DISCOVERY PROGRAM ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

DR. LOUISE PROCKTER
MESSENGER DEPUTY PROJECT SCIENTIST
INTERVIEWED BY SUSAN NIEBUR
APPLIED PHYSICS LABORATORY
LAUREL, MARYLAND
10 DECEMBER 2009

NIEBUR: Today is December 10th, 2009, and I am sitting in Louise Prockter's office at the [Johns Hopkins University] Applied Physics Laboratory [APL] in Laurel, Maryland. We are going to talk today about MESSENGER [Mercury Surface, Space Environment, Geochemistry, and Ranging] and about how she got on MESSENGER. So, we're going to start at the very beginning, more or less. This is for the Discovery Program Oral History Project.

I need to say we've talked about the oral history release form that is required of all interview subjects. A copy of the audio and transcript will be placed in the NASA archives with the files on the relevant mission. And you'll be given an opportunity to edit the transcript afterwards.

PROCKTER: Okay.

NIEBUR: So, could you start by telling me a little bit about your background?

PROCKTER: My background is in planetary geology. Do you want my whole background, or do you just want my education background?

NIEBUR: Let me ask you a couple of interesting questions. The first one is when did you first become interested in space science?

PROCKTER: Ah, that's a very interesting question. I've always been interested in science, but this was not my first career. I actually came into it very late. I didn't get my college degree until I was 30. So I went back to school. I had a series of sales and marketing jobs after I left school that were interesting, but not very fulfilling. And I decided to take a—it was actually the equivalent of a correspondence course in science just on my own time and loved it so much, I decided to go and get my college degree at the age of 27 in the UK [United Kingdom]. So, I came into this by a different path.

Originally, I was in an environmental science undergraduate degree at Lancaster University in the UK, and then I switched into geophysics because I just loved earthquakes and volcanoes and things moving around. The system in the UK is a little different than the U.S. in that my degree program was very heavily concentrated in math and physics and environmental science. There really wasn't anything else.

In the last year, I had the chance to take options. I got to take a planetary science class for the first time with Lionel Wilson, who is a very well-known volcanologist, who's been around since the Apollo days. It just blew my mind, and I realized this is it. This is the thing I want to do. I was able to take another planetary science class. So, that was all I had – two classes in planetary geology, very basic solar system introductory classes. I decided I wanted to do a PhD, and I wanted to do a PhD in planetary geology. Now, tell me if you want me to do short answers or long answers or whatever.

NIEBUR: I think that's great. So you went to graduate school for planetary geology. And how did you choose where to go?

PROCKTER: Well, there wasn't a lot offered in the UK. I had, I think, only three options of places where there were people doing planetary science. One was to stay where I was, one was to go back to London where I grew up, and I didn't want to do that, and one was to go to Milton Keynes [campus], to the Open University, which is sort of in the middle of nowhere. So, none of those were very attractive choices.

Lionel Wilson had worked with a lot of people in the U.S., and he said, well, why don't you apply to do a PhD in the States? I thought that was a crazy idea. I had never considered—I'd never really left the country. I'd been on holiday a couple of times. That was it. So, at the age of 30, I took this great leap of faith, started applying to graduate schools here. I'd never visited the U.S. I had a few offers, didn't really know anything about schools, didn't know what a GRE [Graduate Record Examinations] was, didn't know what the Ivy League was, didn't know any of this. It was filling out all these strange forms and paying application fees – very different from the UK.

I got an invitation to go and be a graduate student at Brown University [Providence, Rhode Island] with a guy called Jim [James W.] Head. Jim came over to work with Lionel every summer usually at that time, and he actually was there in my last year and I got to meet him. He's a very charming, very exciting guy. So I decided to go to Brown. I had got into a couple of other schools, but they [Brown] had offered me funding for the whole five years. Of course, you've got to be practical, and he was working with some really interesting topics.

So I came to Brown to grad school, had no idea what to expect. I remember turning up at Logan Airport in Boston in July wearing UK summer wear, which is lots of sweaters and just being, like, what is this humidity; I feel like I'm in a greenhouse. Anyway, I'm getting into probably way more detail than you want.

But I just loved it, loved it at Brown, loved the environment, loved the atmosphere. For the first couple of years I was working on a project where I was actually looking at sonar data from the mid ocean ridges and comparing volcanoes on the ocean floor to volcanoes on Venus, for which I got the chance to go down in the Alvin submersible just once, which was the most exciting thing I've ever done in my life. Probably the closest thing I'll ever get to space travel, certainly an alien environment.

After two years, my master's thesis was on mid ocean ridge morphology. But that's when I was sort of trying to decide which direction I wanted to go in. And that's when the Galileo spacecraft had gone into orbit around Jupiter and was starting to send data from Ganymede [largest moon of Jupiter]. I had colleagues, Bob [Robert] Pappalardo and Geoff [Geoffrey] Collins, who were working on grooved terrain on Ganymede. That's where the exciting tectonics was. Everyone was looking at the grooved terrain and trying to understand how it had formed, and there were all these images of dark terrain on Ganymede. No one was looking at them because it was kind of boring. It was just heavily cratered dark stuff. So I went to Jim and said, "No one's looking at these images. Can I look at them?" And he was like, yeah, fine, off you go.

I started mapping out just one little area of dark terrain and got completely absorbed in it, as you do. That turned into my first ever science paper. I just loved working with mission data. Jim is incredibly good at giving his grad students opportunities and helping them work on missions if that's what they want to do, and he gave me so many opportunities. I wouldn't be where I am today without those opportunities.

I started working on it—although I wasn't on the Galileo team, I was just one of the many grad students working on it, and I was allowed to go to team meetings. I got to meet a lot of people that I still work with today, who I met on Galileo as grad students, and we all sort of came up together. It was incredibly exciting. I just remember sitting in the team meetings being absolutely engrossed in every little detail of how—sometimes, we wouldn't get data from Galileo because there had been a storm at the DSN [Deep Space Network] station in Madrid [Spain], or one time, we think there were doves nesting in one of the antennas and we didn't get the data. But Galileo with the antenna problem and the tape recorder problem, it was such a challenging mission.

I remember, we really learned to be flexible on that mission. We really learned to cut our teeth on just having such limited resources. What can you do with these really limited resources? We had to squeeze every last drop of science out of every little bit, literally, that came down. It was incredibly good training for me. And that was also where I learned that space exploration is hard and things go wrong. I will get into Discovery soon, I promise.

NIEBUR: No, that's fine. Let me ask a quick question, though, in the middle of that. So, you asked can I look at the dark images, and I'm a little struck by that because we now have a Planetary Data System [PDS]. In theory, anybody can go look at any images that have been archived. In practice, it doesn't always work out quite as smoothly. But do you feel that because you were at an institution that already had access to the data, that that kind of eased your way as a graduate student?

PROCKTER: Oh, absolutely, absolutely, definitely. And to this day, I still have all of the Galileo images as they came down off the spacecraft on my hard drive. I transfer them as I go. Those are the data that I still use when I'm doing stuff on Galileo. I know what orbits, I know what observation—we had to plan some of those observations, so I'm very familiar with it. But some of them, we only had half an image or we took them in a certain mode. Just being familiar with it—yes, you can go to the PDS and download the data, but it's not easy. And that's why documentation of the PDS is so important. I'm learning that now with MESSENGER that it's not trivial. You've got to think about people who don't do this every day. It's not easy.

So yes, and I would probably have never done that. I probably wouldn't have had the confidence to do that, to just go to some Mars data and start working on that. The other thing, of course, is that there was a proprietary data period, which, I don't remember, I believe it was a year for Galileo when no one else was allowed to look at that data. And I mean, people were doing crater counts. So yes, lucky me for having that chance.

But I also got the chance there, which was the turning point for me, where we were working very closely with JPL [NASA's Jet Propulsion Laboratory, Pasadena, California] and helping to plan observations where JPL would send us a file with a footprint on the surface and say, is this where you want this image? We would go back and say, left a bit, right a bit, move it up, and literally in that level of detail because we had so few images to direct. It got to the point where we got into the extended mission. Ron [Ronald] Greeley at Arizona State [University, ASU] was in charge of the even orbits for Europa and Brown were in charge of the odd orbits.

NIEBUR: Interesting.

PROCKTER: Yeah. I worked with Geoff Collins and I don't think I had any official title, but I was in charge of leading the sequencing for the imager on the E16 and the E18 orbits. Sorry, we must have done the even orbits. They [ASU] must have done the odd orbits. I can't remember. But anyway, we planned this whole sequence, which took many months of tweaking and we've got only a very limited number of images, where do we put them?

And then, just as we did the flyby, because the radiation environment in Jupiter is so bad, the spacecraft went into safe mode. We didn't get anything. I remember that was like, "Wow, we didn't get anything. All that work down the drain." For a couple of days, we were sort of walking around stunned. I mean, it's almost like grieving. You're kind of like, we lost everything. We're never going to see that part [of the moon] again quite like that.

We managed to get some of those observations on the next orbit. But then, the same thing happened on the next orbit that we planned, exactly the same thing. Planned it all out, went into safe mode on the flyby, lost it. So, that was a real lesson in learning to appreciate the process and enjoy what you're doing while you're doing it because there's no guarantee of a payoff in this business. That was a very big life lesson for me. Nevertheless, I discovered that I loved working on missions and that's what I wanted to do. So, that was getting towards the end of my career [in grad school]. So, how did I get here at APL?

Really, stop me if I blabber on too much because I have a tendency to.

NIEBUR: Not at all. I'm just checking my recorder. I depend on it.

PROCKTER: Oh yes. So, when I was thinking about what I wanted to do after grad school, I knew I wanted to stay doing mission work. I discovered that because I loved it. It's so exciting. There aren't many places you can do that. I think I applied for three post-doc positions, but really, I wanted to do missions. I think I applied to LPI [Lunar Planetary Institute, Houston, Texas] and the Smithsonian, but I didn't really want to do just science. I wanted to keep doing science, but I wanted to do mission work.

So then, it came down to JPL and APL. And I talked to Carle [M.] Pieters, who was one of my mentors at Brown, and she said APL is a fantastic place to work. She had just worked with them on a proposal called Aladdin that would have been a Discovery [Program mission] had it ever got selected, sadly it didn't. The timing was bad.

NIEBUR: It made it to second round.

PROCKTER: I know, and it came up against MESSENGER. I mean, who knew we would get two in the same round?

NIEBUR: Three, actually.

PROCKTER: Oh, what was the other one? NEAR [Near Earth Asteroid Rendezvous]? No.

NIEBUR: CONTOUR [Comet Nucleus Tour].

PROCKTER: CONTOUR, that's right, yes. All really good proposals. But she [Carle] said she really enjoyed her experience of working with APL. She said they're like JPL were maybe 20 years ago. They're young, aggressive go-getters. I liked the idea that they were kind of leaner.

Anyway, she suggested I come to APL. So I applied here to work with Andy [Andrew F.] Cheng. I remember, the more I learned about APL, the more I was like, that's where I want to go. I want to go work there. I want to go and do stuff with them. And they were working—I think at that time MESSENGER had been selected, CONTOUR had been selected, and NEAR was just about to go into orbit or—I think that's the right timing. It was certainly more than just NEAR. It just sounded really exciting.

I remember virtually stalking Andy Cheng at, I think, LPSC [Lunar and Planetary Science Conference]. I was carrying my CV around. I had printed my CV. I had gone out and bought this really nice paper for my CV and a really nice envelope, and I was walking around this conference for two days trying to find him so I could give him my CV, and hanging out by his poster and he wasn't there. I really, really wanted to come here. I finally found him and he got me in for an interview. At that time, there were only seven people doing planetary. We were part of the Space Physics group and Scott Murchie was here. I remember giving an interview talk and showing him the planning I had done on Galileo and how we did the sequencing and begging them to hire me.

They kept me hanging for a while. I knew they were interested in me, but I think it was another six months before they finally said, "Okay, we've sorted out the funding, you can come." And I was like, thank you. Even before I came, they wanted me to work on NEAR. I think they even paid for me to go to a team meeting somewhere just so I could meet people.

NEAR, of course, didn't go into orbit when it was supposed to. It had an anomaly. They lost the spacecraft for 18 hours, thought it had gone forever, luckily got it back, which you have on tape I think for all the other people. That was perfect for me because I got here in November of '99. We finally went into orbit in February of 2000. So I walked straight into this incredible environment where I'm on an active mission, data is coming down, and my job each day was to work doing data validation. I'd come in every morning, check the images that had come down from the spacecraft that they looked the way they were supposed to. I worked with Joe [Joseph] Veverka, who is just so wonderful to work for, really gave me great opportunities.

Again, I've been so lucky. Without people giving me opportunities, there's no way I'd be doing this now. I remember sitting in a meeting with him when the data—one of the team meetings where even though I was the lowliest minion—I wasn't on the team. I was just the lowliest minion working with a team member, who was Scott Murchie. I remember he went around the room and went through everybody and said what do you want to work on, what do you want to work on. He went through all the team members, he went through all the team member associates, and then he went through all the minions.

I was the last one and I said, "I would like to work on tectonics." No one was doing it, and I was like, I'd really like to work on tectonics. And he was like, okay, off you go then. He let me do that. A lot of PIs [principal investigators] wouldn't let you do that, but he actually made sure. And that was nice, also, because everyone knew what their kind of purview was. So, there was no kind of overlap.

NIEBUR: Power struggles.

PROCKTER: Yes, which is an issue on missions still. So I had my little piece of the action, and it was up to me to pick that up and run with it. I started working on Eros. I'm an icy satellite person, but I had that opportunity to do structural geology on an asteroid that was really exciting. So, I got to work on NEAR for a year and meet a whole lot of people that I wouldn't have met otherwise, different community, really great opportunity.

The really fun part of NEAR was, of course, the landing. We weren't allowed to call it a landing, and no one really knew what was going to happen. Most people, I think, thought it was going to bounce off again. And there was such tension. I mean, you've probably heard the stories. Surely, you've talked to Bob [Robert W.] Farquhar.

NIEBUR: I have not yet.

PROCKTER: I hope you do because—and everyone has their own personal point of view about it, but the stories of Dan [Daniel S.] Goldin pacing up and down outside mission ops—I was sitting over in building 7. Mark Robinson and Joe Veverka were almost like sports commentators waiting for the data to come down, and I was over in building 7 with Scott Murchie and a few other people in our science operations center. Scott and I were sitting there, and all we had to do was wait until the asteroid was in the field of view and then let Mark Robinson and Joe Veverka know because there was some delay. I don't even remember all the details now. It's been some years now. But I remember that my job was just to sit and watch a screen and wait for the asteroid to come in the field of view, which of course, it wasn't doing in real time. There was a delay. But the data were coming down and we were just watching these images.

There was this heart stopping moment where it was supposed to come down at a certain hour, minute, second, and it wasn't there and it wasn't there. It's not there. It was just a few seconds later, and then there's the asteroid. And it's like, the asteroid's there, tell Scott, he relays it, everything's fine. And then, the rest, of course, is history.

But that was absolutely fascinating. Of course, those images going in, we didn't expect them to be in focus and so crisp. We weren't really sure what we were going to get. So that was really historic and it was amazing to be a part of that. Those are the moments where most of our careers in this business are not glamorous, they're not exciting. And then you get those tiny moments of just absolute joy where everything comes together, and it works, and it's just fantastic. That was wonderful. So that was my first Discovery experience.

NIEBUR: Not bad.

PROCKTER: It was pretty—I mean, boy, talk about landing on your feet. I was so lucky. And so, from then until now, most of my work has been on MESSENGER. I transitioned onto MESSENGER after NEAR calmed down, we got the data out, wrote a couple of papers. That allowed me to start getting grant proposals in from the Discovery Data Analysis Program. I still have funding from the follow-on [grants] now. So, that gave me a nice science focus that I wouldn't have otherwise had on asteroids.

NIEBUR: When did you start proposing?

PROCKTER: I started proposing, I think it was pretty much straight after—boy, I'd have to go back – DDAP [Discovery Data Analysis Program], 2004, 2003.

NIEBUR: Louise, I didn't know that. [I was surprised because I remembered being impressed by her proposal and funding it that year.]

PROCKTER: That was my first—no, my first ever proposal was the PG&G [Planetary Geology and Geophysics] proposal to study Ganymede dark terrain. That was a follow on from my thesis. But it took me a couple of years to break into PG&G, and even then, they gave me this little pittance. But my first real proposal where it was something I had done that was nothing to do with my thesis was DDAP [Discovery Data Analysis Program]. I've been funded ever since. I'm on my third round of NEAR proposals now. We're still working on NEAR data. Again, very good opportunity because the thing about Eros [asteroid] is it's the shape of a potato. It is really hard to do imaging geology on something that's the shape of a potato. This is where the PDS is so important. Even now, we're currently trying to develop a tool, partly using our PMDAP [Planetary Mission Data Analysis Program, the successor to the Discovery DAP] funds to allow people to do geology on something that isn't round because it's so hard.

One of the reasons I'm sure that I got funded and that people here at the lab got funded is because we had our own tools. We brought our own tools to try and look at images on something that isn't round. It's really hard to do. I've had conversations with Rita Beebe about this with the PDS. She asked, "Why aren't more people using the Eros data?" It's really hard to use it if you're an imaging person because you can't just reproject it. Things get distorted. It looks all wrong. It's not intuitive. It's just difficult. So again, I was in a really good position in that I was used to handling those data sets. And so, that really helped me.

NIEBUR: And you knew how to take it and make something else out of it, too.

PROCKTER: Right.

NIEBUR: You had that opportunity to get on the NEAR team or to be associated with the NEAR team.

PROCKTER: From my Galileo experience, yeah.

NIEBUR: Right, and you were able to move it forward into something else.

PROCKTER: Yes.

NIEBUR: As NEAR was winding down, did you then have a moment where you thought, oh wait, I have to find something else to do, or was it that there was so much that had to be done here that it was just a matter of choosing?

PROCKTER: At that time, and the way things were at APL—in my group, we were in the space physics group, which at the time I came here, there were 42 people in the group, 2 of them women. We were divided into sections. I was in the—I don't even know what our section was called. I guess it was the planetary section.

After NEAR, at that time, there were seven of us and all of us were working on missions, I think almost all on NEAR. Noam [R.] Izenberg, Scott Murchie, Deborah [L.] Domingue, all working on NEAR. At that time, APL wasn't known for planetary science. It was really known for having scientists who could support missions, in a similar way I think to some industry places now.

And so, after that, we knew MESSENGER was coming down the pipe and we transitioned—Scott and I started working on the camera. He was the instrument scientist for the camera. Noam Izenberg started working on the imaging spectrometer on MESSENGER. So, there was a lot of work. There was no shortage of work. We started hiring more people, as well. And that's when our section began growing until about four or five years ago, they split our section off and made us our own group and called us the planetary exploration group. At that time, there were about maybe 15 people in the group. Today, there are 30 people in the group and we're still hiring.

NIEBUR: Really?

PROCKTER: I've got two new people starting in January.

NIEBUR: Wow.

PROCKTER: It's really ballooned. Planetary exploration has ballooned. And the nice thing about that is that we now hire people not necessarily to work on missions. We're now, I think, known not just for our science, but we're known for having science capability from Mercury out to the Kuiper Belt. We've got people who do everything here now pretty much across the solar system.

Then, we didn't. We had to be real kind of jack of all trades. I'm the icy satellite person, but I've done sequencing. So suddenly, I'm on an asteroid mission. Then, I'm on a terrestrial planet mission. I still to this day haven't worked on a mission that I'm trained to work on, I mean icy satellites. I'm now working on the Europa flagship study hoping that eventually, before I retire, I might see some new data from the planets or the moons that I studied for my thesis and that I loved, maybe. So, you have to be flexible.

But yes, had I not had the opportunity to work on the Galileo data, I probably wouldn't have been attractive as a hire here. I would have just been like any other grad student with a science planetary geology degree. Having had the NEAR experience of working with an imager, I then got onto MESSENGER where I started out as Scott's deputy. I officially became the Deputy Instrument Scientist—I can't remember when—I think it was 2003, 2004. And then, when [Scott] started working on the CRISM [Compact Reconnaissance Imaging Spectrometer for Mars] instrument on MRO [Mars Reconnaissance Orbiter], I took over as the instrument scientist on the camera.

I learned I had to really get down in the weeds. I learned a lot more about hardware, calibration, optical, focal planes, you name it. One thing I didn't do, because we were constrained financially on MESSENGER, as a Discovery mission, I didn't actually do ground calibration, because, at that time, we were very short on funds and it was kind of a choice between keeping instruments on the spacecraft or doing all the things we would like to do on the ground.

So I was sort of scaled back at that time. I think I was doing more science. I do feel that's a gap in my knowledge as an instrument scientist is that I didn't have that sort of hands-on hardware experience. But certainly, I've learned a lot about how the camera functions. I work closely with the engineers. That really helped me as a scientist and that's helped me throughout.

NIEBUR: When you say worked closely with the engineers, how does that work on a practical basis? You've got the missions, they're building it, but you're the one that's responsible for communication and whatnot. What are your other major responsibilities as an instrument scientist?

PROCKTER: That's a good question. The main thing is to take the science goals from the proposal, the high-level science traceability matrix, and make sure that that instrument can do that science. That's not just making sure you've got the right focal length on the instrument, you've got the right planes, you're doing the right filters to do color imaging for the camera. It's also—and this is sort of more the phase we're in now—making sure that once you're in orbit around Mercury, you're in the right orbit that your camera's going to work, you've got the right amounts of time to do that. You've done enough in-flight calibration that you know the camera works. You've got out all the bugs. You've got the software that you need that can take images fast enough, that can take them in the right colors at the right time, that you're not moving across the surface at such a high rate that everything's smeared to hell, so that you can bin pixels when you need to and not bin them when you don't, work when other instruments aren't working.

The key thing on our camera—two cameras, really—there's a wide-angle camera and a narrow angle camera on MESSENGER. But the key thing that gives us a tremendous amount of flexibility is we're mounted on a pivot [Note: both cameras are on the same pivot and locked so that they move to the same position at the same time.] I don't know who made that decision early on, but boy, I'm so glad they did, because we're in an elliptical, very elliptical orbit around Mercury and we can do things at times that the rest of the spacecraft can't. The other instruments tend to be boresighted [meaning that they're all pointed in the same direction at the same time].

While they're pointing over here doing something for the laser, say, we can point over here and move back and forth on our pivot and fill in our global map. Without that pivot, I don't think we could fulfill the science goals, or it would be very difficult. It would be challenging.

NIEBUR: That's a very interesting part of the design. Was that part of the original design?

PROCKTER: Yes, it was. Scott Murchie is an incredible genius. I mean, he thinks of everything. Even though he had NEAR experience at that point as an instrument scientist, he really had the vision to think this thing through from start to end. I remember, early on, for the camera—I don't know how it was for the other instruments—but, we'd already thought about our orbital strategy, how we were going to take data, how we were going to get the polar data, how we were going to fill in the base map, what colors did we need, what's the minimum number of filters we need to answer these science questions about composition.

We were doing that back in 2002, 2003, even though we're not in orbit until 2011. So, that thought ahead of time—and again, working with him, I've learned just so much working with him that I would never have even thought of before. He's just incredible. He's been an amazing mentor for everybody that he's worked with.

And so, yes, and you learn—having the ability to do flybys—obviously, getting ready for launch is exciting. The launch was wonderful. But, doing the flybys has been invaluable to us for testing out the instruments, testing out the sequences. We've learned things about the settings in the software, how does the auto exposure work, what brightness background do you need for different terrains on Mercury when you're looking at things that are very heavily shadowed or things that are very high reflectance.

The challenges when we're in orbit are huge, because of the types of orbits we're in. We're in some where the sun is directly overhead. They're great for color mapping. We're in some where the sun is—we call them dawn dusk orbits—where the sun is off on the horizon and we've got a lot of shadows. They're great for morphology. But you want a map of both of those, really, at the same resolution, while you're in this incredibly elliptical orbit. It's amazing the challenges, but Scott thought them through, and we're still putting the pieces of the puzzle together.

So, the flybys were just invaluable for just turning on—we do in-flight calibration, as well, looking at stars, trying to get the dark current and the background levels, making sure we understand the cameras completely before we go into orbit because when we go into orbit, we've got to hit the ground running and know that it's all been done. So having five years to practice up till now has been wonderful, very useful.

NIEBUR: Well, good. And frankly, you couldn't have gotten there much earlier, anyway. It would have been very difficult to go directly to Mercury.

PROCKTER: Yes, it's been quite handy.

NIEBUR: One last question about the pivot, though; I'm really curious because we always heard the mantra no moving parts, no moving parts.

PROCKTER: Yes.

NIEBUR: So, it's amazing to me actually—I didn't even know there was a moving part like that. I did not know that was on there. You came on after the mission was approved.

PROCKTER: Yes.

NIEBUR: Were there times as things went on that that was seen as a risk? What if it ever gets stuck? Did you develop backup plans?

PROCKTER: I don't know about the design or going through PDRs [preliminary design review] and CDRs [critical design review]. I'm sure that it was. I know that they thought very strongly about the bearings in there and they've had to think about the lubricant that they're using and making sure that it doesn't freeze up. When we were in cruise, we weren't using it all the time, because a lot of the time, the pivot covers a 90-degree viewing range. Remember also, we've got the sun shield, another lovely complication that we have to deal with all the time.

So, our pivot goes 40 degrees towards the sun shield and 50 degrees away from the sun shield. It covers 90 degrees. Doesn't sound like much, but believe me, it makes a difference. And when we're in orbit or doing a flyby, we're moving it in tiny increments all the time back and forth as we're tracking across the surface.

While we're in cruise, we're not doing that. There were long periods where we would not take data for, say, two months, and then we'd wake back up again and do a star calibration and shut back down, wake back up, maybe do a dark current, something like that. And so, periodically, every couple of months through cruise, we do a pivot calibration. The idea is really to actually look at stars and make sure that we know the pivot is still in the position we expect it to be in and that nothing's going wrong with it. But it has the added bonus of moving the pivot through the entire range of motion.

We learned from NEAR, where the spacecraft went into safe mode and couldn't orient itself. And as I'm sure you've heard from other people, it did this—the equivalent of sneezing—I can't remember how Mark Robinson describes it—sneezing 5,000 times. We had this nice layer of crud on the lens. That took an amazing amount of work from Mark Robinson and Scott Murchie to work at how to remove that from the signal. You've got this sort of blurry image and you need to get rid of that.

Because of that, we were very worried about needing to have a cover on the camera so that—instead of a cover, what we do on MDIS [the Mercury Dual Imaging System], which is quite ingenious, is there's a little cup on the spacecraft deck. I wish I could describe this for your audio. The camera is generally pointed up 180 degrees away from the deck. When we do any large burns, we stir it all the way into this cup on the deck. So there's just a very small space between it and the deck. So, if there is anything worrisome, we're safely stowed. Of course, you have to make sure that you don't get stowed and get stuck there if something went wrong.

The other thing we have had to think about—at least we did—during cruise, whenever we finished doing something with the spacecraft, we would put the camera in at sort of zero configuration where it was boresighted along with the other instruments so that, should anything happen to the pivot and it wouldn't move and it would get stuck there, it would at least be boresighted in the same way as the other instruments. So, we have had to think about it.

They've certainly done enough testing that they believe that the pivot will continue to work throughout the lifetime of the mission. But, yes, it's always in the back of our minds that some day, it may get stuck over here or it may get stuck over here, and then we get whatever we get at that position.

So doing the base maps while we are in orbit, we are trying to get the main color and monochrome base maps done within the first six months, again, trying to retire the risk early, meet the major science goals early. The one thing that's difficult is stereo. We have to do stereo in the second solar day, the second six months of the prime mission, in order to fill in the second look direction for the stereo maps. So, that's something that we certainly need at this point the pivot to do it.

Could we do the science without the pivot? Probably. Could we do it in one Mercury year? That would take a lot of doing. It would involve tradeoffs with other instruments, which would be very tough to do. So, having that pivot really enables the imaging science, especially as we're the prime gorilla in the room. For the instrument suite, the imager is always the main data hog. We use over 50 percent of the recorded space on the downlink, because images take up a lot of downlink. And that's mainly because we're imaging these incredibly large areas, but we’re going to create incredibly beautiful base maps. So, yeah, the pivot has been incredible.

NIEBUR: Wonderful. Now, could you talk for a few minutes about the team?

PROCKTER: Yes.

NIEBUR: So, you have a big science team. You have a lot of science. Clearly, you have seven instruments.

PROCKTER: Yes.

NIEBUR: And you came on as a deputy instrument scientist. You have a lot of people here that were already on the MESSENGER team as well as your PIs pretty close down at Carnegie [Science Department of Terrestrial Magnetism; now the Earth and Planets Laboratory]. So on a regular basis, do you guys get together, do you telecon?

PROCKTER: Yes.

NIEBUR: Is there a lot of coordination during cruise, or is it centered around the flybys?

PROCKTER: Well, okay, let me first address the question of being a team member. I wasn't until a few months ago officially on the team. That's been interesting. The instrument scientists are not official team members necessarily.

NIEBUR: I knew they weren't necessarily Co-Is [investigators], but they're not even necessarily team members?

PROCKTER: Well, that depends on how you define team member. That's not a short question. I'm not sure; I used to just identify myself as a team associate. That's what I was on there, a team associate.

Scott Murchie is a Co-I, so he definitely is a team member, and he was an instrument scientist. I was an instrument scientist, but not a Co-I. I work for APL. Same as Noam Izenberg. He's the APL lead for the imaging spectrometer, but there's actually an instrument scientist at LASP [Laboratory for Atmospheric and Space Physics], at the University of Colorado, who is Bill [William E.] McClintock.

So it's a little bit fuzzy around the edges. And that's been sort of an interesting thing because we were a very integral part of the team, but we weren't actually a part of the team. I'm employed by APL, not by Sean [C.] Solomon and the MESSENGER team. So, technically, if APL wanted to take me off MESSENGER and put me on something else after five years, they could absolutely do that. There's nothing to stop them doing that.

There's also a bit of tension. When the MESSENGER participating scientist call went out, it wasn't really clear to us whether we should—we being those of us at APL who were involved heavily on the mission but were not actual Co-Is—whether we should apply or not.

NIEBUR: Interesting.

PROCKTER: In the end, I didn't apply, because at that time I was funded three-quarters time to work on MESSENGER. So for a review panel, would the perception be, well, she's already funded three-quarters of the time on MESSENGER, we don't need to give her more money to do science? But I wasn't funded to do any science. I have done really no science in the last few years. My publication record's pretty poor because I've been working so hard on MESSENGER. That's not meant to sound like a sob story. I mean, that's my job. But I've been very focused on that and getting MESSENGER to where it's going to go. And there's going to be a payoff in the end.

But I certainly haven't had time to do Mercury science, because my funding simply doesn't cover that. My funding is you're working on in this instrument, that's your job, you're getting stuff done, you're working on flybys, you're getting data into the PDS. So, in the end, I didn't apply to the MESSENGER Participating Science Program and neither did, I think, most of the other people who were associated with the team.

Now, having said that, a few months ago, one of the team members died, and I think that freed up some resources. I'm not sure whether they would want that [known]—I don't know whether that is common knowledge, but anyway.

NIEBUR: You mean Mario Acuna.

PROCKTER: Yes. And so, they were able to take on three new Co-Is. I think, at that point, the fact that I had been working very hard on MESSENGER, I'd been very visible, I'd done a press conference for MESSENGER—as someone on the imaging team, it's very easy to be visible. You can show it to anyone in the public and they go like, "Wow, that's really cool." It's not so easy when you're dealing with squiggly lines or particle counts, so I'm very lucky that I have something that people get. I can go to dinner parties and talk about what I do and they get it and you don't have to explain it.

So, I think I was very visible. Also, being a woman on the team, I think I was visible maybe a little more because there aren't that many women on the team. It's getting better.

NIEBUR: There were more on MESSENGER than any other mission.

PROCKTER: There are, but when the mission was selected, out of the 25 team members, there was one woman, which was Maria Zuber.

NIEBUR: Good tip.

PROCKTER: Yes, might want to go back and look at that. So now, with the participating scientists and the Co-Is, there are a lot more women now, which is great. But that's certainly not why I was made a Co-I. I think that my contributions to MESSENGER, the fact that I was doing a lot of things that a Co-I would do, and I was starting to do science, as well, I think they really wanted to recognize that. And that's why they brought me on as a Co-I.

And then, a couple of months ago—I don't know if you even know this—I stepped down as instrument scientist on MDIS. Nancy [L.] Chabot, who's my deputy, has now taken over, and I have now taken over as one of the two deputy project scientists. So, it's been a very nice progression for my career, thanks to Discovery. Discovery has been my whole career thus far.

NIEBUR: Fabulous. Now, what's the role of a deputy project scientist?

PROCKTER: Oh, that's a good question.

NIEBUR: Not every mission has a deputy.

PROCKTER: No. Partly, Ralph McNutt [the project scientist] has a lot of projects that he's working on, so there are two deputies. The other deputy, Brian Anderson, is in charge of making sure that the orbital planning is in place. We have this tool called SciBox [Autonomous Science Planning System], which is a very complicated tool. We've been developing it for years, but it's just amazing what it can do.

NIEBUR: Peter [D. Bedini] was telling me all about it.

PROCKTER: Yes.

NIEBUR: Yes, it's fabulous.

PROCKTER: The problem is you've got seven instruments or eight instruments or eleven experiments, depending on how you count the different heads, and you've got this incredibly elliptical orbit, you've got a sunshade that has to stay towards the sun and can only move a very limited amount. You have incredible constraints all the time, and then you're trying to meet all these science goals.

So, the idea of SciBox is it's helping plan different sequences at different times to make it all work, and it's a huge job. When we're in orbit, we're going to be planning things on a—I think it's a two-week cycle. Given that it's taken us months at a time to plan for a flyby, almost a year for the first one, we will do flybys every day basically. So, we need this automated tool.

On top of that, we're layering in little focused areas that, again, with our pivot, we can go and look at them while we're doing other things [with the other instruments] and try and get higher resolution—we can do probably down to 20 meters per pixel in some areas and maybe even higher if we can play some tricks with the spacecraft.

So, the other deputy is mainly focusing on making sure that that works, that that tool is up and running. That's a huge deal, but he's doing an incredible job with that. So as the other deputy, my job is I'm sort of working more closely with Ralph, the project scientist, to cover everything from making sure that for the monthly reviews at NASA, that we have science slides, working with the science teams to make sure that we're coordinated on what science papers are going out, working with Sean Solomon to try and encourage people to do more science and keep that going. We're working with the BepiColombo [European Space Agency mission to Mercury] folks. We've got some good collaborations going there.

The latest thing I just started doing yesterday, is we're trying to come up with a consistent set of standards for Mercury. For example, for a long time, some of us were using west longitude, the imaging people, and the geophysicists were using east longitude. It's such a trivial thing, and yet, no one noticed that that was happening. And we're coming up with the answer for the radius of Mercury at this time. What is the answer for the pole position? It's not quite where we thought it was when we started this mission. What's the answer for the libration? What's the albedo because that's going to affect the thermal variations on the spacecraft?

So, we're trying to come up with a set of constants that we can all use when planning until we get into orbit when they'll probably all change.

NIEBUR: How exciting.

PROCKTER: Yes, things like that. You asked about how we collaborate. We have two team meetings a year, which are about three days in total, two and a half, three days. At least a day and a half of that is for discipline group meetings. We're divided into four groups: geology, geochemistry, geophysics, and atmospheres and magnetospheres.

Different instruments feed into different groups. The MDIS camera's mainly just the geology group. But the geochemistry group has contributions from different instruments. So people aren't sort of tied to one discipline group. But that sort of helps us focus on our science—some discipline groups like to publish in some journals, some in others. And so, we meet and we have telecons every other week with the geology discipline group, so we all keep in touch that way.

But mostly, the whole team comes together a couple of times a year. Sean Solomon is down here quite a lot for reviews. Now, in the project science office, I'm involved with more of the big picture stuff. I go to a couple of mission operations meetings a week and just keep up to date with what's happening. I was down in the weeds for a long time with the camera. I was checking sequences by hand, every parameter, and there are thousands of different parameters. I'm now sort of making sure that the sequences have the resources they need and just making sure that people know what's going on, that if we've got any more tests to do before we go into orbit, we need to do them now.

I think it's still evolving at the moment because I haven't been doing it very long. A lot of it is just covering for Ralph. If he's not here, they need someone to go to a meeting, go take notes for him and make sure I know where he is.

NIEBUR: Sure. Now one of the interesting things about MESSENGER to me is really how amazing a job the team has done in getting the science out.

PROCKTER: Oh, good. I'm glad to hear that. Okay, good. We try.

NIEBUR: It's incredibly striking. I've looked at the publication record of all the Discovery missions, and MESSENGER has already surpassed most, if not all, of the missions in terms of—

PROCKTER: Oh, really? Oh, that's wonderful to know. Does Sean Solomon know that? He would be very happy.

NIEBUR: We talked last March, so I was very complimentary of the record, but I don't know that I told him it was actually the number—

PROCKTER: Oh, that's wonderful.

NIEBUR: The number's not specific because nobody keeps a record.

PROCKTER: Right, and it's hard to judge science output, yes.

NIEBUR: Exactly. But you guys have done a really good job after each flyby of getting say a Science special issue, for example, and getting all these papers out. I've been very, very impressed that it's not just one or two scientists, either. It really seems to be, at least, a broad distribution of team members.

PROCKTER: Yes.

NIEBUR: Is there anything that you would attribute that to?

PROCKTER: I think Sean's leadership on the science side. He's very focused on the science. And it's really paying off now. I mean, he doesn't sort of badger people to write science articles, but that's obviously very important to him. He's very hands on. He likes to review abstracts, papers.

NIEBUR: I heard he reads every paper.

PROCKTER: He does, he does, and often more than once. I mean, nine o'clock last night, day before the LPSC abstract deadline, I sent out my final version of the abstract. He's still got a few extra things to tweak. So, yes, he's very, very hands on.

NIEBUR: It's good to see a PI who's so hands on about the science.

PROCKTER: He really cares about the science.

NIEBUR: That's what you hope for, right?

PROCKTER: Right. And he could have just sort of blown off the flybys. Even Venus—we didn't do a lot at Venus. We weren't really optimized for Venus science. But there were still some presentations for that. We've tried to be visible at all the big conferences and make sure we get special sessions when we can. Again, as part of the imaging team, the flybys have been wonderful for us because we have been able to do a lot of science. Some of the other instruments are rather lean in terms of science because they only turned on. Everything turned on, everything worked. But they haven't been able to do as much.

NIEBUR: They require much more signal.

PROCKTER: Exactly, yes, that's right. Integration time. With MLA [the Mercury Laser Altimeter], just one track on each of the first two flybys, and in spite of that, they've been able to do quite a lot with that one track. But yes, I think Sean has been very inspiring in that and very encouraging. He makes sure that there is all—I guess Peter [Bedini] makes sure there is—funding for people go to conferences and present their work. We have been getting out there and spreading the word.

I think one of the challenges from the start has been, you launch in 2004, you don't go into orbit [around Mercury] until 2011. How do you keep MESSENGER in the forefront? I didn't know how we were going to do that. I thought we would have a really hard time doing that, and we haven't. Even the Earth flyby—I mean the movie—I think that's one of the things I personally am proudest of because I was involved in sequencing that movie. It was Mark Robinson's idea.

That movie is so beautiful. It's one of the best things of the Earth I think that's out there. What was amazing was we found that Al Gore had used it in the end of his [documentary] An Inconvenient Truth. That's our movie that we took with our Mercury spacecraft. And that was just so—I'm so proud of that because it's beautiful. You can just watch the Earth going around. You can see the specular reflection on the oceans. You know there's water down there just from our movie of the Earth as we flew by it. And so, things like that, being about to get them out, get them on the web.

Nancy Chabot has been incredible at—she's a brilliant scientist, but she's been working really hard at getting press releases out, even for the third flyby. As you know, it did not go as planned. We went into safe mode just at closest approach point and we lost a lot of high priority data that we were hoping to acquire. But you wouldn't necessarily know that because we still had data on the inbound leg. We managed to post things on the web and keep them coming out. And people still looked on it as a success. I mean, it was a success from the point of that flyby, which was to do a gravity assist. It was almost perfect. But it didn't look like a failure because we still had some really great press releases.

We've got some new stuff. We've almost filled in the global map. We've got some really exciting things. We're going to have three science papers out of it – we're doing that at the end of January. We've got a deadline for those, so.

NIEBUR: Let's see. If you get three to ten science papers per flyby, you're doing two flybys a day—

PROCKTER: Oh, if only.

NIEBUR: But how are things going to change when you start drinking from the fire hose?

PROCKTER: That's a really good question. First of all, I'm not planning on any vacation in that year [laughter]. I think is where SciBox is so important because it is going to be largely automated. Up till now, we've been doing everything by hand. It's been a handcrafted sequencing effort, certainly for the camera, I think less so with the other instruments, because they're obviously easier. You turn them on, you turn them off, you change the rate, whatever. But ours is one of the most complicated because we have essentially four different modes – two cameras and you can operate them in two different modes each.

It's going to be largely automated. Hopefully, we will have ironed out any little wrinkles along the way so that we don't have to do it on the fly because it's going to be very hard. If we miss something, we're not going to see it again for six months. So, it's not going to be like Eros where we did go in the same path for a while, sort of slowly inching around the asteroid.

I think just validating the data, making sure that we really got what we thought we were going to get, and troubleshooting if we didn't, is going to be very time consuming. I don't think we're going to find issues in the camera. I think there may be issues with—the thermal environment, we know what we think it's going to be, but it's probably going to be very different and there will be effects and we may have to do a lot of analysis on the fly, just little tweaks here and there to make sure we get what we need.

NIEBUR: If you were looking at this from another industry—you may want to staff up just before something like that.

PROCKTER: Yes.

NIEBUR: You had the PSP [Participating Scientist Program] in 2007. Was that a major part of your staffing up or are people hiring post-docs?

PROCKTER: Part of what we wanted to do on the PSP was hire people who could also help us with the flyby data and analysis. Some of the people who were taken on at that point, not hired, but taken on as PSPs at that point, were people who could help with calibration of the instruments, as well, and with operations if needed, and some of them have done that. So, that really helped. We almost doubled the team at that point. I think we have over 50 scientists now.

Many of those do have grad students and post-docs who are starting to work on things. You'll see more and more abstracts at LPSC where the scientist on the team is the second or third author, which is nice. So, we're already starting to train those new, early career people to help out when we get into orbit.

I think there is going to be a huge amount of science to be done. Certainly here, we have planned that we have enough sequencers to cover what we think we need right now. There is always the likelihood that it won't be quite enough. We found with CRISM, they're doing uplink and downlink almost on a daily basis, and it is tough. Luckily, Scott Murchie has that experience. He's on our team as well, and he has given input. We've sat down with Peter Bedini, the project manager, to make sure that we have those people in place.

The funding profiles are different for different instruments. For example, all of the funding on MDIS is sort of at a given level and it doesn't waver depending on flybys. I mean, sometimes, obviously, you're charging more or less depending on what's going on. But there are other instruments—for example, MLA, where they are operating at a very low level and then they staff up around the flybys. So, when they go into orbit, they're going to staff up.

So yes, we are expecting that most people are staffing up. I think with the camera, because there's so much to do and there has been since we started, we've always operated at a high level. The challenge is going to be doing science and we've been planning a science team meeting that originally was going to be, I think, four weeks after we went into orbit. We've now delayed that, I think, for another four weeks because it's going to be crazy. The first week or so, we're just doing testing, making sure everything's okay before we actually start science operations. But I think those first few months are going to be pretty exciting. It's going to be great.

NIEBUR: What are you most looking forward to?

PROCKTER: Looking at some of the features that we saw on the flybys at much higher resolution, because always, always, in planetary science and always as an imaging scientist, there's always something interesting and you just see it and it's right on the edge of an image or you don't see it at quite high enough resolution. If only I could see if this trough was going across there or if only I could see a flow front on this putative volcanic flow. There's always more, always more questions. So, you see something and it's really exciting and for every question you ask, you just get another hundred questions.

I'm so looking forward to seeing Caloris [basin] again at high resolution. I'll be looking at this basin, the Raditladi basin, which has these bizarre troughs inside it that are very unusual. Even on flyby three, we saw another basin that has them as well. So, we've now got these two examples on Mercury. Nothing else on Mercury has them – really bizarre. We just don't have quite high enough resolution to see them. So to go back and see them again, and just to have a global map at the same resolution, the same lighting, a beautiful global map to be able to see all the compressional features or extensional features all mapped out at once, just to get the global history, it's just going to be amazing. Right now, we've got a lot of different flybys, but there's still—there's always an annoying gap somewhere. So, I'm very excited about the orbital part of the mission. It's going to be great.

NIEBUR: You sound excited. I mean, your eyes just light up.

PROCKTER: Oh, really? [laughter]

NIEBUR: And you go into a different world.

PROCKTER: I've been waiting a long time for this. But the flybys have been really just fantastic.

NIEBUR: Awesome.

PROCKTER: So much fun working on this mission.

NIEBUR: I'm just checking my notes. I guess we've covered most of everything that I had hoped to cover. The one thing is I'll mention that I will be posting excerpts of this on the Women in Planetary Science Blog. I'm wondering, given that you have had such exciting roles on some really major missions in our field, what kind of advice would you give students, undergraduates, graduates and then even the post-docs, if there were a couple of things that really made a difference to you in getting started? People want to work on missions. They don't know how to get started.

PROCKTER: Right.

NIEBUR: What would you say?

PROCKTER: Be tenacious. If you know you want to do something, just go find someone who will help you do it. I've benefited from having some amazing mentors, almost all men, I have to say just because of the nature of the field, at least when I got in it. I started out in a completely different career. It was a leap of faith for me. I was lucky that I was able to take this chance on coming to a different country, doing a PhD I didn't know what to expect. I might have hated every minute of it and just had to go back and do something else.

But don't be afraid to try. Try to find a really good mentor. And if the person you're working with isn't giving you what you want, then go find someone else who will. Don't be afraid to approach people and ask for help. I'm now the group supervisor of this group here, and I started as a post-doc. So, I've had a lot of opportunities here.

I've just taken on our first joint grad student with Hopkins campus. We want to start having more grad students here at APL so they can get more involved in missions, and she's a woman. She has transferred from another school. She was doing astrophysics. The reason she has come here is she wrote to me two summers ago and said, "I'm in the astrophysics program at this university and I just read your chapter on cryovolcanism in this book and I wondered if you had any intern opportunities over the summer."

And so, although I wasn't looking for an intern, I love that. I love that people take the time. They want to do something enough that they are willing to write and say I want to come and work for you. And I was like, "Yeah, come on in." We managed to find some money. It wasn't much, but it was enough to cover her for the summer. She had such a good time, she decided she wanted to transfer into a planetary geology program. She started looking at all the schools, but she decided she wanted to stay working with us because she loves the environment here. So she's starting at Hopkins in January. She's just finished her Master's [degree] where she was. She's going to do planetary geology.

NIEBUR: How exciting.

PROCKTER: She's going to do cryovolcanism. And she's starting to help us do some little studies on the Europa mission study that we're working on. I really admire that. If someone really wants to come and work here and they come and say I really want to come work here, I try to find a way for them to do that. I think maybe not all professors can do that. A lot of people are too busy or they don't have the funds, but it's just worth trying. Just keep going, keep at it and don't be afraid to change your mind. And if you find it's not for you, don't be afraid to change your mind, either.

I came into this very late. I didn't go to college straight from school. And when I go and give talks to college students and career things, people hate it when I say that. Some mothers hate it when I say if you want to take a year off, take a year off. If you don't know if this is really what you want to do, don't do it. Don't feel constrained because you've always got a choice. I really believe that. You've always got a choice. If you're not sure about your career or you're getting channeled into a pathway that is maybe not for you—and I'll tell one other story, which I'm sure won't go in your book.

I was in college with a really good friend of mine doing geophysics and she wanted to be a teacher really badly. Everyone said to her, "Oh, you're so good at this." She was brilliant. "You're so good at this. You should really do a PhD." So she kind of bowed to that pressure and went and did a PhD in fluid dynamics—hated it—in the UK. Finished up, did a post-doc because you were expected to do that—really, really hated it—finally went to teacher training school, got her teacher training certificate, is now teaching all over Europe, and loves it, just loves it, just teaching high school physics. It's her passion and it's her love. And she really, I think, wishes she hadn't wasted all that time in grad school when she could have been inspiring the next generation, which she's doing now.

I think it's very hard, especially in academia. If you are smart, you are very much pushed into getting a PhD. But even with a PhD, there are so many pathways you can go down that are not in academia. I think there's a real snobbery about this, even today, about if you've got a PhD, you should go teach at a university somewhere.

You don't have to go teach. We need good policy people. We need people at NASA Headquarters who can help us get more missions and help channel science and help with R&A [Research and Analysis program]. There are so many jobs in this field, in Congress or whatever, where you just need a good solid science background. And yes, to get on missions it really helps to be somewhere where there's someone doing missions. But luckily, with the Mars program exploding the way it did and with Discovery—I think Discovery has changed the landscape where you *can* now go and be a student and work on a mission. That didn't used to be the case. And so, there are a lot of opportunities. But just don't give up. Go ask people. Just be annoying until you get what you want. That's my advice because that's what I did. And look at me now. I'm running the group here now.

NIEBUR: That's awesome.

PROCKTER: I want people to come be annoying to me. I like that.

NIEBUR: That's wonderful. Well, Louise, thank you so much for your time today. I very much appreciate it.

PROCKTER: You're very welcome. Once again, very sorry. I hope it was worth the wait.

NIEBUR: Oh, absolutely.

[End of Transcript.]