# NASA DISCOVERY 30TH ANNIVERSARY ORAL HISTORY PROJECT
# EDITED ORAL HISTORY TRANSCRIPT

CATHERINE L. PEDDIE
INTERVIEWED BY SANDRA JOHNSON
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JOHNSON: Today is May 11th, 2023. This interview with Catherine Peddie is being conducted for the Discovery 30th Anniversary Oral History Project. The interviewer is Sandra Johnson, and Ms. Peddie is joining us again today from Goddard Space Flight Center in Maryland and we're talking over Microsoft Teams. I appreciate you talking to me again today.

When we were talking last time, we were talking about the fact that this was one of the President's goals, to get back to the Moon. LRO [Lunar Reconnaissance Orbiter] was considered an important mission, and you mentioned a couple times that you were given a blank check, and you said you wanted to tell that story. I know we talked about how some of the people reacted on other missions, but I was wondering if you had more to say about that.

PEDDIE: Okay. First of all, thank you again for taking the time, Sandra, to interview me, I really enjoy speaking with you. I also wanted to again say all glory and praise to God for my life and my NASA career and this opportunity to speak with you. LRO used to be part of, at the time, the Constellation Program. I think the Constellation Program had a lot more piece parts to it, and I don't recall all of it, because I came into LRO just as it was going into its preliminary design review [PDR] phase. LRO was a very fast mission, and by the time we got into that a lot of these missions had been stopped or canceled and Constellation actually I think was canceled, and things were changing.

I think consequently to that, LRO got raised. It was supposed to originally, I think be the scout mission, so it would be the first mission, explore the Moon, and then there would be subsequent missions coming after us, because part of it was establishing a base on the Moon, and then moving from the Moon and beyond. Maybe Mars or beyond, that kind of thing. But establishing a presence so that we could eventually move human beings outward.

I used to describe it to people as like when you're going on a cross-country trip you need to find out where the rest areas are so that you can go to the restroom and get some food before you keep on your journey. That's basically what LRO was going to help do, was map the Moon so that we could find places where we could establish a Moon base, and then people could keep going on from there.

As all these missions fell away, LRO got elevated from scout mission to flagship. It was the preeminent mission for this President's *Vision for Space Exploration*. NASA has a really well-thought-out disciplined process of how we categorize our missions and move them through their design life. For example we treat a Small Explorers mission different than like a MIDEX [Medium-class Explorers] type or a flagship mission is something like a James Webb or a Mars rover, multibillion, sometimes astronauts if they're going to come in contact with the [International] Space Station or something, then those are Class A, and NASA takes a lot more stringent rules in doing that.

LRO was a Class B/C, so it wasn't quite a flagship but it also wasn't an Explorer, it was in the middle. What that means is certain levels of testing, certain levels of material processing we didn't have to do. All of a sudden, we were getting raised to a level that we were not originally supposed to be.

We were a single string spacecraft. What that means is there was no redundancy, and typically in a higher-level mission you have redundant systems so that if one system fails it can fall over to the other. But LRO wasn't designed and built that way, because again it was supposed to be a scout, get out there, scout, and leave the rest to everyone else. But instead it became the mission.

Management at the time were like, "Well, hey, what do you need? Whatever you need, we'll get it for you." Craig Tooley and I at the time, you don't hear that. You never hear that at NASA typically. Your budget is cut. You have to cut, reduce, whatever. Craig and I were like, "What? Well, let's test this out."

Boy, whatever we wanted, we got. The Associate Administrator, I think he was one of the—Doc Horowitz, Scott [J.] Horowitz, was one of our [supporters]—he says, "I'll get you whatever you want, you tell me, I'll go get it for you." We're like, "Okay."

We started buying multiple pieces of things. Because we knew our schedule was so fast, we said, "Hey, we're procuring this transponder. Let's buy four of them. Can we buy four?" Yes. Buy four of them. Okay. You always wanted to have a spare, and the good news, I can say we didn't waste the money. A lot of LRO's multiples that we bought we donated to other missions after us. A lot of people inherited LRO hardware and got to use it, so it didn't go to waste. We did things like that because they wanted us to make the schedule go even faster. Their thought was if we throw money at you, then you can get done yesterday.

There's this thing called time, and it doesn't matter how much money you throw at us. We can't shorten the time it's going to take something. If it's going to take a week to build something, it's a week. You can't make people go faster or machines go faster. It is what it is. We had to explain that to I don't know how many NASA senior—what do you mean? If we give

you another $1 billion, like in two weeks can you get done? We're like, "No. The space-time continuum doesn't work that way. We can't control the laws of physics. It just happens."

One of the areas that Craig and I, we thought okay, well, let's look at this one area. It was the building of our electronic boards. There was this manufacturer here in Manassas, Virginia, BAE Systems, and Craig and I said, "Well, we can drive there. It's only like 45 minutes on the Beltway. Let's drive to BAE and see if we can speed them up."

Craig and I got in the car. We drive out there, and we're having a good old—there's some lunch, we'll just visit these people. It was the most humbling experience of my career. We go in there, and they're really nice to us, welcoming us in, and everything. What can we do to speed up your production of our electronic boards? They just ha ha ha, laugh at these two NASA project—you're so cute asking us this question. We're like, "No, seriously. Management is going to give us money. Money is no object. Can you do it?" They said, "Well, come with us."

They gave us a tour of their facility. Like ooh, get to see BAE. We saw these wonderful human beings that sit there, and all they do for—and the union has a specified number of hours that a human being can do a particular [action,] and they're sitting there step by step putting certain pieces on.

I'm like, "I'm really sorry I'm asking you to do all this." I'm like, "Can you automate that?" In some areas you can, but in other areas you can't. We wanted specific flight programmable arrays. They're just little nuances that we wanted for our mission. You can't really do that. The best thing they found was a human being putting that on. These human beings are not just like—they can't have the Cathy Peddie go in and do it. Do you need my help? No. You're not qualified. There's all these certifications they have to go through, and they have to maintain their certifications.

Craig and I walked out of there. We walked in thinking yes, we got money, and we're going to make you go faster. We walked out of there going, "Oh, oh, we are so screwed. We can't make this go any faster. Even if we try."

I remember Benjy [Benjamin] Neumann. Carl [E.] Walz was our director. He was another astronaut. Benjy came to Goddard. I remember him walking me across that parking lot over there. He says, "Cathy, really, we've got this money. What can we do to make this schedule go faster?" I went, "Benjy, I know I'm going to regret this for the rest of my career. Because you're offering me a blank check, and I have to turn you down. Because I can't make those electronic boards go any faster."

The blanket ladies. I think I mentioned before going over to the thermal blanket shop. I used to call it the haute couture of spacecraft. They made these tailored blankets for all parts of our spacecraft or all spacecraft. It's touch labor. It's a skill. It is what it is. Some of the thermal blanket material requires particular handling. I used to really shake my head at our thermal engineers saying, "Why did you pick that material?" It's the best because we're on the dark side of the Moon and all that. But when you touched it, it smudged it, and it was not usable. The ladies and all of us even in handling, the blankets went on at the very end, but even in handling it took a long time. You didn't want to smudge it because it would mess up thermal properties of it. Here I am telling Benjy Neumann, "I can't speed that up. It's going to take what it takes to put it on there. You can throw all the money at me, but I can't speed up time."

I still regret that because every job after that it was cut cut cut. I would ask for more money and like no, we don't have it. I just remember being in that parking lot turning down a blank check.

JOHNSON: They expected that money to make things go faster, those expectations were out of line, but at the same time that put pressure on you, and on the team, to get things done faster.

PEDDIE: On the team, yes.

JOHNSON: Balancing that with keeping things safe at the same time and not making those mistakes.

PEDDIE: Exactly, and caring for the people. Because I think the untold story on LRO and in all missions is that there's this human cost that nobody talks about or acknowledges. Being the bleeding heart that I am, I talked with a lot of people who were having serious personal issues because if your family is not on board, and you're rarely home, and we worked through weekends and holidays. Craig and I used to bring out food. We brought the holidays to the people. Fourth of July we had cookouts out here. Thanksgiving, Christmas, New Year's we would bring the holidays to the people because they were working.

In order to make that schedule everybody had to work. Then also people were burning out. There's only so much you can do. Just like those people doing the electronic boards. It was the same thing with our team. Not only did they have to assemble it, but then we had to test it. The testing is a 24-7 kind of thing. Then if there was a problem, and there were a lot of problems. We should always expect problems because you work through them and you want the problems to happen here on Earth so that when LRO, we can't go to the Moon right now and go fix LRO. But there's problems and you work through. That takes time too.

I think people like to have the idealistic view, if we give you a lot of money. Doc Horowitz, he was so cute. You need an expert; I'll go throughout the whole world and hire you that expert. It's like great, bring that expert in. But there's still time. Can you move time? No. They were all trying to—because an election year was coming, and that was part of the thrust, you need to launch before that election year. I'm like, "That's not our fault." The human cost was I think pretty high with it too. Even though that blank check couldn't cover that either.

JOHNSON: You came right at the beginning; you said right before the PDR. But there were other reviews and other testing and all that that was still going on. Maybe just talk about that for a minute. Making those milestones, moving up through launch, and how that worked. Like you said, there were problems. I'm sure a lot of that with the testing sometimes you found those problems as you tested. But just talk about that schedule that you were trying to follow as far as all those reviews and testing.

PEDDIE: Yes. Whew, that schedule. I learned to be really—oh, goodness, not only organized and precise, but really succinct and get rid of the stuff that you really don't need. I'm not throwing stones because I think our NASA process is really good and we do a good job of wringing out what needs to be done at each design review. But there's some fluff in there too. A lot of these reviews are dog and pony shows, and that's what people call them. Everybody stands up.

I used to appeal to management like please. At the major reviews where we had to have everybody come, from different NASA Centers, and of course we had science teams from all over the world, their contributors and all that. But we would have that. But all the lower level.

The mission level reviews were one thing. But each subsystem and subassembly had reviews. NASA likes to have a lot of reviews and have a lot of people at it, and Craig and I pleaded and implored and so did all our people, "Please don't make us go through that on every single review, because we will not have time to actually build LRO."

Because a lot of these reviews, they want a document drop 60 days, 30 days prior. Then it's a whole week, and then all this other stuff. Every day was like not just gold but platinum and diamonds to us. Every minute mattered to us. We said, "Every time you take us away from that, that's like a minute-by-minute hit to our schedule and a delay."

A couple of our leaders got it. They helped us. Like I said, Benjy Neumann and Carl Walz at Headquarters helped us. Mike [Michael] Ryschkewitsch. They were like, "All right, what do you want to do?" We said, "What did they do in the Apollo days?"

I think they did tabletop reviews and they all—can we just do that? You just get the experts. We're not saying we're hiding anything. Can we just get who needs to be in there? If somebody wants to watch, fine. But can we just give you our drawing, spread it on a table, and say, "Here's what we're doing" or take you to the room where we're building it and say, "That's what we're doing. Do you have an issue with that? What about these drawings?"?

Mike Ryschkewitsch was, "Let's do it." That really created some breathing room for our team. But then we couldn't get away from the top-level mission reviews. Those had to be the big production and planning for those was really tough. Craig left that to me, and I'm like, "Okay, yes, sure." I naively said, "Sure, I can do it."

We had so many people that wanted to come. Because remember, everything was falling away. All of a sudden LRO got elevated to this mission. I couldn't fit into any rooms around here.

I was like, "Okay." I would send out an invite list and say, "Can you give me your top 20 people or 30?" Based on room capacity and building people and fire departments, they don't want you to exceed and kill people, they can't get out of the room fast enough.

When I gave these limits, oh, people were so upset. They were calling my management, the Center Director, Headquarters. How dare she keep us from this meeting? I'm like, "I can't find a place big enough to bring people in. Where do you want me to go, the stadium? I don't know where to go." I had to have management help me corral the situation and a lot of our meetings were standing room only. There were people all over the place. Watching us.

Craig and I would be looking around the room. Oh my goodness. Because again LRO was supposed to be this little mission. A scout. All of a sudden it became larger-than-life.

We had some good caretakers. Like I said Benjy Neumann and Carl Walz and oh gosh, his name escapes me, there was another guy. They came in to try to provide cover. They said, "We'll slay the dragons for you. You just keep going."

Craig and I were like, "All right. Just keep your head down and keep going." Craig is like, "Cathy, you know that doesn't happen very often."

I go, "It doesn't?" I said, "I think we need it if we're going to survive." Because it was fast but then also this political scrutiny. It was like do we focus on this or do we look behind. I'm sorry, who did we politically offend this time? We're just trying to get this done too.

Also here at the Center, they gave us the priority card. Oh boy, that made a lot of enemies, because like oh, how dare you, how come you're first, and all this. That's how I got to know a lot of people. I would go meet with them and me and Craig. Hey, can we work with you? You're in this test chamber.

They go, "Yes."

I go, "We're." Oh, you're LRO. I go, "Hey, why don't you finish your testing? Can we help you and then you help us? We're not here to boot you out but can we help each other? Because we just want to test. We're not here to boot you out." You know what, that's how I got a lot of friends here, got to know people, let's work together. They helped us with our equipment. We helped us with theirs. If they needed a spare something, we would give it to them. We would trade people. We traded knowledge.

Liz [Elizabeth] Citrin was one of the project managers of SDO [Solar Dynamics Observatory]. That was going at the same time as LRO. She came up to me, she goes, "This is all you, right?"

I go, "What do you mean?" I had happy hours between both projects. If we were having a party or we brought it to the test chamber we would invite the other people, because we knew we'd be testing with them. NASA is a small world. You're going to be working with all these people again. It's not our fault that they made us a priority and we're trying to meet this President launch date or something. Can't we all just work together? We all started to work together at the working level. But the management, they might have been fighting. But those of us in the projects and the teams and in the facilities, we were all getting along.

When they said, "Oh, can we help you with your?" No. We don't need your help, management. Because we were working it all out. Cutting deals. Some people would say, "Hey, I could use so-and-so on my upcoming test. Can you do it?" I'm like, "Well if so-and-so can, sure. But let's try to help each other out and work together and not kill this person, because they're a human being, and if they need sleep let's let them sleep and let's feed them. But if they can help you out on your test and help us out on our test, great. But let's check with the person."

That takes time because we were negotiating with individuals and organizations. That's how I got to know so many people here. In fact I was new to Goddard. After LRO everyone's like, "How do you know so many people?" Like because I had to go talk to so many people. When they got to know me, and they knew Craig, then they realized Cathy and Craig, they're not here to say, "Oh, we're LRO and get out of the way." No, we were just like, "Can you please help us? We're dying here. We are dying." There were so many people that came out to help us because I think they saw that it was just a ridiculous schedule. We were out here all the time. We were always here. I think people like nobody wants to be in that situation.

I think the good Samaritans, the humanness came out of a lot of people to help Craig and I and our team. It was just a beautiful—a lot of these people have retired but we were friends for many years after LRO launched. I knew I could always call somebody and say, "I have no idea what management is asking me. Do you know? Can you help me?" I had so many people that I could just call or walk over to their office and they would help me out. That's just a beautiful place to be.

JOHNSON: It really is. It's a good situation.

PEDDIE: But those reviews were hard, besides that, then the testing. You have to have a review before the testing. Thankfully our management was good with the tabletop reviews. Sometimes we held them outside a test chamber, or wherever we were, because we had nothing to hide. There was the hardware. We were running fast. Can you help us?

Even when we had issues, I remember going over to the facility. I have people say, "Oh my gosh, we had this failure, we don't know what to do."

I go, "Oh gosh, can we call people? Can you come over to Building 7 to the test chamber? Can we talk about this? What should we do?"

Many times people will just come around. I had to get used to this. They go, "I've never seen that one." You really want somebody to come in and go, "Oh yes, this is what you do and this will solve it." But no. Many times they were like, "I don't know, Cathy." They'd be standing there like well, what should we do, Cathy?

"Me? I don't know. Well, can we try something?" I said, "Well, let's just try it. If it doesn't work, we stop. Is there another thing we can try?"

We were just trying all kinds of things till we found how to resolve the problem. We got used to working that way. I didn't realize until LRO launched and I'm with these other missions that people were like, "Oh no, it has to be all spelled out before we can do anything." I go, "No. Sometimes you get into a situation. Everybody goes, 'I have no clue what's going on.' You have to try to figure it out."

But I met a lot of people that are just not comfortable. They want to document; they want it all planned out. I'm like, "Sometimes you're in the test chamber and there is no document, there is nobody who's going to help you, so you just got to be disciplined in your approach. We're all engineers. Let's just figure it out. That's what we're supposed to do." A lot of us like puzzles and games and stuff. I think that helps. You go to your actual job at a test and it's like a big old puzzle with huge implications to your career but you got to figure it out and put it together.

This was a great team. We all got used to doing that I think because Craig and I were never punitive. The one thing we wanted was you tell us the ugly no matter what it is. We're not going to go, "Oh, how dare you?" Like tell us what it is. I think they saw that Craig and I

were there with them figuring it out. There was no punishment. We didn't say, "Oh, you designed that crappily." We never said that. We're like, "Oh gosh, okay, what do we do? How do we move forward?" That was always our thing. How do we move forward? How do we move forward? There was no blame. Some people wanted to play the blame game. We didn't have time for that. It doesn't matter who's at fault at this point. It's broken. We got to fix it. If you want to learn about that later we can. But later after we launch. Right now we got to move forward and blaming doesn't help us fix the problem.

We heard a lot of ugly. I saw a lot of ugly. There was a lot of broken stuff going on. I can say that now because LRO is successful and at the Moon and still going. But that tells me that even if you make a mistake and it breaks in a test, you can fix it, and you can make it better and make it into—I think we made it into a better product. I think our testament is that it's still at the Moon all these years later when no one thought it would be. They saw us work over there.

Some people dropped screws and washers and they were trying to shake the spacecraft to get it out. I saw people step on stuff they never should have stepped on. I saw stuff melted. People scraping stuff they never should have scraped. I saw it all. I had I don't know how many heart attacks standing outside the clean room. I was banging on the clean room door once, "Get off that wire. Get off."

"What?"

I go, "Get him off that." This fragile space wire.

They go, "Oh, I'm sorry. I didn't know I was stepping on them." Like oh my gosh. I had so many heart attacks. But LRO works. That's why I can tell people now when they all get all anxious and everything. Listen. I've seen a lot of ugly. But it works and we got good people that know how to fix it.

Nothing is perfect in this world. Don't expect it to be. I think that's part of the problem, that we had a lot of people that wanted LRO to be so perfect, and Craig and I were always managing those expectations. We're going fast. It's single string. They kept saying, "Oh, it's got to last."

We're like, "No, it's only supposed to last a year."

They go, "Well, maybe two."

No. One year. One year. We kept trying to pare down expectations so that everyone understood what we were doing. With each review, each test, we were beaten up, because I think people thought we were rebellious, we were running with scissors, we weren't disciplined enough, and that's not true. We were disciplined. We weren't disciplined to the gnat's eyelash. But we were disciplined so that whatever the as-built configuration was in that test chamber was what we had right there in the official documentation and all the test plans and data were associated with that. The pedigree of LRO was always officially documented. Did we have all the fluffy charts and reports? No. We didn't have time. If we could have that'd have been great. But no. We had the official documentation.

I think that is enough. If you have time to do fluff, great. But I think LRO has shown that you can do—I would not recommend anybody go as fast—but you can go fast and still maintain pedigree and integrity of your system, and some discipline, and move through and be successful. But each review though we were spanked and [told] you naughty rebellious people.

It got kind of hard for us. But it bonded us as a team because everybody called us the rebels. We were like, "All right, let's just own it, we're the rebels. Let's wear an eye patch, let's be pirates." But we knew what we were doing, and it was the greatest team. It's the best team.

In fact when we see each other now it's like a family reunion. We hug each other. Oh my gosh, I miss you. They're a great group of people. They're the best NASA has.

JOHNSON: Like a band of brothers, you go through fire with somebody and you band together.

PEDDIE: Yes. We were definitely in the foxhole together for a long time.

JOHNSON: You said something in there which I've heard from a lot of people. Perfect can be the enemy of good or good enough when you're building those things. I would think sometimes that's hard to explain to engineers and scientists also and some of those instrument teams. You mentioned that they were worried. You kept telling them, "We have to get you to the Moon before we worry about you."

PEDDIE: Right. No Moon, no mission, that's right.

JOHNSON: But on those instruments that were selected, you mentioned last time the Mini-RF, it was a tech demo.

PEDDIE: Correct.

JOHNSON: You said it was a navigational minefield. I was wondering if you could just talk about that for a minute because we mentioned it and then you said, "We need to talk about this."

I don't think I've ever heard it described that way. If you can go ahead and talk about that experience.

PEDDIE: Yes. LRO, when Craig told me, it was only supposed to have like two or three instruments. But like typical NASA fashion, "Oh, opportunity. Let's throw on more." It had a complement of six instruments and one tech demo. But Mini-RF got promoted to instrument status. It's considered an instrument status. It's well deserved. It's done a great job; all seven instruments have done an awesome job on LRO. I'll say that.

Getting Mini-RF to the spacecraft was a nightmare. I mean it came from the Department of Defense, I think. Or another government agency which they would never tell us. Craig and I didn't need to know that. But they were really big on well, we're just going to come and attach to your spacecraft and none of you can look at it. We're like, "That's not how it works." It's like integrated. There's this testing.

When that battle came out, I remember it got up to a couple of AAs [Associate Administrators] at Headquarters. Craig and I, I've never been to Headquarters with so many managers in a room arguing about something. I remember Bill [William H.] Gerstenmaier beating on the table about Mini-RF. It had so many issues. The material it was made out of absorbed water. We were going to be sitting in Florida for a while. I don't think that's a good idea.

The struts buckled, and we were saying, "We can't have it puncturing LRO." That kind of thing. They were having so many issues, and remember, we were racing towards getting to the Moon and they were lagging way behind. They wanted more time. Can we have more months? We said, "We don't have that. We have nothing to give you."

We were worried, "We don't think they'll make it." We were in the room with I think Doc Horowitz and Bill Gerstenmaier. He was beating on the table. If I have to fly a brick, I'm going to fly a brick on LRO. We're like, "Okay. You can tell us to do that. But we're going to recommend to you that you might not want to do that." He's a legend. To me he was a legend. I'm like, "Oh my gosh, he's upset, he's beating on the table." You don't want your managers to be that upset. It's a little scary. I remember Craig going, "Okay. We will fly a brick if you want us to."

We thought oh, okay, we're going to try to work with you. They didn't make it easy. The organization, they were a partnership and a consortium between these secret agencies. A couple. They said, "You can't be in the room with us."

"But I have to be in the room with you. If you want to turn your screen. I don't need to look. I just need to make sure that you are working with my team and not harming my spacecraft that we're building here."

There was a lot of tension. I know you're going to speak with Arlin Bartels. He did a phenomenal job of navigating with them as well as the other instruments. Some of the people they didn't want—it was like we're secret so we can't talk to you. You know me, "Hi, who are you?" "

I can't tell you."

"Okay. We're from LRO. Things we talk about—we're about to do this test. No Moon, no mission. Can we talk to you about that kind of stuff?"

Eventually people relaxed and started realizing that we're going to try to get you onto the spacecraft but there's these rules that we live by, like when you're going to go into a vibration test you really don't want somebody whose struts buckle and puncture you. We're just going to

try to make sure you're steady, safe, and secure. Here's our limit loads. We have to talk to you about that to make sure that you're going to survive the test with us. Can you share that information?

It was this detail-by-detail blow-by-blow. They eventually relaxed and realized that we were trying to get them on and help them to succeed. That's what we were trying to do with all the instruments. And that they were not going to be the ones attaching to LRO. We had these experienced technicians. You've probably seen photographs. It was very precision how they installed our instruments. It was a big deal. We had safety and mission assurance. We had systems engineering. We had everybody there watching any installation. It was a highly orchestrated very disciplined process.

I think they thought they would just show up at the launch site, pop onto LRO, and get launched to the Moon. It doesn't work that way. We typically test as we fly. If there's test as you fly exceptions, then we have to review that too to make sure that there's no harm done to either the spacecraft, the launch vehicle, human beings, that kind of thing. I think we helped them realize that that's what we were after in our whole integration and test campaign.

We had a great team doing all that that helped them. They eventually realized. I think they really hated being called a technology demonstration because they really wanted to be an instrument. That designation came from, I don't know, someone at Headquarters. I don't know where that came from. We treated them like we treated everyone else on the team. They were the ones that gave us the hand most of the time. We were really happy to see that they got promoted to being an instrument because they did go through all the hoops that all the instrument teams went through. They survived. They took some of the lessons from our engineers and our

technicians. I think when they relaxed a little and saw that we just want you to succeed so we can succeed, then they modified their instrument so that it did survive.

We had materials experts that worked with them. Goddard has a great materials group. I think we helped improve their instrument so that it could be more successful than what they had originally designed it to be. But we included them, the happy hours, the parties, because they were part of the team. But it was a lot. They gave us the hand a lot. It was a lot of working on them to get them to work with us. To this day a lot of them, again they're friends. I think that all relaxed, but boy, it took Bill Gerstenmaier pounding on the table I think, and then people going, "Okay. Let's see how we can work together here."

JOHNSON: It's hard to imagine him that angry.

PEDDIE: Yes. It always makes your heart pound when your manager—like oh my gosh. I didn't mean to upset you. I've seen a lot. LRO made a lot of senior managers upset. Craig and I saw a lot of senior managers upset. It was always shocking because Craig and I, we did not have poker faces. In those meetings both of us were like, "Sorry. Sorry. Sorry." What else can you do? They come up with these things. I told you Ed [Edward J.] Weiler threw down this piece of paper and said, "How dare you?" We were like, "What? Sorry. We didn't do that." I apologized a lot for things I didn't do. "I'm sorry. I don't know why that happened. That press release that I didn't even, I'm sorry. I don't know what's happening there."

JOHNSON: Part of your job description, apologizing.

PEDDIE: Apologizer. Yes. Complaints department was over my door, I think. Take it to her. Make her deal with it. Okay. Sorry.

JOHNSON: We just mentioned LCROSS [Lunar Crater Observation and Sensing Satellite] last time too. But that was another addition. I was wondering how your team and their team, how you managed to work together, because that was a big integration also. It was quite a different separate mission but hitching a ride with your mission. Talk about that and the relationship between the team and with Dan [Daniel R.] Andrews and Tony [Anthony] Colaprete and working with those people.

PEDDIE: Yes. I tell you it's like can you beat us up anymore when they said, "You're going to have a secondary mission." It's like oh my goodness. They said, "Oh, but don't worry, it won't interfere." It's like there had to be some interference. But Dan Andrews, oh my goodness, what a consummate gentleman and a professional. Just such a wonderful person to work with. His Deputy was John Marmie at the time, and they said it and they meant it when they said, "We won't interfere."

We were always leery. Yes, everybody says that. Then all of a sudden, it's like Craig and I having to spend a lot of time with these other people. But we really didn't. Like I said, our procurements were going through, and they jumped on it, and they wanted to take it on, but oftentimes Craig let me do most of the procurement, so me being the core, I said, "Why don't I just—do you need this? Let me add like how many do you need, four, let me just add four to my order or something and we can talk. Otherwise, to hand it over to you, that just would be too much. Just let me do it, or if you buy something maybe I could tag on to you." It was pretty

good on that. The only times we had interactions with them was at the major mission meetings, like at Kennedy Space Center [Florida], when they talked about how we're going to be manifested on the rockets and everything.

We did invite them to our reviews. But they weren't a participant in it, because I think they just used the ESPA [Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter] ring, I think. They really were noninterfering at all. In fact I wish that we had more interactions with them, because they were just so good at what they did, and really helped as opposed to—with all these other fires and people it's like what can we do to help you and stay out of your way, and they really did. We didn't have a lot of interaction by design, but I wish we had, because they were just the best.

They did a great job. I got invited to their—after launch when LCROSS—we called it kissing the Moon, not crashing. It was kissing the Moon. I got to work with Dan and John more then at their event, and that was really exciting to be with them on that event, to say goodbye to LCROSS as it did its historic kissing the Moon and discovering water ice.

JOHNSON: Yes, that's an interesting way of putting it, kissing the Moon.

PEDDIE: Yes. Don't say crash, we're kissing the Moon. Oh, okay, all right. That's a more gentler way of putting it, I guess.

JOHNSON: Did LRO have any responsibilities like the camera LROC [Lunar Reconnaissance Orbiter Camera]? Were they taking pictures of when it kissed the Moon also?

PEDDIE: Yes, they wanted to make sure our instruments were pointed. They picked the spot and made sure our instruments were pointed there. I remember our public affairs people, wonderful, but they blew it up, I think the public thought there would be this wonderful Hollywood spectacular of a huge explosion and everything. But it was like a little poof. I remember people going, "Was that it, was that all?" I'm like, "What do you mean? That's pretty historic." But no, people expected a big Hollywood explosion. She didn't, because where she landed, moondust, it wasn't going to be this giant plume thing.

But yes, I remember talking to some of the general public. I happened to be in Hawaii at the time. I'm from Hawaii and they were holding it on the Big Island where the big telescopes were. The public was waiting for a big explosion. I said, "No." I was trying to—like no, no, this is the Moon. We don't want to explode the Moon. It was hard to explain to people. We don't want to blow it up, we just want to see what's on the Moon, that's what we're doing.

The general public was disappointed, but the rest of us were really excited that that happened. They did a great job. The LCROSS team did a great job.

JOHNSON: Don't want to explode the Moon. That's a good idea.

PEDDIE: No. Please don't hurt the Moon, please.

JOHNSON: Let's talk about that. This was the first time since Lunar Prospector that NASA had launched a spacecraft to the Moon. As you said there's a lot of attention, a lot of things were going on. But did you get to see the launch yourself?

PEDDIE: That's a really funny story. I wanted to see the launch of LRO, and when I went down there to Kennedy all my managers were like, "What are you doing here?"

I go, "Well, I want to see the launch."

They said, "Well, typically the deputies are back at the Center in the mission ops center [MOC].

I said, "I didn't know that." Because Craig was going to be giving the go, and I thought well, I'll just be one of the many observers going, "Woo-hoo."

They said, "No, you should be back at the MOC."

I asked Craig, "Should I be at the MOC?"

He goes, "Well, you could come with me when they launch. You could run up to the roof and say, 'Woo-hoo, there goes the rocket.'"

I was talking to my husband. I said, "I think I should go back home to be at the MOC." Also getting our mission ops team, like I told you, remember, I had talked to the scientists. We were really struggling at the end, no Moon, no mission. I said, "Yes, I left so-and-so in charge. I probably should go back there and make sure they're not beating each other up." Because tensions were so high, and some of the team members didn't get along, so I said, "I really should go home."

I decided to go home, and my flight was going to supposedly get me there 2 hours before the launch, so I had my husband rushing me to the airport. He was going to go with me. My family and friends were there and they were going to take pictures to make sure. I said, "Oh no, we're missing the launch." Andrew is like, "That's okay, we'll get you home."

Our plane got diverted and we were circling Dulles for a while and I'm like, "Oh no. There's this launch. Oh my gosh. What am I going to do?"

We land, and my husband said, "Okay, you run. You just head to Goddard. I'll get there as soon as I can, don't worry about the luggage."

I grab my purse, I'm running, I grab a cab. You know Washington, DC, the Beltway, we hit traffic. I told this guy, I said, "Could you please get me to Goddard before?" I forgot what the launch time was. Could you please get me there? Oh no, I don't think I'm going to make it.

I was on the phone with people there because they were waiting. Cathy, are you going to make it here? I go, "I don't know." I was on the phone with people. Oh my gosh, I don't know. Maybe I'll listen to the launch on the phone. This taxicab driver, bless him, he found a way, got around the Beltway, got me to Goddard, like 15 minutes before the launch. We come into the gate. I said, "I'm trying to get to the launch site." My team was there. How do I pay the—we got it, Cathy. Somebody drove me to the MOC. I'm running into the ops center. There were TV cameras there, so they caught me running. I'm all sweaty and running in. I sit down, and then they go, "We're just about to start countdown." I couldn't catch my breath. Okay. Okay. I just barely made the launch. I got to the mission ops center just as it was. I got to see it on TV. I guess it went into the clouds. The people at the launch, they said, "You didn't miss anything, it went into the clouds."

At least in the mission ops center we have the STK [systems toolkit] tool that showed us and of course the rocket cam. In the mission ops center I got to see all that, the stage separation, and be part of all that. Whereas my teammates down in Kennedy didn't get to see it. But yes. That was my launch story.

JOHNSON: Very exciting.

PEDDIE: Good thing I was a lot younger then and could run. That was amazing that I made it. But thanks to my husband for getting the luggage home. I ran, I just ran. But I got to see it launch.

JOHNSON: That's good. Let's talk about after launch and some of those milestones about entering the Moon's orbit. You did say that there was a—this was one of your quotes—five-days plus the scary time to get captured by the Moon. Talk about those days in between, once it was launched and then getting captured by the Moon and starting that orbit.

PEDDIE: When I got there it was good, because like I said, the team here was very tense. Trying to get them ready and monitor the spacecraft and get it. The first thing is initial acquisition so that you can talk to the spacecraft, so that we know where LRO is, can talk to her. I finally revealed to my team that I never thought we'd talk to LRO because I saw what we did to the com antenna. I was so worried about it. I had begged Craig to buy another one. He said, "We don't have time and we can't afford it, takes a year and a half." I go, "We should start because if they mess it up, we're screwed."

They melted the cover and they were scraping it. I said, "Oh my gosh, we're never going to talk to [LRO]," and I didn't tell anybody. I told Craig. I could only tell him but I didn't tell the rest of the team. We had these waveguides and I wasn't sure that the waveguides were going to work, how the systems went in. When we went to go meet with the vendor that does the waveguides, and they did these waveguides for a whole bunch of DoD [Department of Defense] projects, and they agreed to do LRO because they wanted NASA on their resume. But when I

talked to them about can you assure us, they were this big DoD, like oh, you cute little NASA person. No, we're just putting NASA on our resume.

They did a good job, but I was like, "I don't know if they're going to work."

We had a new com lead at the time and he said, "Why do I have to do all this?" A lot of our leads were new and they thought all we had to do was build something.

But we were like, "Can you tell us the schedule? How are you doing on your budget? Do you have any risk?"

They're like, "Why do we have to talk to you about any of this? We're engineers." No, we need to know how you're doing.

I had to help him, and visit the vendors with him, and there was all these horror stories I could tell you about that. I never thought the com system would work. I didn't tell anybody because I was hopeful.

When we're sitting in the ops center, I think it was day one or two, I can't remember the mission timeline, so in five days we had to monitor it. The first thing was can we talk to LRO, and I was tense, because I didn't think we'd talk to her. I was tense. Everybody's wondering what's wrong. So when the com lead [Adan Rodriguez - Arroyo] comes running in, and we had initial acquisition and can talk to LRO, he goes, "I told you so."

I said, "I never thought it would work."

He went, "What?"

My entire crew turned to me in mission ops. "What?"

I said, "Hey, I'm just being honest." I said, "Do you remember what you guys did to that com system over there in Building 7? I never thought she would work. Can you blame me with what you did?"

They went, "But it works."

I went, "I'm glad it works. I'm glad we can talk to her. Now we can upload the commands."

Then we were preparing everybody for lunar orbit insertion. That was the scary thing. We had to cruise to the Moon and then get ready to do a couple of burns and get in there. Our public affairs lead, she goes, "Oh, this is a great milestone. Let's put it live on NASA TV."

I went, "I'm just not sure that's [a good idea]." Remember, I put my team through mission sims and mission rehearsals. Now I can reveal this. We crashed into the Moon every single time. I was like, "I'm just not sure this is going to work. If we miss the Moon or crash into the Moon, I really don't think we should be on TV. I don't think we could cover that. That would be a big I'm sorry moment."

But they convinced me. Oh, Cathy, this is big. We're going back to the Moon. We have this whole campaign we're going back to the Moon. I think everybody should see this. I was like, "Oh my goodness, what are we going to do? Okay."

It snowballed. All the Center management, senior management, oh, this is going to be a great big event, we're going to put it live on NASA TV. I'm trying to prepare my team because they're nervous. Oh my gosh, Cathy, what's happening? I go, "Well, you just do your jobs." Remember, they were giving me a hard time about the checklist? I held up their book. "You got your checklist. You just watch your telemetry. You just follow the procedures. It doesn't matter if you're on TV or not. Just follow the procedures."

Goddard wanted a JPL moment. Remember when the rover landed and JPL is like, "Yay." Goddard is like, "We're going to have that same moment." I'm like, "Oh my goodness, I hope we do." I was just not sure. Because again, the mission simulations, I'd been there with

my team. We were working out the bugs and people were freaking out. I was trying to get people calmed down. If you don't see this or it's out of limit, what's your checklist say? What do we need to do? Do we need to—I was trying to coach the team. Ignore the cameras. Focused on your screen and your checklist.

The day we're going there, and you could probably see any of the videos on us. They go, "Oh, the excitement is palpable." Oh, Sandra, it was—I mean I didn't sleep. I didn't eat. I was so stressed. Craig, we were all like just stressed sitting at the table. There are all these cameras on us and they said, "Oh, they're just excited." I'm like, "My gosh, it's not excitement. It's just fear." We were so afraid. Because here's this moment.

They're interviewing all the people. They interviewed Craig and me and all our senior staff, everybody's excited. We had all these VIPs that wanted to come into the MOC. I wanted to put them somewhere else. They're like, "No. We need to be in the ops center."

I had this fight with management. I said, "We're trying to get LRO to the Moon." I kind of said the same thing when I said, "No Moon, no mission. If you guys distract us, I'm not sure that's a good thing."

They reluctantly agreed and there was this conference room just on the other side of the mission ops center. We had to have the VVIPs there, and then we had another room with our engineering support center. That's where all our engineers were. Then in the mission ops center we were trying to keep it clear in case something went wrong. Then we'd have to be commanding the spacecraft and freaking out. There were curtains.

Craig and I were prepared to close. There were other lesser VIPs, outside the windows. We were going to close the curtains. Kick the cameras out. Something. We were prepared for

all that. You could hear the "Oh, they're so excited." No, we're just scared. This is big. The Moon has to capture us.

We had to do these prescribed burns and all that. The team did an excellent job. As we were getting ready to go into that—I think it was a series of five burns or something. I'd have to go back and look at the details. But as we were getting ready to go into that last one, we had our flight dynamics lead [Mark Beckman]. There were five of us sitting there and Craig was on one side. I'm on the other. Benjy Neumann was sitting next to me. He was at the end. He went, "Oops."

Craig gets up. He shoots out of his chair. Craig shoots. He storms over and goes behind Mark's chair. He goes, "What? You went, 'Oops.'"

He goes, "Oh. I was just on the wrong page." We're all like, "Oh."

You don't want your flight dynamics lead to say, "Oops," in the middle of this maneuver. I looked at Benjy Neumann. I said, "Good thing my heart is young. Because I thought we were dead there for a second."

Boy, you could hear a pin drop. We were all so quiet. We were all focused on the screen. The cameras were looking. You guys aren't saying anything. I had hired bouncers by the way. They weren't external. They were people from the team that were not going to be sitting on console. I said, "Can you be tough and if somebody wanders in, kick them out?" I had a couple of my friends go, "I can do that." Sure enough, we had some senior managers that wandered in and these ladies were just—and they were all ladies by the way, and one of our big guys. They gently went up and said, "Excuse me, can I help you into the next room?" I watched them just gently escort some of these senior managers or external VIPs into the next room. I'm like, "See, they're wandering in." But my bouncers did a great job. Very tough ladies. Because

they wanted to see like why was everything so quiet. They wanted to come in and look. It's like no. They did a great job. People were mentioning, "You had these people come up and herd us into these rooms." I said, "Yes. Because I needed you to stay out of the way."

But when we finally made it, oh my goodness, it was relief, woo-hoo, it was a really nice Kodak moment. When I finally talked to my team they go, "Cathy, you had us do all these checklists and we did a perfect thing."

I said, "Yes, but if it wasn't, you would have been really crying to me like I didn't know what to do here." I said, "But look. You were so trained. You knew everything that needed to be done." They were all just so confident by the time we got to the day there. But before that no one had seen the I don't think so, we just crashed into the Moon. It was all a bunch of anxiety and fear and all kinds of stuff. I'm glad we made it.

We were popping champagne in the mission ops center. You can see on one of the videos. It was one of my things. I always told my team that I am their biggest fan. I said, "I'm your biggest fan. You guys totally rock. We're at the Moon." That was the next phase. We were going to the Moon. Then the next publicity campaign was hey, we're at the Moon. We finally got there and were able to—like I told the scientists, "We're at the Moon now, so we can turn you on and get you going for your mission, we got you to the Moon."

It was a lot of work to get them to the Moon though. There were days, Sandra, I would leave Goddard and go, "Oh my goodness. I don't think we're going to survive." I would tell my husband, "We're so screwed, I don't know what to do." But we're there, obviously, and we've done a great job. But it took a lot of blood, sweat, tears, crying. There was a lot of flesh left on. It was brutal. It was brutal.

JOHNSON: It sounds that way. That's amazing. Talk about those first photos that came down after you got there, from the camera.

PEDDIE: That was so amazing. LRO just worked way better than we thought it would. When those photos came back it was incredible. It's surreal. Our whole time designing LRO, you know that earthrise picture that came from Apollo? We got to have a picture like that from LRO, and I was like, "Oh my gosh." That was something I always wanted.

When they showed the Apollo landing sites, it was surreal. We were joking. I said, "Oh, look at that shot. They left all their trash there. Who's going to go clean it up?" Now we can tell them, "Look, you left your whatever. We got to go back and clean it up."

It was amazing. I have a poster the LROC people sent me. I got this giant tube in the mail, and they gave Craig and I this big panorama of some of the first photos that they had. On the outside they put a heart that said, "We love you, Cathy." It was just beautiful. It was historic. Worked better than we thought it would. The thermal map of the Moon. All the data that's come back and all the images has been very humbling. Knowing that we worked so hard to make sure that we would do that and that it did do that. Then now something like Artemis is going to use it. That's exactly—we said it. I'm not sure I believed it up until then. Because when they had us do the talk about the mission we said, "We're going to provide a comprehensive atlas of the Moon." I would always explain it back then. We had gazetteers. I would explain it to people. People would buy these gazetteers, and you know your road trip, I said, "LRO is going to do the same thing with the Moon so that everyone can look at it and go, 'Oh, I want to go here, I want to go here or this crater or whatever.' That's what LRO is going to provide." We did it. We absolutely provided a very comprehensive look at our Moon. We

definitely have enabled NASA and every other organization to be able to go to the Moon and do what they need to do in order to further explore. We did it. This team did it. Feels good.

JOHNSON: Yes. Especially since it wasn't supposed to last more than a year, and 14 years later it's still mapping and still providing more.

PEDDIE: Exactly. It's still going. Craig did tell me that when we did our propulsion tanks. He said, "Cathy, we're going to have so much fuel, it's not funny." That's part of our legacy. Yes, it's going to last a long time.

JOHNSON: Yes, it's quite amazing what they're still getting from it. The information and the mapping. We touched on it I think a little bit last time, but let's talk about the importance of outreach and education, especially with a mission like LRO, even though this mission got a lot of attention, more so than other missions, but especially with a mission like this. Also for the Discovery missions and New Frontiers missions as far as getting the word out for schools, educational facilities. I know some of that has been cut back for NASA. I believe it used to even be part of the budget for these earlier missions. But talk about how important you feel that it is to continue doing that.

PEDDIE: Oh yes, I think it's really important. I got involved when like I mentioned before this press release went out that nobody knew about. Then I got involved and found a bunch of organizations that weren't working together. Then we formed a team, and then that became the precursor. Everybody realized when you get all these organizations together it's very powerful.

LRO was just so easy to do outreach because everybody can relate to the Moon. Everybody can relate to the Sun. Everybody gets impacted by it. But the one thing that I think we did a good job, and the people that I got to work with are just the best at understanding what was going on in the times, what the culture was, and how best to hit different audiences, no matter what the age group is, no matter what the segment, no matter what people were. I think we did this really good job of hitting those different populations, and then using the tools at hand.

We got into social media. That was new. I was tweeting from the first person. That made LRO so relatable. People wanted to be BFFs with LRO and see what she's doing. But it was really cool to me to go out into the general public, all of us, and then get to talk to people. Why were they so interested? First of all, everybody loves NASA. Everybody can remember seeing those Moon images and Neil [A.] Armstrong and NASA is cool. It's just cool.

Then there were the skeptics who were like, "Well, why should my tax dollars pay for that?" But NASA has done a lot for society in terms of our tech transfer. It's all over the place.

But the inspiration I think is something that we have not done a good job of measuring in terms of helping not only schoolkids but also adults. I would tell people, anybody, we need anybody and everybody, because NASA is not just an engineer; NASA is not just a scientist. It's a community where we need people of all skills. We need artists. We need people who can organize things. We need people who are good with numbers. We need everybody. That was part of what I tried to do on LRO. Shipping and receiving. If they didn't work with us, then we didn't get it. Those people, I go, "You're part of the LRO family too. We need people like that."

I'd have people say, "Well, I'm not a scientist so I can't work at NASA." Yes, you can. We need all kinds of people. That would inspire people to think, "Maybe I could too." Because I would say, "Look, if I can be there, anybody can be there."

It made me feel good because when you talk to people, you're like, "I don't know if that's going to make an impact." But I had some other people say, "Oh, my daughter heard you speak," or "Because of you I went back to school." I go, "What? Because of me? What did I say?"

I think our team did a good job relating to everybody. Just getting to where whoever you are, wherever you are, we were able to relate to so many people, and around the world. When people would send their name to the Moon, I remember putting their picture on the clean room and taking a picture and then posting it on Facebook saying, "I know you're not here but you're kind of here with LRO." Just so people would feel a bond and be connected to it.

LRO got all this support, and that's what we all want, because if we can't get the support, whether it's from the public or the scientific community—and LRO was not a science mission. Craig and I, even though we weren't a science mission, we did tell our scientists that we're not a science mission but you're really important to us. What would be the purpose of us going to the Moon if we didn't have our science missions and our scientists telling us all these things about the Moon that all of us were like, "What? I didn't know the Moon was that."

It appealed to so many people, and I think that was important for the support, so that people could say, "I really want a mission like LRO, and I want more missions." Or, "I want more exploration."

The technology that comes out of mission—even though we didn't have a lot of new technology. But there were still new things that were coming out. Like now we know there's

water ice on the Moon. We do know that we can go build a Moon base and we don't have to lug a lot of resources. We could manufacture them there.

That's what I used to tell people. They're like, "Well, it's the Moon. Isn't it dead?"

I'm like, "Well, how would you like to go there and be able to not have to?" I go, "Have you carried on a heavy carry-on in the airport? Isn't it better if you don't have to drag all your water and your food with you? And that's part of the purpose that you have these exploration missions is to look." Because we always want to know when we see the Moon can we go there and what is there. We see Mars. Can we go there? Can we survive there? I go, "Don't you want to survive? You don't want to go there and go, 'I'm dead.' It doesn't help you explore if you go someplace and you're dead. We want to help you get there."

I used to tell the next generation, "I'm not going there, it's going to be you, this next generation, that's going. We're just trying to make sure that you're okay if you go out there."

I think it's really important. People like my mom and my family who are like, "What's that? Why do we care?" I told you that before. Like oh, you wear glasses and sunglasses, well, thank you, NASA. For a small dollar amount, because NASA's budget is such a small part of the entire federal government, and that was part of us educating people on that. You get a lot of benefit from that. Society gets a lot of benefit from that. I think it's phenomenally important. You're right, it used to be part of the budget, and because of what happened on LRO, and I got to meet all these wonderful people, on my next missions I just automatically did it even though it wasn't part of the budget. They're like, "Why are you doing that?" I'm like, "Because it's important."

Also we got some interns. We got to get people to want to come to work for NASA. We have a couple of engineers who came on like don't you want to come work for NASA? Why

don't you come work a summer with us and see if you like it. Some of them have come back, so now we have a propulsion engineer, a couple of mechanical engineers that are working on NASA's next generation. We need that in order for us to be vibrant and if we really are going to explore the universe then we need those people, we need those companies, we need those scientists, we need all kinds of people to want to explore and keep moving with us. It's phenomenally important to do it.

JOHNSON: NASA's push is for STEM [Science, Technology, Engineering, Math] education but also for diversity. Being a woman and an engineer, we talked about that last time too. But do you encourage other young women especially or do you do any outreach for younger women wanting to explore this as a career?

PEDDIE: Yes. In fact because I'm a minority from Hawaii—I never thought I was a minority till NASA was telling me that I'm a minority. I'm like, "Oh, oh, okay"—they would put me on these panels. I didn't realize it, but it made a difference. I had some young women, especially young Asian or Hawaiian women or minority women. They'd never seen someone like me at an event like that. I know you mentioned that as you were going through the Discovery Program.

Me too, when I look around, there's not that many people from Hawaii here working on missions. I'm very different. I dress differently. I like to hug people. I now ask, "Is it okay if I hug you?" Because I'm a hugger. But yes. I've had people gravitate towards me because of that.

It is difficult. I don't candy-coat it for any woman. It is tough. But a lot of people—and it's not just minorities and women—but a lot of people if they're not known too, it doesn't matter

what race you are, whether you're a man or woman. Sometimes if you're not known either, they tend to not look at people, because it's like who you know here. I've kind of busted a lot of that. They put me on interview panels because they have to have a diverse panel, so I'm an easy checkmark to their requirements, and I often bust them open saying, "Why are you focused on this one person? What about this?" Oh, we've known them for 10 years, they haven't done anything new. That was 10 years ago. I'm not the same person I was yesterday.

Why don't we give people a chance to see what they have and unlock their potential? Also give people more of a chance, because oftentimes it takes courage to go into a place where you're the only person of—I don't know how many meetings I've walked in and I am the only woman there. They all look. Like I told you people asked, "Can you tell me where the copier or the coffee?" Like oh. If I know I'll help them. But if not, I go, "Let's go find out together." I could take it as an insult, but I've decided don't do it. That's a way for me to not only help someone, because I like to help people, but also maybe educate them on maybe I'm not so different than you. I may look different. Thank goodness that I don't look like—because I'm me. But maybe I can educate them. I'm often put on these panels because they want to appeal to a broader audience. I have heard from some of the younger ladies that they just don't see that.

Now NASA is getting better at doing that, but there's still areas. I don't think it's necessarily NASA not doing it. But I don't think that we've seeded society or the community either. Some of the schools that I've talked to, some of the younger people, they don't want to go into the sciences or math or anything hard. They just—I just want to be an app developer or a game developer. Something like that. I'm like, "Do you like puzzles?" Because NASA is where you come and solve puzzles. There's a huge segment of society now that no, they're not interested in that. They'd rather be with some of the cool stuff that's going on in society,

whatever the latest cool thing, whether it's a sports thing or going on *American Idol* or something. I think it's really important. It's hard. We're even seeing that in trying to hire people at NASA. We're having a difficult time finding some of those technical people and people wanting to come work for the government, because the government doesn't pay as well as a cool SpaceX or Google or something. We're not keeping up with some of these cool places in terms of the federal salary. The only appeal we have is that NASA is cool. You could take a pay cut and work for cool NASA. Are you willing to do that?

I think NASA could still be relevant, I really do. It would take work. Again, I think our outreach team—and we were from all segments of the population—to reach out to that. I think that's what it takes is people to come alongside other people and to help. Naturally we're going to gravitate towards people who are like us. But also, I've always told these people, "Dare to be different." That's been my thing. I've always been different. My entire NASA career I've always been the different one. There's nobody from Hawaii often that's in my meeting. Often, I'm the only woman. I just had to get used to being different. I would say that to the young women. I said, "Dare to be different. It's great. You'll be the one blooming flower in a sea of grass. Which is okay. Don't be afraid of that. You have something to contribute and keep doing that."

We'll get there someday, I hope. I'll keep trying from my little corner of NASA.

JOHNSON: I had a mentor tell me years ago that normal is a setting on the dryer.

PEDDIE: I like that. I'm going to have to use that. Because there is no normal.

JOHNSON: There is no normal. You do need to encourage people that it's okay to be themselves.

PEDDIE: It's okay to be, yes.

JOHNSON: Not look like everybody else. Or act like or have the same skills even as everybody else has.

PEDDIE: There was a point where I thought that NASA uniform was a navy-blue blazer and khaki pants or khaki skirt. Do you remember that? I did that. But I would put a little flair in it because I just couldn't—I'm from Hawaii. We don't dress like that. They go, "What are you doing?" I'm like, "I just want to fit in." Blue blazer, khaki pants. They all went, "Oh, we all do that, don't we?"

On LRO I got everybody to have LRO Hawaiian shirts at least. If you see the LOI [lunar orbit insertion] video, some of us are wearing the LRO Hawaiian shirt. Let's have a splash of color here.

JOHNSON: Let's put some flowers in there.

PEDDIE: Put some flowers. A little aloha spirit here. No blue blazers and khaki pants.

JOHNSON: The JSC uniform, everyone thinks of the short-sleeve white button-up shirt and the pocket protectors.

PEDDIE: Oh yes.

JOHNSON: That's what they all wore in mission control.

PEDDIE: Yes, that's true.

JOHNSON: Looking back at your experience with LRO, what would you say were some of your lessons learned from that mission?

PEDDIE: Oh, wow, there's so many. I think Craig and I really, we were a partnership. I did an *ASK* magazine article about that called "Reflections of a Deputy." A lot of my career I had talked about that, how to work with people. But Craig and I really did it. I think we were a good example of two very different people with different skills coming together and working together and then being able to manage a very tough situation.

I think anything is possible. Like I said, I saw a lot of ugly. I meant that things broke. Things were not perfect. My mom brought me up, you can never be perfect. My parents gave me such great lessons. But I actually saw it on LRO in that a lot of us drive towards this perfection and Craig and I encouraged the team. It just has to be good enough. It just has to work. It doesn't have to be perfect. So many people almost killed themselves trying to get that perfection.

I think I got to see that first of all it wasn't perfect but sometimes it even broke, and then we fixed it, and it certainly wasn't perfect after you fixed it, because it broke and you fixed it, but it worked really well. It was good enough. But look, 14 years later it's still working. That has

helped me in my personal life but also professionally when I talk to people. Look, it doesn't have to be perfect. We just have to get to a viable working solution. That was a really good lesson learned too.

But I think the most powerful one was about the human relationships. The relationships between people. Often, we as a corporate entity give lip service to the team building and the humanity of what's going on. But like you mentioned earlier, we were in the trenches and there was a lot of life that happened to each individual personally and professionally. We all moved through it together. Sometimes managers that I've been with, they almost criticize me like you're too vulnerable, you get too close to people. Which is true. But I actually think that's a strength.

I got criticized that was a weakness, but I actually think that's maybe a weakness and a strength, because when you get on the human level and get one-on-one like heart-to-heart with somebody you not only get to know that person but you can actually help them in their job. Really help them in their job. Sometimes you can help them in their personal life. That wasn't my job on LRO, but sometimes I did. I was always trying to help them in their job. They're a human being. They needed to eat, drink. They had personal stuff going on. I felt, and I know Craig was also a people person, that we needed to get on the heart level and deal one-on-one, see the human being, and then how do we get you to do what you need to do on LRO.

I think that's a good lesson. I think a lot of people get afraid of that. It wasn't all perfect relationships. There were people who were going to punch each other out. There are people that wanted to file complaints and grievances. I think that's just part of the work environment. But I think it's important to look at individuals as who they are, human beings assigned to a particular job at NASA. That job is not who that human being is. I've taken that like I said to everywhere

else. I'm known as the manager of the people, but I just don't know how you can get the high performance without understanding who this person is and what they bring to the table and if there's something that they're dealing with can you as a manager help them, then you help them.

There are some things I would tell people like I am just not qualified to help you with that. Some people were having marital issues and I'm like, "I am not qualified for that. But there are these resources that can help. NASA has these resources. Or you can do your own personal relationship mending and we can give you the space." That's the one thing I can do is give them space to deal with that, understanding what was going on.

I think that's the biggest lesson. I'm often pulled in to try to help resolve some personnel issues, and I really don't like that because you don't know what you're dealing with. But again I have this heart for people and I think it's really important. It was successful on LRO. I think if people learn that you don't have to be perfect, it's good enough, you pay attention to the people, then I think you can go fast and still make something work and be successful. If we could lessen the cost on the human beings, that's something I don't know how to do, but that would be something that I would try. I've tried to do like now in one of our current missions we have people freaking out. I go, "We don't have a rocket waiting for us. We do not have to rush. So what is all this about?" Just trying to get to it. Because I remember that rocket waiting for me and rushing to that. That was really really a tough time. I think those were good lessons.

JOHNSON: Sounds like it, yes. Thinking about that mission also, what do you think you're most proud of?

PEDDIE: Oh, I survived. No.

JOHNSON: Survival.

PEDDIE: I think I'm most proud of the people that worked on it—like I said I believe they're NASA's best. I think there's other NASA best people too. But those people did such a great job working on LRO. What they did, it's still working 14 years later. They have impacted so much of NASA. They've opened the door to so many things. I'm just so proud of those people. A lot of them didn't think they could do it too. It was nice to go tell them, "You see what you did? You see what you did?" I'm most proud of that. The people, and the relationships that I got to have with them too. There are lifelong friends. It's very heartwarming when somebody sees you and they go, "Oh my gosh." There's the hug. It's nice. It's nice to have that type of human relationship in a work environment.

I think I'm most proud of—I think we did it against the odds. Remember, we were the rebel children, the people that everybody thought we were swinging from rafters, but we weren't. We did it. We did it. We got NASA back to the Moon, and now we're going to help Artemis get to the Moon. All those phenomenal pictures.

People now can go on Google Moon. You go on Google Moon because of us. It's just awesome what we did. It's a great legacy to leave, what our team did.

JOHNSON: Are there any stories or anecdotes that you wanted to share that maybe we haven't talked about so far?

PEDDIE: We've touched on a lot of them. It was a hard time but it was a good time. You can tell I'm relieved we made it.

JOHNSON: How long did you stay? Because LRO continued but I know you went on to other positions. How long did you stay with LRO after it started sending those photos back and you knew things were working?

PEDDIE: Only three months. Typically NASA—Craig and I were the development team. They typically roll a development team off and then they hand the mission over to the operations group. Rich [Richard R.] Vondrak, he really had a hard time with that. He really wanted us to stay, Craig and I. We're like, "We have to go." They were already reassigning us to other things. He went to management. You can't move Craig and Cathy. We need you. Because there was the Indian mission, Chandrayaan was coming up. There was all these other missions. But no, they had already assigned another flight director from operations, and they were moving Craig and I. Rich is like, "This is not right. We need to keep you."

We made sure that LRO was at the Moon and commissioning where you make sure all the instruments are turned on. I told the scientists, "We're at the Moon now, so now we have a mission. Before I told you no Moon, no mission. But now you're there." We stayed on, made sure she was working. We stayed for the LCROSS event.

Then there were some callbacks to some of our team members. But both Craig and I were reassigned and we were not reassigned together. We both were put on different missions. Although we wanted—typically they try to keep a team together, but there wasn't a full mission

to put all the LRO people on. Typically they move us together. They scattered us. But we would reunite occasionally when we could. It was a great mission. Great people. Good time.

JOHNSON: It was a lot different than, like you mentioned a few times, other missions, and other things that you've been assigned to since then.

PEDDIE: Oh yes. Not as easy to relate to. I went to a dark energy mission, and everyone's like, "What's that?" Doing the outreach for that was a little tough. LRO was just a pleasure. Recently I had to call one of my LRO electrical leads and she was like, "Oh my gosh, LRO, yay." Because it's like a reunion every single time. When I'd like an answer, like I said I've met so many people, I just give them a call.

Unfortunately now a lot of people are retiring. I consider that the ultimate promotion. They're not there. It's kind of a sad day that they're not there for me to contact.

JOHNSON: Yes. Dark energy to me, I immediately think of like Darth Vader or something.

PEDDIE: It's true. It was on the *Avengers* movie too. But it has nothing to do with that. So how do you explain that to the general public? The Moon is easy. We're going to the Moon.

JOHNSON: It's a lot easier when like you said it's something that humans on this planet can relate to. It's a little easier to explain to them what you're doing.

PEDDIE: And get excited. Craig was right. Remember I told you when he interviewed me and said, "Follow me to the Moon, you'll never look at the Moon the same again." I'm like—but he's right. I do not look at the Moon the same anymore.

JOHNSON: How do you look at it now?

PEDDIE: When I look at it, I get a very warm feeling because I know LRO is there. I would visit LRO every night. Before I went home, I would make sure I went to go see her and say good night. But I used to always love to get—those bunny suits are awful—but I would like to dress up, just go be near her, as much as I could. I know she's up there.

For a while we had this—I called it the stunt double. The structural verification unit. They put it in our visitor center. I used to call her LRO's stunt double. The media loved it. I go, "You know, stunt double. This is going to do all the stuff so we don't hurt the star of the show." They'd laugh. They dressed up the stunt double, the SVU [Structural Verification Unit], put it in the visitor center. I used to go over there because she's at the Moon.

Recently at a budget meeting someone said, "What do we do when you bring something back?" Because in our Explorers Program some things we'll put on the [International] Space Station and we'll bring them back either to here at Goddard or the scientists. I said, "I'm not used to that. We just launch things and send them to the Moon, and they just don't come back home. They just stay there." I go, "This is beyond my expertise, folks, I don't know what to do when you bring them back."

When I look at the Moon, I always joke with my husband, "Oh, did you see that? LRO is orbiting the Moon." We get a good chuckle about that.

JOHNSON: Part of you is up there.

PEDDIE: Yes. I spent a lot of time with that spacecraft. I feel very close to her. She's a her to me.

JOHNSON: I've noticed that. All the way through. Ships are usually her.

PEDDIE: I will share a secret. I don't know if it's a secret. But we had a project mascot called Baby Baa, a little lamb, that we would take pictures of everywhere. We also got a twin for Baby Baa but we did put a special place on LRO and Baby Baa is at the Moon with LRO.

JOHNSON: I did not know that.

PEDDIE: Yes, that was our team mascot. I go, "We have to fly something there." We didn't tell anybody. We just put Baby Baa there. She was all shielded and everything. Of course our names were inscribed. The team, we inscribed our names on the inside of LRO. One of our engineers who did the reaction wheels, he passed away during—of course his name and his contributions. A piece of all of us is up there on there. Of course people who sent their name to the Moon, it's on the spacecraft. I think it was a jump drive disk that went up there with LRO. That's protected. I don't know if it's in the same compartment as Baby Baa but it's there. I can reveal the secret now.

JOHNSON: That's right. After all these years you heard it here first.

PEDDIE: You heard it here first. Just like I didn't think LRO would work after what I saw. But it did. It worked fine. We did fine.

JOHNSON: All right. I think I will go ahead and stop the recording. But I appreciate you talking to me again and sharing all those stories. It's really been fun.

PEDDIE: Thank you.

[End of interview]