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EDITED ORAL HISTORY TRANSCRIPT

ROBERT M. LIGHTFOOT, JR.
INTERVIEWED BY SANDRA JOHNSON
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JOHNSON: Today is June 22, 2018. This oral history with Robert Lightfoot is being conducted in Huntsville, Alabama for the NASA Headquarters Oral History Project. The interviewer is Sandra Johnson, assisted by Jennifer Ross-Nazzal. We want to thank you again for agreeing to talk to us.

I want to start by talking about the beginning of your interest in engineering. Let's talk about your education and background, and how that prepared you to work for NASA. From what I read, you'd actually thought about going into journalism at first.

LIGHTFOOT: In high school I was the editor and sports editor of our newspaper, and we won some national award. One of the schools here in the state, if you were the editor and you had these awards, you could get a ride, a scholarship. So, I assumed my future was in journalism. My guidance counselor, though, saw my scores from my ACT [college admissions test] and said, "You need to go into engineering." I had no idea what that meant because I had no role models.

I wasn't from here. I wasn't fortunate like a lot of people from Huntsville, they lived and breathed engineering. I had no idea what it was. Honestly—and I've said this a bunch of times—I said, "I thought I was going to be driving a train." I thought that's what engineers did. But that's what started me down that path going forward, and why I went into engineering. Not because I had any great passion, it's just what the test scores said I should do.

JOHNSON: Your father was an educator, is that correct?

LIGHTFOOT: Yes, he was a professor at the University of Montevallo [Alabama], a little south of Birmingham down there. He taught math to start with and then became an educator of educators. I used to see my dad in my classrooms a lot because he was grading the student teachers that were there, so that was always an interesting dynamic.

JOHNSON: Yes, I can imagine. I heard that you described yourself as a "guinea pig" for him more than once, I think.

LIGHTFOOT: Yes, he used to use me in his classes, and for Alabama Public Television. He had a 30-minute science show that he used to do, like a *Mr. Wizard* [Donald J. Herbert, children's science television educator] kind of thing, and so I was on there a couple times as well.

JOHNSON: I bet that was quite an experience.

LIGHTFOOT: I just barely remember it. But I do remember him tricking me with the beakers - the short fat beaker and the tall skinny beaker and then the one in the middle. He'd say, "Which one had more water?" Of course they all had the same, which was unfair. He was just trying to show the students how people think. They think differently from whatever their background is.

JOHNSON: That's a good lesson to carry on into your career I would imagine.

LIGHTFOOT: Oh, yes. My dad is my hero. He gave me all sorts of lessons. More than I care to admit.

JOHNSON: When your guidance counselor, because of your ACT scores, said, "You need to become an engineer," what did you do? Where did you apply?

LIGHTFOOT: I went to University of Alabama [Tuscaloosa]. I probably didn't have much choice there. In the state of Alabama you pretty much decided at birth whether you were going to be Alabama or Auburn [University, Alabama]. Most of my family was Alabama, so I went there, for no other reason than that's where I knew I was pretty much going to go, since maybe like one year old.

JOHNSON: When you first started taking those classes that would lead you into an engineering field, what was it like for you? Since you thought at first you'd be driving a train.

LIGHTFOOT: I think the challenge with engineering school for me always—I'm a visual and hands on learner. I'm not an academic or theoretical learner by any means. I think my challenge was the basic classes that you take when you first get there. They're not engineering. It's math and science and electives. I didn't get to engineering classes, basically till my late sophomore or early junior year.

I struggled; I struggled mightily. In fact, my dad sat me down and said, "Are you sure you want to be an engineer?" after a couple of interesting semesters. I'll just leave it at that, since this is a history. I remember specifically telling him, "Dad, I don't even know what an

engineer does." Because I still hadn't had anything that taught me what an engineer does yet. It was all calculus and physics, and I hadn't gotten to the engineering part yet. I would say the first two or three years were really a struggle for me.

What changed that was between my junior and senior year I was able to come up here and work in Huntsville. My girlfriend at the time, who's now my wife, is from Huntsville, and I got a job working out at [NASA] Marshall [Space Flight Center] on one of the test stands out there. They were getting ready to put a Space Shuttle main engine on the stand to do testing, and I was doing something as simple as just drawings for the test stand. I wouldn't call it real engineering. I was doing drawings, and really reproducing stuff from the '60s. This was late '80s, so we could use it.

I'm not one of those people that wanted to be in NASA from day one, I can't claim that. But I got the bug, I got hooked pretty quick. Would go to the [U.S.] Space & Rocket Center [Huntsville, Alabama], and see the Saturn V [rocket] laying there. My dad had built a Saturn V as a model when I was a kid, and I remember that specifically being in the house. I knew all about the Moon program, I knew all that stuff. But I didn't know much else.

But for me I got hooked. All of a sudden all those academic things became very visual to me. I saw them playing out in practice and I began to understand. I had just taken a propulsion systems class at the university. To see an engine packaged up and what it looks like was like "Oh! I get it." It was a big "aha!" moment for me.

My senior year was just much better. I got out of there, thank God. I tell the joke all the time that some people graduate —what is it? Magna cum laude, summa cum laude, cum laude. My dad said I graduated "Thank the laude," that's what he said. It's really true from that standpoint. But after I got out of school I went to work for Rockwell International. Actually that

summer was the summer of ’85 that I came up here and worked. Really excited about what I was doing, totally changed the way I was looking at the job boards at the university.

Then [Space Shuttle] *Challenger* [STS-51L accident] happened in January of ’86. Job boards disappeared for obvious reasons, at least in the areas that I wanted to work. My summer job was with Rockwell International, and they had a Shuttle support contract, and I went out there that summer for them. Oddly enough they ended up getting a contract to help Return to Flight, all the activities that were going on, and they brought me back in.

It allowed me to work Return to Flight, so I hit the ground running. The first day I was there we were testing O-rings, if you can believe that. Spent a year testing O-rings and being part of the redesign effort, in the same test area that was going to be testing the main engines that I worked on in the summer before.

After the redesign effort was over, my task got shifted over to doing the Space Shuttle main engine testing again. We were still just activating the facility, cranking up from where we’d done before. But again, I was still Rockwell International at the time. Did that for a couple years. We got the facility activated; we ran a couple of tests, again, as a contractor.

Somewhere along the way—I started ’86, so probably ’86 or ’87—that particular program was called technology testbed. We weren’t really testing the Space Shuttle main engine. We were using the Space Shuttle main engine as a platform to test technologies. I don’t know if that makes sense. But really what it was was the Space Shuttle engine was considered a stable platform.

People were trying to do new things, and you needed that platform to be able to test them. There were things like ultrasonic sensors. Can you actually measure turbomachinery torque while it’s running, can you tell rotation? A lot of the things we did operationally to the Space

Shuttle main engine, could you actually put a sensor in so you didn't have to do things post-test? Different ways to do that.

The testing of the engine was very rigorous. One of the things we did was we actually ran the engine off of an IBM [International Business Machines Corp.] ThinkPad [laptop computer]. Just to prove that it didn't have to have that big controller. It was interesting that we did that. We did shorter chill times, we did accelerated drying. All these different operational things we were just using the engine to do, but also a lot of technologies.

One of the ones in particular that I remember working on the most was called optical plume anomaly detection system. What somebody'd come up with was if you could look at the plume of the engine—which is clear because it's just liquid hydrogen and liquid oxygen, it's basically steam—and see that something's eroding inside the engine and catch it before you have a bad day.

We had all these sensors looking at the plume. These guys had been working this for a long time. The big challenge was false positives, because the last thing you want to do is shut an engine down, especially when you're flying, with a false positive. One of the things that I got to work on and help design was the system that squirted liquid chromium into the engine while it was running, because chromium is a material that is throughout the engine. The problem that the plume anomaly people were having was calibrating. If you see a streak, what just eroded? How much? Often you wouldn't find it.

But we actually squirted chromium in there. Then I could go measure how much we put in after the test and tell them. It's hard to do this when you're running the engine. People get a little bit wound up about you squirting things inside an engine while it's running. But they'd come along and basically at 50 seconds we're going to turn the system on, and 60 seconds we'll

turn it off. You'd see a spike, and then they were able to calibrate the spike. You could then take that number back and actually calculate how much hardware eroded, if you were thinking about an erosion situation.

I'll never forget one of the cool things about that particular one. We finally got it to work. It took a while to get that to work, because it's hard squirting things in the engine while it's running. When it worked—this guy had been working on this for 20 years, this was a technology he'd been trying to develop for 20 years.

The door to the control room is locked, and when we finally did it and it finally worked, somebody's pounding on the door at shutdown. Engine shutdown, we're going through all that. The guy comes in, just gives me a big hug. He was so excited that we had actually done this. But anyway, I digress.

JOHNSON: No, that's great.

LIGHTFOOT: For me, getting back on the engine program was a big deal. I went back over there, started working. The NASA guys were given the job. They decided not to let—at the time it was going to be Rocketdyne [Division of Rockwell International], the same people that were running the test facilities down at [NASA] Stennis [Space Center, Mississippi].

Somebody made the decision that they wanted the NASA engineers to get the hands-on work. I thought I was actually going to be a test conductor as a Rockwell employee, and somewhere in that transition they decided to let NASA do that. I was kind of like, "Oh man," because that's really what I wanted to do. So I stayed there as a contractor, but the people

running the tests and running the systems were NASA guys. Good friends, we all stuck together, but I was just supporting the test conductor there.

I think it was ’88, ’89 timeframe, again Rockwell had a contract supporting the Shuttle program. I really wasn’t that involved with the program, it was more the testing. We ended up going—there was a plant out near Las Vegas [Henderson, Nevada] that blew up, ammonium perchlorate plant. The name of the company was [PEPCON (Pacific Engineering and Production Company of Nevada)]. They made the ammonium perchlorate, which is the oxidizer in the solid rocket motors. The only place in the United States that made it.

The plant blew up, so it was a pretty big deal. If you ever want to see anything interesting, Google [internet search] the ammonium perchlorate plant. Google the PEPCON explosion and watch what happens. There happened to be a TV crew filming a commercial on the top of a hill when the thing blew up, so they got it all on film. It blew out windows miles away.

As part of the contract that we had with the Shuttle, the solid rocket booster team came and said, “Hey you guys, we could use somebody to go out there and help them reactivate their facility.” They moved to Cedar City, Utah, and I went out because I’d been activating test stands, to activate their facility. I spent about four months out there.

While I was out there, I got the call from NASA. I had applied for a job at NASA and I got a call from my old NASA boss—he was actually the boss of the engine program. They wanted me to come work on the engine program with him. I got a call offering me a job, so that’s how I got to NASA. Flopped over, and we had been testing a particular engine in the test stand, just to make sure the test stand was working, and doing some technology work.

But the real test engine built for this was Engine 3001. Its own moniker. No other engines have a 3 in front of them. That was going to be the technology testbed engine. When we had the instrumented turbopumps on there, we had roughly anywhere from 1,500 to 2,000 pieces of instrumentation when we ran the test. We'd never done anything like this, crazy stuff. Hypodermic tubing going through the engine just so we could measure data we'd never measured, what they call Herschel-Venturi [tubes] in every run line.

For years they'd built a model on how the Space Shuttle main engine works, but they'd never calibrated it, it was just a model. So we ran this thing and calibrated that model. Just amazing. But I ended up being the person responsible for getting that engine out of Rocketdyne. Spent a lot of time at Canoga Park, California.

I call that my first child, Engine 3001. It sits out in front of Building 4200 at Marshall now, it's the Space Shuttle main engine that sits there. It's my old baby. That was cool, and that's how I got back to Marshall. Stayed on that program, Lord, I guess till it ended. There was a lot of reasons it ended.

JOHNSON: You said you went to Las Vegas because you'd activated facilities before, and that's the facilities here at Marshall you were talking about?

LIGHTFOOT: Yes, the test facilities.

JOHNSON: Can you talk about the different test facilities that you worked on, and maybe just a little bit of information about those?

LIGHTFOOT: Yes. I worked on several test facilities, mostly doing either small component testing like O-rings, all the way to the big engine testing. One of the things we were responsible for at Rockwell was writing procedures for activating systems, but also writing procedures for operating.

I had written several activation procedures for some of the systems. The liquid oxygen systems, some of the pneumatic systems on the test stand. I'd written the operating procedures as well, in other words how we're going to use them for a given test day. Eventually I moved over toward writing procedures that were specifically around the engine, procedures that we'd gotten from Stennis, because Stennis had been running engines for years.

That set of skills, I guess if you want to call it, of being able to take drawings and systematically check something out, but then also about how you're going to operate it at the end of the day, with all the parameters that are required—that's what they asked us to go do. Rockwell had been doing that for the Agency for a while.

Same kind of thing. You build a brand-new facility, it's got to be brought online, leak-checked. All the different things that you would do before you get there.

JOHNSON: As you mentioned, when you were still with Rockwell you were doing testing on the O-rings. That time period at NASA at all the Centers was a little traumatic, just because people didn't really know how long it was going to take to get back to flight. Can you talk about that? Maybe your impressions of what the atmosphere at Marshall was at that point and how it affected the work.

LIGHTFOOT: You know, I didn't have the trauma that a lot of the team had, because I was in college when Challenger happened. I didn't necessarily have the connection. I will tell you I understood it more during [Space Shuttle] *Columbia* [STS-107 accident], because I was there with *Columbia*. I didn't get that, but what I saw was this just incredibly focused team to get back to flight. Incredibly focused. In some ways it was exhilarating being part of that.

I hate to say coming out of a tragedy that something was exhilarating, but being part of a team that was really trying to accomplish something and get back to flight. That was probably the first thing I remember is "Man, these folks—this is a team, really focused." There's been times in my career we haven't been that focused. People were focused. Very focused. That was what I remember the most. People were doing just about anything they had to to get us there.

JOHNSON: Before we talk a little bit more about once you started at NASA, I was just wondering. That summer when you were working you said was your first time in the test stand. Can you talk about that? Because obviously we've never been on a test stand. Just describe what that was like and what you saw, and what gave you that excitement to work toward a career with propulsion.

LIGHTFOOT: I would say the enormity of things. The test stand we were working on was the one where they tested the Saturn V for the first time. So the enormity of a facility that holds down the rocket that's going to the Moon.

Even in my latter days in the Agency I would tell my friends at the Cape [Canaveral, Florida], "It's a hell of a lot harder to hold it down than it is to let it go." Because they get to let them go. So when you got all that thrust and you got to hold it down, there's a lot of concrete.

You're walking around 150, 200 feet in the air. It's launchpad-ish in some ways, with a lot more infrastructure to keep things from going where they're not supposed to go.

The enormity of that, and realizing the history of what had happened there, was probably what was coolest to me. I'm not a big history buff, but I always am amazed. I've done so many speeches where I always talk about standing on the shoulders of giants, and that's what it felt like. It's like the ghost of the past. You just know some cool stuff went on, and you want to be part of that. You never think about it when you're in the moment, that somebody else is going to be looking back going, "It had to be really cool." So that was the part that struck me.

I'd played sports in high school, and knew the team aspect, but for me it's always been fascinating the team aspect of NASA. Everybody's just trying to get the job done, and the boresight focus around that. I just wanted to be part of that. I don't know what else to say, that's kind of contagious when you see that.

JOHNSON: I can imagine it is. Like you said, you did it for a while, but one of the things I read that you had worked on was the RD-180 [rocket engine] testing. Talk about that, and why you were working on the RD-180 at Marshall.

LIGHTFOOT: Actually NASA had nothing to do with this one. It's actually a very interesting story, at least to me. The Space Shuttle main engine testing left Marshall. There's a lot of reasons. They put stuff down at Stennis, moved a lot of the rocket propulsion testing to Stennis at the time. There was a lot of reasons. There were political reasons, but there were also technical reasons from a duplication perspective. So a lot of stuff moved down there.

We didn't have any work, right, so what are you going to do? At the time Lockheed Martin [Corporation] was changing their Atlas [rocket] program to what they called the Atlas III/AR at the time. It had a Russian engine in it, and they basically didn't have anywhere to test. These guys are in Denver [Colorado], they don't have anywhere to test.

They were looking around the country at where they could test their engine. They had us and the guys at Rocket Ridge AFRL [Air Force Research Laboratory] out at Edwards Air Force Base [California]—where they used to test [North American] F-1s engine (first stage of the Saturn V moon rocket), just like we used to test F-1s here. Big test facilities up there. They had us all come in and give them what we would do.

To me it was pretty innovative from a perspective of we were actually the contractor to Lockheed, which was about the most bizarre situation in the world. But we did it through a Space Act Agreement. They were able to actually pay us to do the testing for them, so we went out and had to bid on it, and that's when I learned that for me maybe my calling was more in an interface with others than running tests.

I used to joke about the test area. Test areas are all fenced up pretty big, because we always say "keep people out." It may have been to keep us in, because we're a different breed out there in the test area than most. But I was able to survive outside the fence in that world.

We went out to Lockheed. We were almost doing a proposal, like a contractor would to NASA. And it was terrible, by the way, I just want you to know. After I moved up a little bit, started seeing real proposals, I thought "Man, these Lockheed guys must have been going, 'What is wrong with these people?'" It was so simplistic. But we were real, and they knew we could do it. We just might not have been as polished as most, how about that? I'll just leave it at that.

We ended up doing that testing for them. They had to do it as part of their agreement with the Department of Defense to show that they could test the engine domestically. So we tested the engine, plus the whole propulsion module. We put it in the same test stand where we'd been testing Space Shuttle main engines.

It was a cool program. Then to see it fly on the Atlas later was great. Now we're still flying it. It's a fantastic engine, and it's delivered many, many payloads for us and the Department of Defense. To be on the front end of that was fun.

I used to—when I did the interviews back then, a long time ago—talk about the irony of testing a Russian engine on the test stand that we built to beat the Russians to the Moon. It was always fascinating to me that we did that.

JOHNSON: History changes, doesn't it? It's really interesting. You did do testing here, and I know of course you said a lot of it moved to Stennis. But the testing that's done here and at Stennis—there's a lot of studies that NASA had to do for test criteria to protect the environment, protect the communities around, to reduce noise, and to reduce any impact on the local residents.

What kind of testing was done, and how did they come up with that? Or is that anything that changed from the time they were testing early on, like you said the Saturn V, into Shuttle or the RD-180? Did it depend on what you were testing?

LIGHTFOOT: Yes, it depended very much on what you were testing. In the Apollo days of course I wasn't here, but the stories I would hear. When they tested the Saturn V first stage—I want to say they did it five or six times here, I can't remember exactly—they just paid insurance claims

like crazy. Because you're tearing people's houses up and china would fall off the walls and windows would break.

By the time I got around to testing, we're testing Space Shuttle main engine, very high frequency, didn't have the rumble like a Saturn V would. We didn't have any challenges with that at all. When the RD-180 came in, because it was liquid oxygen and kerosene like the F-1, there was a lot of concerns about the noise level. So we did a lot of balloons. We would do things to make sure we weren't going to reach from a sound level outside the gates of Redstone Arsenal [Alabama]. We did a lot to do that.

Most of it's not the direct noise coming out of the flame bucket. It's more what they call—there's a noise that goes up and it may hit a cloud deck or even an invisible layer of something in the atmosphere and reflect back down. When that reflection hits the one that's running along the ground, it almost multiplies the decibel level that you get. They call it acoustic focusing. There was a lot of concern about that.

We probably overthought it a little bit. I remember the first test we ran, the guy that had helped me with all the modeling and all the analysis of that, he actually had a noise meter and was outside the gate in the area we were worried about. About 10 minutes after the test my phone rings and it's him, and he goes, "Can you tell me when the test is going to go?" I went, "We already ran." It was one of those cases where I went, "Ooh God, I wonder if our modeling was conservative," because he didn't even know we ran the test.

But we did a lot of that. Really didn't have to worry. One of the reasons a lot of testing moved to Stennis—they had a huge buffer zone. Stennis has an enormous amount of acreage around it intentionally so that you don't run into that problem. But we were concerned because a lot of the area outside the arsenal, the direction the flame bucket points—which is pretty much

west—had been developed residentially, and so we were a little nervous about that. But it ended up not being a problem.

JOHNSON: On days like this it wouldn't be a good test day, is that correct, because of the cloud cover?

LIGHTFOOT: No, probably not. They probably wouldn't let us test today. That reflection off the clouds, that's what causes that focusing. It can be really loud when it gets there.

JOHNSON: That's interesting. You moved pretty quickly. As you said, you got the job with NASA to be the program manager for that project. Then you moved to deputy division chief for the Propulsion Test Division in '98. Talk about what you did as that, then after that you went to Stennis where most of the testing was done.

LIGHTFOOT: Yes, the opportunity to move up to be the deputy—I'd been a team lead. The deputy division chief came open. The person that was in the division chief job called me and said, "Would you please apply for the deputy?"

All that really was was I had the entire test area instead of just—when we were doing the Space Shuttle main engine testing and the Russian engine testing—we did some other testing too by the way out there, but that's what I was mostly involved in. That was called the West Test Area. Where I did the O-ring testing was called the East Test Area. So it was two different areas, basically one side of the road or the other. When I became the deputy division chief I had both. Both fell under my responsibility, so helping the division chief run that.

He asked me if I would apply. Well, several people asked me if I would apply so I was like, "Well, I'll move up and do that job." It was my first step into management, if you want to call it that. Other than being a team leader, that was the thing I did.

JOHNSON: At the time was it an easy step into management? You said you had noticed that you were good at communicating with people.

LIGHTFOOT: There's a story in there. When I was running technology tests, even though I was a test conductor at some point I got pulled up to be the program manager of technology testbed. I came up to do that. When I say up—I got out of the test area, there was another building.

So I was sitting in there, and we actually needed to run a test. All my test conductors were on leave, it was the end of the year. I still thought I could do the test, right, even though I was in a management position. I am absolutely positive my ego got in the way. I said, "I'll go run the test." I went back, and it wasn't very long into the countdown I realized this was a mistake because I had not been following along as closely because I was the program manager. I was worried about other stuff at the time.

It worked out fine. The engine test went fine, everything went fine; my team was going to take care of me. Luckily nothing popped up. I'm not sure that if anything had popped up it'd have been a problem, but it was very clear to me that was my last test. Even when I took that position, that position was always a one-year rotation. I always figured I would go back and test.

I remember going back home that night and telling my wife. I said, "That was my last test." It was pretty emotional too, because I love testing. But I knew it was wrong, and I

probably should have not run the test. I probably should have let somebody else and let me just be their backup. But I love running tests, so that was part of it.

That was my first foray into realizing that I wasn't going to be in the technical side anymore, that I felt more comfortable on the other side. What I found, again, with the RD-180 stuff was I could actually help my team get work. I had the ability to actually go out and get more work for the test area than actually doing the work.

When you take that step—my buddies in this field have had to make that decision, when you go from the technical part to the management part. In some ways it's depressing, and in other ways you see how you play it out in a different way. You bring your skill set.

JOHNSON: You have to figure out what your skills are and use those skills the best way you can.

LIGHTFOOT: Yes.

JOHNSON: You had that background in communications because of the interest in journalism early on. Maybe that helped you communicate a little bit better.

LIGHTFOOT: Maybe, I think maybe it helped. I think most of my advantage there was just my mom and dad, my dad in particular.

I worked at a summer camp in college before I had that job. I worked at a summer camp and I was the story guy. They called it the "hike dude." The hike dude had to tell stories because the kids would get tired. Bunch of fourth, fifth, and sixth graders you're taking around

all over this place. You're doing campouts, you got to tell all the ghost stories. I had to tell all the stories, and I was the storyteller. It teaches you a way to tell a story that brings people in.

People have told me there's an authenticity that comes with that, there's an approachability that comes with that when you share those stories. I think that was innate for me for whatever reason, I can't explain why. I would say that was innate, and probably one of the reasons that my writing was okay from a journalism perspective. I don't know what came first, but most of it was my dad probably. My dad was a pretty sharp guy but you wouldn't know it. He was just laid-back, but he could tell lots of stories.

JOHNSON: Communications is important, especially as you mentioned the engineers, the fencing maybe to keep them in. Not all engineers can communicate as well as others, so it's probably a good thing that you could.

You did go to Stennis and you became the chief of the propulsion test operations. Do you want to talk about that move to Stennis? Did you physically move, your whole family move?

LIGHTFOOT: Yes, yes. My wife is a native Huntsvillian, fourth generation, and the first time she'd been out of this town. We moved down there. My daughters were first grade and third grade at the time, so it was uprooting them. We did that, we moved down there.

The opportunity was that I could get back into testing. The testing up here was getting less and less. In some ways, though—Marshall was developing a lot of propulsion hardware and they needed a place to test it. I think, bluntly, I've always been a bridgebuilder in my career. So what I wanted to do was build a bridge between Stennis and Marshall.

When I went down there you could look at it two ways. You could say, "Okay, he went to Stennis, he's a traitor." And if you were at Stennis you could say, "He's a spy." However you want to look at it, but my goal was to get the two teams together. Me and one of my other friends down at Stennis—probably couldn't even do this today—but we rented a bus, a big bus, and we came up here to Marshall, and we picked up all the propulsion developers. It's a six-hour drive from here to Stennis. Guy's name is Mike [Michael C.] Dawson. Me and Mike Dawson sat up at the front of that bus and took questions from the propulsion developers the whole trip. Then we toured them around the site down there, showed them what we were doing for them and what we could do for them in the future.

Most of them knew me. So it was okay, wasn't terrible. But at the end of the day the goal here was "Look, we got to work together, so let's try to do this." I think that night we had a shrimp boil or crawfish boil depending what season it was, I can't remember. Had them all over and did that, and sent them back the next day.

I'll never forget one of the guys out at Marshall wrote a trip report that got shared with me and said, "We're at the shrimp boil and one of the Stennis guys says, 'I got to leave. My kid has a soccer game.' Kind of hard to be mad at people that are dealing with the same stuff I'm dealing with, because I'm missing a soccer game." So that was pretty cool, it worked out well from that standpoint.

But for me the cool thing was I went down there in operations. They were trying to activate new facilities that they had basically been given. These are high pressure, these are just incredible facilities, and they were having trouble with the activation part. A couple of people at Marshall actually said, "Hey Robert, the propulsion test job is coming open. Operations job is coming open."

That job was held by somebody you probably have talked to, a guy named Bill [William W.] Parsons. Parsons had that job, and he went to Houston to work for Mr. [George W. S.] Abbey. When he did that, that job came open. I didn't know Bill Parsons. I go down there, I take the job, and I'll never forget—they open the job up. [L.] Boyce Mix was the boss, and then Roy [S. Estess] of course was Center Director.

I had to go interview with Roy, who ended up becoming my mentor. I get emotional thinking about Roy, just because he passed too soon. Just a great, great man. Oh my goodness, great, great man. We went back and forth. He had Mark [K.] Craig interview me. It was one of the most bizarre things I've ever been in in my life. They ended up selecting me. I felt very fortunate for that reason, and I got to learn from him over time.

But I got down there. It was really just activate these facilities they'd been given, from an overall perspective for the nation. It was hard, that was really hard. I had operations. My counterpart was Rick [Richard J.] Gilbrech, who's now the Center Director at Stennis. Rick was running engineering design and I had operations. We were trying to get all this done moving forward.

That was the move. The first move, as we did that. And I had a blast. Ultimately, I moved up. Boyce Mix retired and I moved up into that position to run the whole, what they call, Propulsion Test Directorate. To be honest with you, I was in my dream job. That was 2001, 2002, and I was kind of done. I was pretty happy, 38 years old, I think, if I remember correctly. Man, life was good.

Then we lost *Columbia*. That was a game changer for a lot of people, a life changer for a lot of people obviously. Crew's families for sure. But that was what probably started the whole next set of steps that went on.

JOHNSON: Let's talk about that day that the *Columbia* accident happened. Talk about where you were and what you did right after that and what transpired immediately following it.

LIGHTFOOT: I was at home, Saturday morning. I remember it very well. It was the last flight planned that was going to come over the United States coming home. I lived in Mandeville, Louisiana, which is on the north side of Lake Pontchartrain. They told us, "You'll be able to see the Shuttle coming home."

I'd never seen a Shuttle coming home, so I thought that'd be kind of cool. So I took my two daughters and we went down to the lakefront and we were there with a couple of sheriffs and sheriff deputies because the sonic booms they knew might get people spun up. Everybody said you'd be able to see it. Then they said, "But you never know."

We sat there on the lakefront. This was before cell phones, this was before all that stuff. I'm sitting there on the lakefront and I'm looking at my watch. I'm going, "Ah, I guess we just missed it, we just must have missed it." Climb back in the car, we went to Burger King [restaurant] to get the kids breakfast. I remember that very well.

I walked into the house, and we just come bebopping in the house and my wife looks at me. She says, "You don't know, do you?" Because she didn't go. I get goosebumps just thinking about this. The TV is on and it's the infamous debris picture because that's all they really had to run as they talked about it. I said, "God, I don't know what to do. I'm just going to go to the office." Did like what everybody else did.

Bill Parsons was the Center Director at the time, he'd come back to Stennis by then. Most of the senior management team, we just kind of—I don't know. If I remember correctly, I

took a shower. I remember my youngest daughter, coming up—she may have been third grade by then—she goes, "Dad, what does this mean?" I remember saying, "I think things are going to be a little different for a little while. I really don't know."

I got in the car and headed out to Stennis and we just all got together, "What can we do?" Stennis is such a smaller part of that whole family. A lot of helplessness really, honestly, with "What do you do, what happened, how did it happen," all that sort of thing. We went through the same process everybody else did, I'm sure, from the overall process. Then Parsons got pulled over, [NASA Administrator Sean] O'Keefe asked him to come run the Shuttle Program. When was that? I want to say April, maybe May, he moved on over there.

Mike [Michael U. "Rudi"] Rudolphi was the acting Center Director at Stennis at the time. I think Rudi followed Dave [David A.] King up to West Texas at some point. To sync it back to what I said earlier, when I said I was in the job that I wanted. I remember Rudi coming in my office. This was May, I want to say it was May of 2003.

I had my feet up on my desk. I was just sitting there looking at a status report. I was pretty good. He walks in and says, "Hey, what do you want to be when you grow up?" This is a famous thing that Mike Rudolphi would say, "What do you want to be when you grow up?" You knew when he asked you that question you should not answer. You should never answer.

But for some reason in the back of my head I made some comment, "You know, I've been in this Agency this long and I've never been to [NASA] Headquarters [Washington, DC]. So Headquarters might not be a bad thing."

He goes, "Yeah," and we talked about some other stuff and he left. He came back about two hours later and he had this really sheepish look on his face and said, "Hey, you got to get on a plane tomorrow. You got an interview in DC."

I'm like, "Oh Lord, what have I done?" I remember telling my wife all this. She's like, "What?" I go up there, and I'd never been to NASA Headquarters in my entire career. I go to Headquarters, I had to find it. Go in to interview with Mike [Michael C.] Kostelnik, who was the Deputy Associate Administrator for [International Space] Station and Shuttle. He had Station and he had Shuttle underneath him.

The person that was running Shuttle at the time was a guy named Parker Counts, who used to be here at Marshall, and Parker was retiring. He didn't tell me that, by the way. And the person that was running Station for him was Mark [L.] Uhran. You may know who Mark Uhran is. Mark was doing that, so looking for his counterpart to run Station.

I remember it was a fascinating interview. Kostelnik, who was a former two-star general in the Air Force, could not believe I'd never been at Headquarters. Because in his mind that was Pentagon, and how could you become a general officer—an SES [Senior Executive Service] is kind of a general officer equivalent over there. "How could you become that and not have come to Headquarters?"

By the way, also I'm not naive enough—I was not the first choice to do that job. I knew they were looking for somebody to go do it, I wasn't the first on anybody's list. So we went down that path. It was actually very interesting. I was thinking "Man, do you really want me to come up here?" It felt that way in a lot of ways.

Then I walked in to see Bill [William F.] Readdy, who was running—it was Code M at the time [Space Operations Mission Directorate]. Reads had some sage advice for me as well about it, which was trying to give me an indication of what the DC environment was. "Whew." He tried to help me.

I went to see Lynn [F. H.] Cline, who was his deputy. She was the deputy and Lynn was awesome. She was very encouraging and said, "Look, you'll get used to the pace, you'll get used to all this. We really could use the help." I somehow know that I said yes. I don't really know how, but I did. I said yes, and uprooted the family again. I went up there for about a year before they came up though because we were traveling, we were all over the place for Return to Flight.

Bill Parsons had actually called. Bill, who I'd gotten to know very well of course since that time. Parsons was pretty much—he said, "Look, I need a friend in DC. I need somebody I know." We talked every morning and he would yell at me. Get it out of his system, that's what he used to say. I used to laugh at him saying, "All right, get it out of your system, just go ahead and yell."

He and Kostelnik had an interesting relationship. I was in between them all the time. But it worked, it all worked. We got back to flight. The first big job we had was getting the Return to Flight implementation plan written after the CAIB [*Columbia* Accident Investigation Board] report was dropped. That was fascinating.

I learned—I met so many just amazing people. Because you got to remember I had just been doing Space Shuttle main engine stuff and I really didn't have responsibility for that. Marshall had that. We were just doing the testing, we were just bringing and running engines. My involvement with the Space Shuttle Program was actually pretty small. Very minimal actually, just from Space Shuttle.

Part of this whole thing for me that was so exciting, so interesting, was I got to meet some amazing people. I hate like hell that it was because of the accident, but I wouldn't give back the relationships I got, the people I got to know. Bob [Robert D.] Cabana, Ellen [L.]

Ochoa, Terry [Terrence W.] Wilcutt—all these different people that I worked with for the rest of my career.

That relationship was forged in trying to get back to flight and really just doing it the right way. I met some just amazing people, people that I think are just heroes for how we got back to flight. Would have never had that opportunity, I don't think. I could have been still sitting there with my feet on my desk running tests, which is where I thought I'd be.

I did that for a couple years and I learned a lot about DC. I think my bio [biography] sometimes says I was leading the Return to Flight efforts. I didn't have anything to do with Return to Flight efforts. Unless you talk about the political piece, and briefing OMB [Office of Management and Budget] and briefing the [Capitol] Hill.

JOHNSON: Let's talk about that a little bit, because you were an engineer and you liked testing and you felt like you were in the right place. You'd been at Marshall and Stennis. Now you're at Headquarters and having to deal with OMB and you're having to deal with congresspeople.

LIGHTFOOT: And Headquarters themselves, by the way.

JOHNSON: And Headquarters themselves, which is completely different.

LIGHTFOOT: It's different to any Center.

JOHNSON: Just talk about that transition for you.

LIGHTFOOT: You know, you just fall back on the same stuff you learned as a test guy. I've always said that testing is probably the ultimate systems engineering job. Every piece of hardware that shows up, it's usually behind schedule, it's usually over budget. It's not where it's supposed to be and they want you to pull some miracle to get it all done. That's what test guys do, that's what you do. You're ultimately the integrator of all these different things.

I felt like when I was in DC, I just had a different set of systems. When I work on an engine, you've got lines, you've got valves, you've got ducts, you've got turbomachinery. Those are the systems that you're trying to put together. In DC you've got the Hill, you've got OMB, you've got GAO [General Accounting Office], you've got the IG [Inspector General]. You've just got different systems. You've got to figure out how to make those all work together, work for you.

It was just really interesting to learn the different way of thinking. I remember one particular meeting on the Hill. We were giving an update on where we were. This one guy, we were talking about something—I don't even remember what the topic was—but he was clearly not happy with the way we were going.

He was a staffer for one of the [congressional] reps[representatives]. I want to be really clear, especially with this being an oral history. Staffers are just worked to death, oh my God. I don't know how they keep up with everything that their individual members [of Congress] have to deal with. They get me one hour a month maybe, or one hour a quarter.

So now I'm expecting him to remember exactly what I told him last time. "You're supposed to know everything, what's wrong with you?" But I remember this one particular staffer said, "Well, I don't know if my member is going to vote for you to fly if that's what you're doing."

I looked at him and I went, "Your member doesn't get a vote. That's not the way this works, I don't understand." But the guy was probably 24, 25 years old. He didn't mean it in a bad way, he was just concerned about what we were doing. I remember thinking, "This is fascinating."

I can remember a particular staffer I gave a briefing once, General Kostelnik didn't come. He sent me to do the briefing, and the staffer just yelled at me for five minutes about "Why is General Kostelnik not here." I'm thinking "Wow." The first time that happened—because I'll get to the second time in a minute.

The first time that happened I kind of took it personally like, "Wow, I can brief this, it's no big deal." The second time I went back was like a month later, and again I hadn't seen this person at all. Walk in, same thing. Yells at me, "Why is Kostelnik not here?" I remember thinking—it just clicked, "Ah, this is theater." It's as much theater as it is—has to make the point in front of everybody else in the room that they requested that the general be there.

Once I realized that, I developed a pretty good relationship with all those folks. A really good relationship actually. My relationship with folks on the Hill was probably better than what I had with the White House. But I didn't really have that much interaction with the White House. Some with OMB when we were talking budgets, but that was about it from that standpoint.

Later I had plenty interaction with OMB and the White House, when I got up there in '12. But I did that for a couple years, and I had promised Readdy I would stay till the first flight. Didn't realize it was going to be that long before we got back to flight. That's the way that worked.

JOHNSON: While you were there, President George W. Bush, his Vision for Space Exploration was announced, which was going to close out the Shuttle that you'd been working on and change the direction. The first of many we've had since then, but let's just talk about that period and when that announcement was made and the direction that he wanted to go in closing out the Shuttle Program and how that was handled, especially working in the area that you were working in at the time.

LIGHTFOOT: Clearly it affected us. What I got asked to do immediately was be the guy to start doing transition and retirement planning. If you remember, we were still trying to do Return to Flight, and so 2010 was so far away. To me it just seemed like forever away. I'm like, "Okay, whatever."

But we can start talking about where all our property is, "What does it actually mean to transition out?" Because even in the Shuttle Program we still had stuff left over from Apollo that we were carrying. So I put a small team together to start doing transition and retirement planning. Dorothy [S.] Rasco, Karen [D.] Lucht, Ruth [G. Caserta] Gardner, Loraine [M.] Shafer—a whole bunch. All these good folks that came in and helped me.

We put a pretty good plan in place. We executed it for the next six years, and we actually executed it pretty well. Frankly, the Shuttle—when we retired it, we got property off the books. We did it in a pretty good way, I thought. I was really proud of the team executing it. Dorothy took over from me later when I went on to do the jobs here at Marshall. She tweaked it quite a bit based on what we were learning, and she'd done some stuff like that before at Palmdale [California, assembly facility] for the last Orbiter.

I think we were so focused on Return to Flight and announcing the retirement—part of it, probably deep down inside we thought that was actually saving it. That we were going to be able to finish out the manifest, get the Station built. Without that people might have said, "Golly." It seemed like that was now the Shuttle's mission, this was it.

It kind of gave it a final mission. I mean, you saw that. You saw in 2011 when we flew the last time, the amount of people that walked with [Space Shuttle] *Atlantis* back to the OPF [Orbiter Processing Facility] that knew that was their last day. It's an incredible dedicated workforce surrounding it. That's what's drawn me to this the whole time, watching these teams just do what they do.

But I don't remember thinking much one way or the other, other than "That's a long way away." I think we can compartmentalize that way, a lot of us do. It was 2004 I think when he made the big announcement. I remember thinking, "Six years, wow." Six years ago was 1998, I was in Marshall Space Flight Center. I wasn't even at Stennis yet. I was thinking, "That's a long time from now, and we got Return to Flight right in our face." It was interesting, very interesting.

JOHNSON: I would think it would have been an interesting time, since you were, like you said, working on Return to Flight and then having to think about canceling the program at some point. One of the things I saw, while you were there you worked on the technical and budgetary oversight.

LIGHTFOOT: The whole time we were doing Shuttle Return to Flight, the Shuttle had a certain budget that was already appropriated to it, so what was going to be the delta [difference] because

of the Return to Flight activities that were going on? Having to build those budgets and go to OMB and the Hill and defend them was part of that. Again, I'll just say it was just part of that learning curve of being in Washington, DC.

Honestly, what you saw was a tremendous amount of support. People really wanted us to get back to flight. I will say that there was never any question about that. There was a lot of question about our ability to predict how much it was going to cost and when we were going to do it. That was probably the bigger thing. That was just hard, it was just hard.

JOHNSON: This would probably be a good place to stop because after that you returned, you went back to Marshall.

LIGHTFOOT: That's fine.

JOHNSON: All right, I appreciate it.

[End of interview]