simulators, some of those would be trainers, and also helping them in talking about the approaches to that. The NASA folks obviously had an idea. We would sit, and we were their

contractors that helped advise them on some things. That's what I worked on until the program was canceled, so I continued to work at more of the DoD things, and then those got canceled. This was probably 2008/2009 time frame. My company, I was also beginning to work commercial crew. They had a contract at JSC for the commercial crew, working in the program office there in supporting them, integrating, and helping them work with their actual partners who were developing the plans and programs for these vehicles.

So I worked that for a while, and then the commercial crew program was transitioned down to KSC [Kennedy Space Center, Florida], so we worked with setting up and helping that team at KSC. At the time I think it was Ed [Edward J.] Mango and his team, by briefing them on all the industry partners, because we had been working with all of them on behalf of NASA, so we had to get understanding of what those companies did. I'm going to call it, and this is probably the wrong term, but I'm going to call it a boot camp, with a five-day, get everybody that was in that office briefed on the different partners and where NASA was to date in the commercial crew program.

Shortly thereafter, I just started thinking about moving on to a different industry, because it was uncertain if that program was going to continue and what kind of funding it would have. Funding was just getting cut, cut, cut, and I thought, "Hmm." There were layoffs at my company, there were layoffs at other companies out here, and I just thought it might be time to move to another industry, if I could find a job. I didn't want to do that, because I was actually very excited, for example, working on Constellation. I got to work with a lot of new folks, and even a lot of new NASA folks, and I was happy to be able to bring the expertise I had from my years of working in the Shuttle program and early Station to some of these newer NASA hires as well as new systems engineers that were working for my company, helping them think through

and not have to learn some of the lessons that we did because we didn't know. I was just really very, very psyched to be doing that and enjoyed it immensely, so I was very sorry to see that go away. That was fun.

ROSS-NAZZAL: Constellation was pretty young at the time you were working on it. I mean, it had just pretty much been on the drawing board.

REED: Yes, I think they awarded the contract to my company in 2005, I think it was actually awarded in 2005, could've been—no, I think it was 2005. Anyway, I didn't start working it till about 2006, and I think it was canceled, was it 2008?

ROSS-NAZZAL: 2010.

REED: Ten, 2010, yes, okay, that's right. The administration changed because the election was in late 2008. So it was a better year after they actually came in and took over.

ROSS-NAZZAL: So how did you come up with these plans? We didn't have much on the drawing board at that point.

REED: Mission Operations is working with the engineering folks and all the other folks that are responsible when we're developing a new program, what is it going to be. We knew what the vehicle was going to be. A little bit nebulous at that time, you didn't know exactly how things were going to work, but you could begin to have a high level of understanding of how that

vehicle worked, how many crew members are going to fly on it at the time. You always live with uncertainty when things are being developed, but you did the best you could. We were really focused on, once they do get ready to fly that thing, we need to back up our timeline and have a plan of how we're going to do the flight tests, for example, like they're doing with Orion right now. You can't just decide, when they say, "Oh, we're ready," go do a flight test. You need to understand that it's years of preparation. The Mission Operations people have got to think about, "Okay, we're going to have mission controllers sitting on console for that flight test. At some point we're going to have a crewed flight test, there will be a crew onboard. What training do we need to do? What documents and procedures and roles and everything do we need to create?" You know, all the stuff you would need to fly. That takes a while to work through and develop. That's the kind of stuff we were working on.

If you're going to train people, then you have to think what artifacts and what trainers, meaning buildings, what brick-and-mortar things do we need, what software needs to be developed? All of those things. So that's the planning I'm talking about that Mission Ops would be doing, and that's who I was supporting, Mission Operations. Again, backing this timeline up a couple of years, if contracts need to be let for somebody to build that thing or if people need to be hired, then you have to decide, once you're deciding all that, how are we going to train them. You need to look at what are the requirements of the flight test, because somebody's written them and they've handed them to you. So that drives what you need to train the crew and the mission controllers on. You look at how much automation they've built into the vehicle, and what will the crew actually be doing, what will they be monitoring, for lack of a better word. A lot of things are automated, and it's a matter of they don't react unless there's an anomaly of some sort. Those were the plans that we were putting together.

And then, after you decide all that, you don't want the first time that you use the simulator, if you will, that you're going to train all these people on, or the software in the Mission Control, it would have to be new software, it's a new vehicle. How's that going to integrate with the Mission Control Center, all of that requires testing. So that was what we were putting together, the test and the verification plan, to say, "Yea verily, we're ready." And then we were deciding at what time before this first flight test you start training people so it gets backed up quite a few years.

ROSS-NAZZAL: That's amazing.

REED: But we don't get to decide what the vehicle is. We're handed, "Here's what we're doing," from whatever the program is, and it was the same for Shuttle, it was the same for Mercury, Gemini, and Apollo, and it's the same for Station. There's people designing it. Powers higher than us decide on what the elements of the program will be; we're just, how do we operate what they've designed and what they're going to be using as their means to get to space and get back safely.

ROSS-NAZZAL: That's always the important thing.

REED: That's the goal.

ROSS-NAZZAL: You were working with MOD [Mission Operations Directorate]; were you also liaising with Engineering and those folks?

REED: Yes, one of the things that I led was a trade study on how do we provide breathing oxygen in whatever simulator we had for suited training? Because in an astronaut's training, they will be in the suits at some point in time, in the simulator, for a launch sim. When they put those suits on and lock the helmets and have everything tightened up, you have to provide oxygen for them. So what was the safest and best way to do that? We looked at how we did in the Shuttle program, how they do it in different areas, and NASA had given us the guidelines, "Here's what we want you to explore, and come back to us here." I had a team of people, that included someone from engineering and someone from the EVA [Extravehicular Activity] suit area, someone from the simulator hardware/software area, so those are engineers, and then someone from the training division. We went around and studied what were the best options that we would recommend for NASA for providing suit O_2 flow during those suited simulations.

Off and on, all of this Mission Operations integrated verification plan that we were coming up with for Constellation went through several boards, and every month there were meetings where I would work with my MOD counterpart. At a certain point you would always go to the control board and talk it out, and there were representatives from all the different directorates there, because it's a Constellation type board, and everybody's weighing in. When we would reach a certain point that we needed to present something like, "Here's a draft of our plan," it would go around and be reviewed by everybody. Then the NASA manager for that would stand up and brief it, but we would support, be there, answer questions and [provide] data and take notes. We'd go back and revise it based on what happened, especially if it didn't get approved at that go-round. They want you to change this, that's not going to work. It was always a give-and-take.

You work with people. By the nature of Mission Operations, you have to, because we're at the end of the engineering and the design, if you will. At the end of the day, Mission Operations does training, they do flight operations, and planning for those missions. We have to work with all the other directorates when questions or issues or things we learned in Operations, "Okay, we know you guys designed this this way; were you aware that this might not be safe?" Because they had done their testing, but sometimes you just learn lessons as you fly. That gets fed back, and sometimes they change things, or sometimes they will say, "Okay, do the trade-off." Maybe it's too expensive to change, or we don't have the budget to change whatever it is on the vehicle or the suit, but you can maybe change the procedures and then train the crew differently, if you can find some other way to safe the system by [having] them closing a valve or taking certain precautions before they do something. That's the best way I can describe it. It's always a give-and-take.

ROSS-NAZZAL: So was Orion then on the books at that point when you were working?

REED: Yes, Lockheed Martin had the contract for that—still do, as a matter of fact—were the prime [contractor]. That was the vehicle, so that was the vehicle we were working to.

ROSS-NAZZAL: So you were working with them as well? Because obviously you had to know the vehicle.

REED: Yes, we had some Lockheed Martin counterparts. Now, we had a whole team of people with my company that were specifically working vehicle issues from the Constellation program

office with them. I shouldn't say issues, but just working whatever came up, because they were the support contractors. We, our company, were the support contractors to the Constellation program office, systems engineering, and wherever in the directorates that needed the help. So whatever the NASA program manager on down needed, then we would have people assigned to work with them as they went through tests or observed tests. They were also writing plans in the various areas about how you do things. Worked with all the contractors at some point or other.

ROSS-NAZZAL: You were also working on training facilities. What sort of things were you looking at?

REED: Well, I think the first and most lengthy thing was, we had a rough design of Constellation: how many crew members, what kind of equipment displays were going to be in there. No details on any of those, mind you, because it was still being developed, and we had an idea of the types of missions that Constellation was going to kind of fly. So our first objective was to start determining high-level training objectives for the crew, writing those requirements. Had numerous board meetings with the contractor that would be developing the simulator, with the NASA division that owned the simulations, the training facilities, if you will, and the software group, and Mission Control, because ultimately, at some point, whatever simulator you have, it's going to have to integrate with the Mission Control Center so you can do integrated simulations and talk back and forth between the buildings.

So that was the first line of order, and you would think that that's fairly easy, but they broke it down into every system that was on there: electrical power, data processing, environmental control and life support. You start going through what are the training

requirements around all these different systems, what do we know on that. And then you go by flight phase: what are the different flight phases we're going to experience. Now, we know this, because that piece hasn't changed too much. You have pre-launch, you have ascent, you have post-insertion, and on-orbit, de-orbit prep, reentry, and landing, and then post-landing. So what were the things that we needed to be training in those flight phases as far as—and I'm talking very basic stuff, because we don't have details on the actual systems. You write all those down, you document them, and it's painstaking. Lots and lots of meetings to go through and document what are the requirements. They're going to be the "shall" statements, you know, the crew shall be able to do this, shall be able to do that.

So once you had all that, everybody agreed on that, then from that, once you know the requirements, then the people building the simulators can come back and say—because they can then build the simulator to be able to do those high-level requirements. For example, there was probably a requirement in there that the crew needed to understand how to deal with electric power failures, so they can go off and start to think about what does that mean for those software models. How do they need to build the software models that drive that simulator? The environmental control and life support system, same thing. What will the crew members in the simulator need to do, because this ultimately rolls down to that instructor station that's in the simulator, because somebody's going to be putting in or making those models react to give the crew training. It comes down to, then, we have to design when this valve closes on a pressure tank, that the pressure drops. So you begin to just get down into the weeds there of all the models and what they need to do. That's what we were doing.

At the same time, there was a group looking at the hardware, what did the actual simulator look like, what did the actual instructor station displays and consoles look like, and

what was the means of communication between the instructors in the simulators and the crew that would be in this new simulator, and how was that going to work. Was it going to be a headset? They began to explore different things, and this is where some of those trade studies that I was talking about come in. Because there may be, as the group begins to discuss the requirements, the requirements working group might come up with, "Well, it sounds like we've got three or four really good options here." You go off and do the trades on them, you compare them, and you come up with your recommendation to NASA, "Here are the three or four that you asked us to look at, here are the pros and cons of each, and that's everything from the performance, the cost, and maintenance," and you look at a whole bunch of different things. How easy is it going to be to use them, how easy is it to turn it around, because in simulations, unlike spaceflight, you might do an ascent sim for four hours with a group; they leave, you turn it around, and you've got another group coming in to do an orbit sim. So people have to reconfigure those simulators. How easy is that going to be to do, how time-consuming.

In the one that I did with breathing oxygen, you have to consider how is it stored, where is it coming from, what kind of pressure is it under in those tanks, and what are the risks safety-wise having those if you have them in the building, and where they're located and so on and so forth. So a lot of trade studies were going on at the same time to look at, in a systematic way, with data backing it up, which of these do we choose. Sometimes NASA asked for a recommendation, and you would get one coming out of it, but you gave them the full report that showed your thought processes, what you looked at, who you interviewed, what were the products you looked at, the different methods, and you would go and present it in some formal way to whatever board or meeting. They would discuss it and pick a way to go.

ROSS-NAZZAL: Was there any discussion about reusing some of the Shuttle facilities or hardware?

REED: Definitely reuse of the facilities, as in the buildings. That was a given, because we didn't need to go build any new buildings for training here in Houston. For example, the Shuttle Mission Simulator, they kept that up to date, but that was built in the '70s, and over the years certain components—don't get me wrong, but certain things changed and they followed with the technology. Some of the interfaces that were coming with Constellation, I don't recall any actual reuse of any of the Shuttle systems.

The simulator was going to be in Building 5, like the Shuttle simulator was, and the Station simulator still is. I do recall there was a big discussion around, did we really need motion, a motion simulator. The Shuttle had a motion base, so one that moved, and a fixed-base simulator, and when you add motion, you're creating a system that's making it feel, as close to as you can, the movement of space, not only the flying aspects but the launching aspects. With that comes extra maintenance, extra equipment, extra things that could break. So there was a trade [study] done on that: do we want to add motion, have a motion simulator and a fixed simulator? What do we want to do? So I don't recall them reusing anything from Shuttle.

ROSS-NAZZAL: Fascinating. How many people were working on your effort? Just sounds like a lot.

REED: You mean in the trade study, or—

ROSS-NAZZAL: In MOD and—

REED: In MOD? Gosh, I don't know exactly. The ones—I'd have to say—

ROSS-NAZZAL: Or even the trade study. It just sounds like a lot of work.

REED: Well, on the trade study there were six of us. I led it, but we had five others than me, and we all went around and interviewed many others, as we needed to talk to them, from Engineering, like I said, and EVA, because EVA was still designing what were these suits going to look like for this program. You have to make sure you understand that and understand how they're going to use it, and how that might connect into the simulator so that they can actually get the breathing oxygen in there when they were doing suited runs. In MOD there were probably hundreds of people working this Constellation program. And that was just what I ran across, but there may have been more.

ROSS-NAZZAL: Sounds like kind of a herculean task at the beginning of a project.

REED: Well, if you think about it, it was along the lines of any of the other programs. It was a brand-new program. Granted, we were almost 50 years in, so we had the benefit of all that came before us and all the lessons learned about flying in space and starting new programs. When you are starting a new program, you literally have to start at the very beginning. Somebody's going to build a vehicle, somebody's going to build a rocket to put it on at this stage, and that has many components. So you might have a prime [contractor], like Lockheed is the prime [contractor] for

Orion, but they've got subcontractors doing different pieces of that. If you think about it, it's this huge jigsaw puzzle that somehow comes together.

You have all the different pieces, like I said, the elements of the program, whether it's the rocket and the vehicle, but then you have all of the different, I guess, specialties at NASA, the Engineering Directorate, Safety and Quality Assurance, and the Mission Operations Directorate, and on and on. All of those groups, everybody's focused on this one program, if that makes any sense. So it's move this program, "Okay, we understand these guys are going to go build the rocket; these guys are going to build that. Now how are we going to test it, fly it, maintain it, ensure that it's safe?" All of those different directorates, here and at the various Centers, because obviously JSC does Mission Operations, but launch operations happen down at Kennedy. And Marshall [Space Flight Center, Huntsville, Alabama], it's got payload operations, it's engines and things like that. You've got Stennis [Space Center, Mississippi] that does the testing of the engines, and on and on.

It's a huge, huge integrated effort, or it needs to be, because if everything doesn't align and people aren't talking, or the groups aren't talking, that's when things can be missed, that's when you increase your risk. If you increase your risk, then bad things can happen. That is just one thing I think NASA does really, really well, because they are herculean efforts, but somehow or another they've gotten it down to, I hate to say this about rocket science, but gotten it down to an art of how to do it because they've learned over the years how to do it, and they do it very, very well.

ROSS-NAZZAL: You mentioned risk, and one of the things that was on your resume was your work with the NASA Safety Culture Working Group.

REED: Yes.

ROSS-NAZZAL: I wanted to make sure I had that right.

REED: I know, it's a mouthful, SCWG.

ROSS-NAZZAL: So how did you get pegged to be in that group?

REED: Through a connection in my CAIB work. On the CAIB, as I indicated, one of the Group 2 board members was General Kenneth [W.] Hess, who was at the time the head of the Air Force Safety Center [Kirtland Air Force Base, New Mexico]. He had several members of his team, because that whole team was devoted to investigating anything in the Air Force that had to do with safety and mishaps and accidents and incidents. So several of the people that came with him to support the CAIB were from his actual group. There was one psychologist whose specialty was accident investigation and safety culture and human factors, if you will. Years later, it's ironic, but anyway, I got to know her and all of those guys, and still stay in touch with many of them, but I lost track of her, because her work on the CAIB was finished before mine. I continued on, she had gone back to her Air Force job, and I lost track of her. I was sitting at my desk, actually here in Houston, working on the Constellation program, when I got an e-mail saying, "Is this still a good e-mail for you," at my NASA account. It was [from] her.

Turns out she had been asked by Bryan [D.] O'Connor at the time, who was the head of OSMA at Headquarters, Office of Safety and Mission Assurance, to come in and start a safety—

she was going to manage the safety culture effort going on at NASA. There had been many attempts over the years, by numerous industries, not just NASA, but culture is a difficult thing to change, because it's so invasive and embedded, so much so you don't even realize that it's there sometimes. It's just who you are as a member of NASA or a member of the Shuttle program or a member of any religious organization or education. Every organization has a culture that makes them who they are. So they had tried to change things over time. After the CAIB there was a big study done, and I'm not sure how it all happened, but they decided to actually, in the Office of Safety and Mission Assurance, have a safety culture director or manager, I'm not sure her actual title, who would work on that for all of the Centers.

I get this e-mail, and she tells me that this is her new post at NASA. She's retired from the Air Force and is working there now; would I possibly consider being the industry member, because they had representatives from every NASA Center that would be working on this. When I say industry, bring a contractor viewpoint, because I had been a contractor within NASA for many, many years. The contractors are so integral but also integrated within NASA, she felt it was worth having a representative there.

I said I would love to, but I don't get to make the decision, because my company, I have to check with them. She said we're going to start having a working group, and we will have meetings every month, not where we would actually fly anywhere, but telecons, teleconferences every month. We're going to try to work into a program where we can bring awareness in a consistent way, so this was why every Center was involved. Get them together, talk about what this program would look like, how would we implement it, and try to change this culture. She had done a lot of this work with the Safety Center and established some tools for managers to get the pulse of their organization and look for trends and see where maybe we were falling back

into old patterns that hadn't been identified, and so on and so forth. So, spoke with my bosses, they agreed, and I worked that straight through until I left to go to another industry. I still stay in touch with her, we still bounce things off [each other]. She's still there and doing great work.

I think safety culture is hugely important. We've seen where, for example, from Apollo 1 to *Challenger* [STS-51L] to *Columbia*, you tend—you being an organization, not calling NASA out specifically, but you see this if you look at organizations over time that deal in high-hazard or high-risk endeavors. Most of them are very good at what they do, but they will develop a culture where there's definitely a very good side of that, but there's also a bad effect that sometimes comes out of that that's unnoticed. NASA is can-do, and NASA does amazing things. I still pinch myself that I was so lucky to get to do this. For example, schedule, schedule pressure to do things, money, budget cuts. When you take an organization like a NASA, or you could even make comparisons to airline industries, nuclear industry, the medical field, when budgets get cut, when things are out of the average working level middle managers' control and the people actually doing the work, then it can make them do things that they probably wouldn't normally do.

So, case in point, and this is documented in the CAIB report, over time in the Shuttle program, budgets got cut, they just consistently were cut and cut and cut, yet Station came on line and the flight rate grew and grew and grew, and so did the complexity of the missions. As that pressure came on the Shuttle program to get these launches up, assembly flights were carrying up large pieces the Station that needed to be assembled, so we could meet that end date for the Station [assembly complete] program. Nobody wants to stand up and really say, "We can't do it," the average Joe or the average Jane out there. You're so all-in on the program, you

want to make it happen, so every week they take away from you or every piece of budget they take away from you, you find a way to make it happen.

What you don't realize is that in doing that, you're building up little tiny bits of risk. This is why it's so pervasive and so dangerous, this culture thing, because you're just doing your job, whoever you are, and you're doing what you think is the right thing. You might not realize that you're taking this little piece of risk, but maybe there are a hundred other people also biting off a little bit of risk. That risk, aggregated, if somebody could roll it up and show it to somebody in the size of a big ball, they'd go, "Whoa, whoa, we can't do that." But that doesn't happen.

The other thing that doesn't happen is, nobody wants to say they can't do it. At NASA especially, look what we've done. We are known for doing the impossible and making it look easy. NASA has put men on the moon, we've launched men when nobody could even imagine sitting on top of a rocket. We were putting people on top of rockets and launching them. We have done amazing things, but I think there's always that downside that doesn't get looked at, because you're so focused and so goal-oriented.

That's what this working group that they've established is trying to look at: how do you pull out those little bits? How do you teach managers to recognize, when they come in and say, "Hey, our budget got cut," how do you talk to your employees about what does that mean. How do you encourage them to speak up and not think that, number one, you don't think they can't hack it if they bring up an issue? So it's not that anybody was—for example, anybody at the upper echelons of NASA were saying, "I'm sorry, I know I took all your money away, but you've still got to do this." Nobody was saying that. It's just everybody still keeps trying to do the same thing, as money and schedule erodes away. At the end of the day, it's a very dangerous

business, so you've got to just be almost hypervigilant. That was probably a longer-winded answer than you wanted, but hopefully it made sense.

ROSS-NAZZAL: No, absolutely.

REED: The thing about it is, you can—if you go out and look at any high-profile incidents that have taken place just outside of NASA, it's interesting to read those. If you've worked here you can make the similarities and you go, "Oh, wow!" It's almost easier to look at some other organization that's done it, because it's hard to turn that white-hot spotlight on yourself and really get true with yourself, but I think NASA, after *Columbia*, was doing that, and I was really happy to see that. Can't speak for where they are now, because I haven't really been back in the organization, but I know a lot of the folks who had been around for a long time were really trying to change how things were done.

ROSS-NAZZAL: That's what I was going to ask you. Did you get a sense of any sort of changes that came about as a result of this working group?

REED: I left before they actually rolled the program out, so I don't know. I do know that they were implementing some training programs, just pointing out to people that thing I was talking about, about how pervasive it is but it's hidden; you don't know. So bringing culture from the subconscious in front of their face, "Hey, recognize this," and making them cognizant of it, because you really don't [see it].

It's funny, as Americans we don't think about our American culture that much, we just live it. If someone from Britain or France or some other organization—some other country comes over, they immediately can peg it. We don't see it so much. And the same about them, if we go over there. That's what it's like being at NASA, or being in the Department of Defense, or being at Google or any big industry. You have to almost—those things you take for granted—bring them up and say, "Remember these? You don't realize you're doing this, so let's watch it." And then they go, "Oh yes." So when I'm going all gung-ho, and I'm all can-do, because that's what we do, we make things happen, just watch for those little missed signals that you might otherwise not even notice. That's really all you can do.

ROSS-NAZZAL: It must be challenging, though, especially nowadays. You're always told make do with less; do more for less, that attitude.

REED: I see that in the industry I'm in now. I'm in the oil and gas industry. It's the same thing, and that's why I sit and I chuckle to myself, but I'm just amazed at how similar [they are]. I know when I was here at NASA, and people would come in from external things [industries or organizations] and say, "Well, y'all need to do this, you need to this," the initial reaction you have is, "Yes, but what we do is different; you don't understand." I've gone to the oil and gas industry, I see the same thing, and I'm like, "Oh man. It's just what it is." Even as special as an organization or as a person in an organization may think the area or the discipline you're working in can't benefit from some outside entity looking at you once in a while, you should think again, because actually they're offering some very good insights usually. Doesn't mean you have to take them all, but they're the people that'll kind of swing you back if you're not

already trying to do it yourself and go, "Maybe we ought to look at that. Okay, let's hear them out, see what's going on."

ROSS-NAZZAL: So what are you doing these days with BP and the oil industry?

REED: BP had its own accident back in 2010, April of 2010, the Deepwater Horizon accident. I remember the night when that broke on the news and seeing the flames and all, and my heart went out to them, because I knew what was going to [happen]. Nobody knows what happens at that point in time, but I remember thinking, "Boy, this is going to be a long one for them." There may be a loss of life, and as it turns out there were people that died that night. Then I also knew that if people survived, that was going to change them as well, it was going to change the organization in some way.

So I came in in 2012, and there had already been not only an internal investigation, but also a government report or a commission that reported on the industry in general around that and how these things could happen. I was brought in purely because of my background. They were looking to bring people in—they were hiring, first off, so they weren't just making positions, but they were hiring. There were a lot of things that they were wanting to change in the time after that accident, much like NASA would do in the past when we had our return to flight; they began to look at how they're doing things all the way around. "You're not flying, let's look at where we can improve things."

I came in specifically to do training. The organization I work in is the organization that [helps develop the technical training for] the operators and the engineers that work on wells. It's a very high-risk endeavor when you start drilling down into the Earth, and they work in deep,

deep water, high pressures, that that they're drilling through to try to find the oil. All of these people that work on the rigs are a team, and they've got to be able to communicate and work together well. In their case, if something goes wrong or you miss signals along the way, just like any other endeavor, you can have something happen like the Macondo or the Deepwater Horizon—Macondo was the well they were drilling. I just saw similarities left and right.

I came in as a project manager first, to help in developing some of the new training programs that were specifically to address some of the recommendations from that incident in training some of their rig personnel and leaders and engineers. I did that for a couple of years, then I became the instructional systems design lead, that gets back to the designing of training, so it was over all the different disciplines. They have engineering, they have sub-surface, they have the wells, people that drill the wells. I'm doing a very similar thing, but in a different industry.

At the time I came in, they had brought in a new drilling simulator. Two of the courses that were part of the recommendations that my team was developing, was teaching people about managing resources and communicating and everything in the middle of one of these operations, which was exactly what we were doing over here [at NASA], in addition to training them on the Shuttle mission and all the different disciplines. We were teaching that crew to work together, and it's called crew resource management. It's what they train airline pilots in, military pilots. NASA instituted it, and we called it spaceflight resource management. It's just ensuring that the team, the crew, works together well, that they all have good situational awareness, decision making, that they are communicating together to hopefully trap any bad things that might be [occurring]—identifying things early and working through whatever may come their way. It's all about communication and situational awareness and decision making.

We brought rig crews in, put them at their different stations, and began to give them scenarios that exercised those things. Very similar to what we used to do over here [at NASA]. There's goodness in doing that. So they all seem to like it, and I like simulators. A simulator is a simulator.

ROSS-NAZZAL: The pool, the NBL [Neutral Buoyancy Laboratory], is doing some work with the oil industry in terms of training. Is your organization involved in that?

REED: No, but as part of that organization in developing one of these programs, ironically, they wanted to come down and look at what NASA is doing and they asked me to come with them, so I went out to the NBL with them and I saw that. If you think about oil and gas rigs, especially in the Gulf of Mexico, most of them are offshore; there are some land-based rigs all over the world, but most of this gets done in water. The rigs sit in water, so you have to transport people via boats or helicopters. At the time, they were looking at providing some of that training, because these guys have to be trained in the helicopters. If there's a problem on the helicopter, if it goes underwater, how do you escape? So they showed us that.

I don't know if they've actually started this, but they were looking at possibly having one of the control rooms out there be some sort of emergency training between people in a control room and people out on the rigs. I don't know if that ever came to pass. But I did come out [to the NBL], and it was real fun to go back in the NBL and see what they were doing. They gave us a brief and saw lots of old friends. They were really shocked when they came in their briefing, they're like, "What are you doing here?" "Why, I work here." Or I work with these guys, anyway.

ROSS-NAZZAL: I was curious if you could look back over training from the time that you began out here, after *Challenger*, until you left, how did training evolve or change over that time?

REED: I think when I first got here, post-*Challenger*, they were in the downtime, so like I said, they were looking at a lot of things. I believe they increased some of the training, so in other words, I think some content was added, and that adds hours and more training. That's a typical and very expected reaction after an accident. As they returned to flight, and the flight rate picked up, we began to get crunched on time. You couldn't fit all of that in, so I saw an effort during that time, and was part of several of them, to look at where we could remove some of that extraneous training.

For example, it had gotten a little top-heavy. Maybe we didn't need all of it. So there was a concentrated effort to look at just what was it we needed to train them on, what objectives, and let's not add more into their training than is really needed. I'm a big proponent of that, actually, as an instructional designer, because you want to focus on the stuff that you need to train. For example, operators don't need to know how to build a Space Shuttle. Crew members don't need to know every single thing about that Space Shuttle. They need to know how to operate it, they need to have a basic understanding of the systems going into that, but they need to know how to operate it and safe it when something goes wrong. They need to know what they can handle on orbit and see, in the ways of displays or feedback from the gauges or talk-backs, and what extra data Mission Control might have, because Mission Control would have more [data], to work together to solve any problems, and also to just do their normal job on orbit. In other words, they need to understand how the Shuttle works at a high level, and the systems

work at a medium level, but they don't need to know how to break it apart and tear it down. That's what the engineers need to know and the mission controllers need to understand a little bit more in depth.

Then the other thing I saw changing is, we were about to start a new program, new Station program, and as we moved toward that and the Station program was approved, the budgets just began to get cut more and more. So we moved from predominantly—for example, all NASA team leads in the simulator, we moved to the Shuttle operations going to a contractor, the United Space Alliance [USA]. In that respect, the NASA [training] personnel moved out of the Shuttle training world and moved over to focus predominantly on Station and getting that up to speed and running. So everyone on my team, starting about '96, were all contractors. So the Shuttle was a contractor-managed program with NASA oversight, so less NASA people actually interacting with us. When I was early in the program, all the managers of the Shuttle groups I was in were NASA people; that shifted, now my manager was a USA manager, and we answered to them on the Shuttle side. Then we had a [separate] group of Station [training] people, which looked a lot like our old [Shuttle training organization] configuration, which was a mix of NASA people and contractors.

We began to see larger AsCan [Astronaut Candidate] classes, because they were staffing up now for Station. Whereas we might have 16 in an Ascan class coming in, 16 to 20 in the late '80s and early '90s, we had, oh gosh, how many were in the Sardines? They were named the Sardines because there were so many of them. I want to say it was 40?

ROSS-NAZZAL: Somewhere in there. I thought 35, 40?

REED: It was a large amount. It was the ’96 class. Anyway, those classes got bigger, so it added additional training, because when the AsCans came in, there’s a whole lot of training that they’ve got to do. All the same instructors that are training Shuttle crews that are flying, you have to support the training of those guys going through their briefings, going through single-system trainer classes, so that began to change. We just had a heavier load, and nobody was complaining, but it was like, “Wow, we got a lot of people!”

We also saw some changes as the Shuttle was aging, and they began to look at taking out some of the displays, and the technology was changing, too; that’s how we ended up getting the MEDS [Multifunction Electronic Display Subsystem], the electronic displays in the Shuttle. So we had to look at how do we train those, because that was a whole new interface. So all the crews, everybody had to be trained on that. It caused some downtime in the simulators, because we had to take down one whole base so that they could change the displays out. Whereas we had three running full time, we now had two, and we were hitting a pretty hefty flight rate going into the early Station assembly flights and the final Shuttle flights that were deploying that were doing life sciences.

Going back in the early ’90s, we had Shuttle–Mir, so that introduced a whole new thing. We had Russian cosmonauts coming over for training. We hadn’t really worked with internationals before. They had had people fly as payload specialists, that had flown from different areas [international partner countries], but most of them came in and spoke English well, and that was not the case with the early Russian cosmonauts. They spoke passable [English], but we had to look at how were we going to train them, and how did we change any of our training flows to meet their needs and bring them up to speed quicker, because in a lot of cases they would send over two, so we had a prime and a backup, so that added some changes. It

prepared us well for what came with Station, because then we began to get international crew members that came into the AsCan classes that were from different countries, that were partners. So that was different.

I think the biggest thing was just budgets kept getting cut and cut. I do remember that, because we had to do more with less. We began to try to push things out of the simulator into lower-level trainers, which was a good idea, but that was forced by the budget cuts, and in some cases it worked well. Then just the technology over time changing, with computer graphics, they learned how to take the actual simulator models and put them in smaller computers. With a little bit of working, they could come up with little ascent trainers that the crew members could go sit down and run by themselves, just to practice, if they didn't get simulator time. Because a lot of the AsCans, there were so many, they were looking for opportunities to get simulator time to just sit in there and see things. Where we could, if we had a free seat, we'd check with the commander that we were training and invite them in, but they were all scrambling to get time to actually get some sim time to experience it while they were waiting for flight assignments. That's kind of what I remember as the changes over time.

The big one for me was when it shifted from being a NASA-led event supported by contractors to being a contractor-managed event, and all those guys moved over to the Station group, began to get that program up and running.

ROSS-NAZZAL: Do you think that was problematic for NASA, having that switch?

REED: No, actually I don't, because most of the contractors that were there had been there for years, and we knew everybody so well. It was just interesting that all of our groups became just

contractor-managed. We all sat in the same building. It was just a different thing, and I think that USA actually did a really good job managing the Shuttle program, and the training especially, because a lot of the same people that managed that right up to the very end were the people that worked in it with me when I came in in '87 and had progressed through their own careers there and never left the building, if you will. So they were very knowledgeable and very experienced, and it showed. Having to deal with the budget cuts, and we're at the whim of Congress and the [Space Shuttle] program, and they were cutting budgets because they needed budget for Station, it was more difficult going through. I think some of that hurt the program a little bit in what people could do, but it's understandable.

ROSS-NAZZAL: Do you think that was your biggest challenge?

REED: The budget? No, it was one of them, because they began to go to more generic Shuttle flight loads in the simulator, so that did affect us there. Because used to you would get—they had a generic software load, so that's all the models that would run the Shuttle simulator, but you would very quickly get your own flight specific [software] that had all the flight-specific stuff for whatever mission you were training on there. We trained on those generic loads a lot longer, and we didn't get the flight-specific loads till much later in the flight flow, so you'd have to train the crew—for example, their payload would not be sitting out in the payload bay in the [simulator] visuals, in some cases. Or a certain thing that they had on their flight would not be in the software, and you'd have to say, "Remember, now, this looks like this here." So we did a little bit of that, but we got so used to doing that that I don't think it impacted anybody. If those loads

came in late in their flow, if anything was wrong with them that you had to keep going back and fixing, then I felt like that wasn't optimum.

I think the other thing that really impacted us was the—and I talked about this last time—when the Shuttle began to take up the first Space Station crews, it took [away] part of the [typical number of] crew you had to train on some of the missions with them getting more complex. That was probably, toward the end, my biggest difficulty. They made changes after a while, but it was really hard [early on]. The flights got more complex, and you had less crew members, because they were in Russia training or they were training on their Station mission, because they were going to be up for six months. They had crunch training flows too, so it was this balancing act. So toward the end, the flight rate had picked up because they were under pressure from Congress to complete the Station, so they never moved that end date. It was hard to move that end date, so I think I referred to this, you used to get time off between missions, and when I say time off, I mean time off of flight-specific training.

ROSS-NAZZAL: Right, not a week or two off.

REED: You didn't get time off, you would go into the generic training flow so you could kind of take a little bit of a breath before you had to start planning and doing all the things for an[assigned] crew. We were getting them where I would have two going at one time in various stages of their preparation, and that was really uncomfortable and hard to do, because you need to focus on the mission [that was launching first]. When you've got this one getting ready to fly or three months out from flying, and now you're starting with these other guys who are chomping at the bit to get going, it was a difficult balance.

ROSS-NAZZAL: What do you think was your most significant accomplishment while working here at JSC?

REED: While I was working at JSC, I would have to say probably—that's hard. It was probably the development and training of the docking system and bringing that in [and updating the simulator models as we learned more with each flight]. It wasn't new to the Russians, but it was a new piece of hardware and a new system for the Shuttle. [It] had to come in and be integrated into it. A lot of people worked very hard on that, but as the years went by, we had to work to get the model right, I had to train people to do it, I had to work with the crew [during Shuttle-Mir and the first ISS assembly missions]. Every flight, there were some procedural changes, and this is a natural effect of it's a new system and you learn things on the flight that you didn't know. I'd say that that stayed in place until the last Shuttle flight, so that was pretty significant. They changed the procedures as they needed to, but I remember we had to figure out a way to get it in the simulator to model it; we had to figure out what the training flow would be.

Probably after the [STS]-71 flight, I became the only instructor that was certified in that, and working through the flights up through—71, and that would have been [STS]-74—through [STS]-84, 85, 86. That was a heavy time and we were learning a lot about the docking system, so there were all these changes. It changed the ecosystem somewhat, because it added a whole external airlock and different hatches, so those models had to be done [modelled in the simulator]. Worked with the programmers—I wrote the requirements; we submitted the change requests for the simulator. They did it. We tested it and went back and forth.

That worked as well as it could, without having the actual [working unit]. For example, in the Building 5 simulators, we just ended up with a board that mocked up all the different valves and stuff. Early on I realized that probably the biggest complaint I was getting from the crew members during the integrated sims was that whole valve configuration. There were a lot of valves [that needed to be opened or closed] spaced at certain times [in the post-docking timeline], and waiting for pressures to equalize with the Mir. We had to model that in some way, otherwise they were just sitting back there in a chair going, "Okay, I'm opening the valve," and it would say "Monitor it," and then they'd go, "Tell me what I'm seeing," and we modeled it so that we could make it work like the other models. So they liked that a whole lot better when we got it online.

ROSS-NAZZAL: I'm sure they did.

REED: These procedures were really lengthy, and they were very coordinated events with the people on the Mir. We were doing these integrated sims and it could've been better, so we made it better. From a training perspective, we made that training much better. After I left JSC, I'd have to say the CAIB was the most significant thing, my second contribution to NASA.

ROSS-NAZZAL: It's pretty significant. So I wanted to ask you, you mentioned a board that they were working on with the—

REED: Well, in the simulators, if you can imagine the middeck as mocked up in the simulator for the fixed-base over in Building 5, was about the size of this room we're in now. You have an

access ladder going up to the flight deck, and then the flight deck, you got up there, it looked just like the real Shuttle. Downstairs they had mock-ups of the middeck lockers here, and the galley was where it would be, and the WCS [Waste Collection System] was actually down the hall and they had a trainer there. It was less mocked up. There were none of these equalization valves or the airlock mocked up at all in this square area on the middeck of the fixed-base. So that's why they would be going through the procedure and it'd say "Turn this, the airlock equalization valve, to depress." They couldn't do it. Because you had a hatch going from the Shuttle into the external airlock, and then you had a hatch when you got in the airlock up here, that was a lot of valving and changing of valves and watching pressure dials and whatnot moving around. They would literally just be like I'm sitting here, going through the procedure, "Okay, I've waited five minutes, what does it [the pressure gauge] say?"

Because it's not realistic, they're not as engaged. It wasn't that they weren't paying attention, but they would do the wrong thing, and then it would take you down a path in the simulation, and you've got Russia on the line and MCC on the line, and they would start working something that they accidentally told them the wrong thing. "Oh, we've got a problem."

So I created, right beside the middeck access, where this bookshelf is, and actually about that size, a panel that had [been] labeled, this is the hatch and here are the equalization valves here, and it had gauges just like the real ones did that would show them the pressure drop. Then the model behind it, I could be sitting at the console, and because we had written it when they turn it to on, whatever the ambient pressure in the model is in that airlock, do this. It would react. They could actually turn it and see the reaction. That was more realistic. It was simply a board painted gray like all the Shuttle things [panels], and it had, gosh, I can't even remember how many sets, but it was easily three sets of pressure and equalization valves and their

associated gauges, just as they would see them on the Shuttle, same writing. Granted, we didn't have an actual airlock in the simulator, but it was the best we could do.

ROSS-NAZZAL: And so it stayed that way for the entire program?

REED: Stayed right on that back wall, because that back wall was open. I literally went in with the hardware guys and said, "Okay, where can we put this?" Because that wall in the Shuttle is actually the hatch. If you were in a real Shuttle, that wall had nothing on it, because that's where the hatch they come into would be.

ROSS-NAZZAL: Would not have known that. That's fascinating. That's part of that NASA can-do spirit, I guess.

REED: Well, and it's a little bit of listening to your clients, if you will. I had enough of those sims, I was supporting them all for a while. They would complain in the debriefs, and they had right to. Now we're doing this, and we've never done this before, and these procedures are really lengthy. They were, and they were joint, written in English and in Russian, because the Russian counterparts were on the other side working on this same procedure, written in their language. It was really easy to miss when you're just pretending, if you will, and that's what they were doing. So that at least gave them the physical motion, having to read the gauge and then report back, they could time it, which things were timed out in some of those cases. It just gave them a more realistic look and feel of actually doing these actions instead of sitting, for about an hour and half, and going through—that's about how long, once they docked, you spent

time equalizing the pressures. It was about an hour, hour and a half until they actually opened that hatch and shook hands, but there was work going on during that time.

ROSS-NAZZAL: So that's why it was so important—I read your interview with Rebecca [Wright], and we didn't talk about it, because I thought you guys did a good job covering it before. But why it was so important at the Cape [Canaveral, Florida] to point out all of those features to them.

REED: Yes, I probably got more trips to the Cape than the average instructor toward the end there, because we did not have some of these things at JSC to show them. A picture truly is worth a thousand words. If you can get down there and show them—I think the big surprise to me when I got down there was, I'd be standing with the crew out there, looking at the docking system, we'd go down in the vehicle, look at the external airlock.

The first time that one of the Orbiter Processing Facility leads came and said, "Would you mind talking to the technicians, and would you mind talking to these people? They're not familiar with this [system] and they would love to know." I ended up teaching them, because these are the guys that have got to take care of it. They had engineers who were versed in that, but the ones that are actually out in [facility]. I would be standing on a platform in the middle of the payload bay that surrounded the docking system, with five techs, and they'd take them out and bring in another group, just to explain, "Okay, this is what this does," and it was the same for them. You could see the aha moment. "These little things right here, these pedals, help the two vehicles come together because they've got a docking system on their side that fits right in between there, and then these are the hooks that come up and grab it together. But at first, on

these little pedals were these little latches that collapse in and then come back out for an initial hold it together until you can get all the hooks latched." It was more fun to watch them finally—they'd probably done four or five flights by that time, and they'd never really seen it. They're working with the hardware, they're not the engineers, they're the guys who are doing the vehicle turnaround and maintenance. I never thought that they wouldn't have known about it, because the guy gingerly approached me, "Would you mind, there's some guys..." and I'm like, "Come on, it's what I do, I train people. Come on."

ROSS-NAZZAL: How wonderful. Well, I think that you've answered all the questions that I've come up with, but I wondered if there was anything else you might want to talk about, since you're here today. And I'm not going to keep you over, I'm looking at my watch.

REED: Okay. What time is it?

ROSS-NAZZAL: Quarter till.

REED: Anything else I want to talk about? I think that at some point in time, if people are reading these oral histories, and you hope they would—number one, I commend you guys for documenting this, because there's a whole human side, ironically, to human spaceflight, and it's the people that made all this happen. I am just one person in a long line of people who loved this program, and I mean the NASA program, the NASA human spaceflight program. I've talked to many that I've met that worked with Apollo and Mercury and Gemini, and that continue to work there, the love of the program and usually the desire to join the program before they ever got

there. And the camaraderie that goes along with that. You can meet somebody from NASA that worked in these programs, and you might not have run across them, but you immediately go to a place where it's an understanding. I think that was the best part of it, was just knowing that people had your back and they knew you had their back, as far as everybody pulling together on doing these amazing things.

I got to do so many amazing things that I never would have dreamed of as a kid, and to be a part of that and realize, even today, when I walk outside and I see the Space Station flying over Houston, or even if I'm in another city—when I was in Colorado Springs, I would go out still and watch it—and realize it was people like me, average, everyday Americans, and now international partners, that love exploration and want to see us go do that. There's just this desire to continue to explore. I think humans are that way.

I just hope that people realize how much fun we had. When I was growing up listening to people talk about Apollo and Mercury and Gemini, they were talking about how much fun they had, but how hard it was to do. I totally get that. It's very hard to do. A lot of sacrifices of your own time, but there's nothing else you'd rather do. It's hard to explain. Being a part of it was awesome, and I feel so blessed and fortunate to have gotten to do some of the things [I did]: stand at the top of a launch pad with the Shuttle on it, train crews who went on to make history. To see pictures coming back, even today from Hubble or Chandler X-ray Observatory, I was the training lead on that flight, to still have the connections and friendships, it's pretty amazing. That's what I'd like people to know. I hope young people continue to dream and come join this program, and I think we'll be back in space one day.

ROSS-NAZZAL: I hope so. Well, thank you so much for your time.

REED: You're welcome.

[End of interview]