NASA JOHNSON SPACE CENTER ORION ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

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INTERVIEWED BY SANDRA JOHNSON
HOUSTON, TEXAS – JULY 28, 2016

JOHNSON: Today is July 28th, 2016. This oral history interview with Charles Lundquist is being conducted for the Johnson Space Center Orion Oral History Project in Houston, Texas. The interviewer is Sandra Johnson, assisted by Jennifer Ross-Nazzal. I want to thank you for joining us today. You'd mentioned in a previous interview for ISS [International Space Station] that you were—and this is a quote—pulled back into the flight programs when Constellation kicked off. I believe if I'm not mistaken you were the Division Chief working in the Human Adaptation and Countermeasures Office.

LUNDQUIST: Correct.

JOHNSON: So if you want to talk about how you got pulled back into Constellation and then that progression of your responsibilities.

LUNDQUIST: Sure. I had heard about Constellation. The ESAS [Exploration Systems Architecture Study] Report was going on and we were supporting that to a certain extent insofar as contributing dollars. The new Constellation Program was standing up and it required a significant amount of funding. Actually NASA was descoping a lot of its R&D [Research and Development] programs to cover it. At that point I was in the donation organization who was relooking at all of our content

and prioritizing it so that dollars that had been allocated for applied research could be freed up for Constellation.

Mark [S.] Geyer, he was Deputy Program Manager for Constellation, called me and asked me to come over to support Constellation in the Test and Verification Office [T&V] at the time. I had worked with Mark on Space Station before, and he actually worked for me at that time. Now I was working for him. I guess you never know who you're going to work for here at NASA. Sometimes they work for you and later you work for them. Just make sure you don't get people mad at you.

I came over to Constellation and worked there for about two years in the Test and Verification Office. Ultimately it merged with the SE&I [Systems Engineering and Integration] Office, so I moved and became the Deputy for that combined office where Chris Hardcastle was the lead of that. I don't know how much more of Constellation you want to talk about here.

JOHNSON: We can talk about it. But I wanted to ask you. In between that time though I believe is when you were at [NASA] Headquarters [Washington, DC] for a few months. You were working the Human Architecture Team? When was that?

LUNDQUIST: That was after I moved to Orion.

JOHNSON: We can talk about that in a few minutes then. But yes, talk more about Constellation and what you were doing before that was canceled.

LUNDQUIST: Constellation was in the formulation phase, so initially there was a lot of requirements writing going on for the integrated end-to-end exploration architecture. Remember, at the time, we were writing requirements for the integrated architecture that included lunar surface systems. We had to have the requirements in place so that all the parts, even the parts that were designed and built early, would match and sync up with the parts that were built and designed and funded for later.

The other part that was going on in Constellation early on was reformulating its workforce into multi-center teams. We were asked to support the 10 Healthy Centers concept. Constellation's workforce was built up upon the contributions from all 10 NASA Centers, who might have at one time had a specialty in aero [aeronautics] or rocketry or launch processing. Everybody was engaged in building up this program team, using the skill sets from all the various Centers. We built a very distributed virtual team on Constellation. It was not just all JSC or all [NASA] Marshall [Space Center, Huntsville, Alabama]. On Constellation we had all 10 Centers represented in the management team.

That was actually probably one of the great legacies of Constellation in that it really was a forcing function to get the Centers to work together better. I see that now much more these days than I saw it in the past. We retained that all the way through to Orion now. We're a very badgeless team. Some of it is based on the technology that we have today. We have such wonderful tools with the WebEx [video conferencing] and the telecons and the handhelds. We can stay in touch so much better than we could in times past.

Geographical location hasn't been the impediment to teaming that it once was, and so probably one of the key takeaways from Constellation going forward was ability for NASA to really utilize its skill sets across the Agency and apply those to the Agency's priorities.

Constellation work that I did was supporting the Test and Verification Office. We were generating the T&V requirements which included the facilities and infrastructure necessary to test these integrated systems as the architecture came together. Then we were supporting the various reviews as the Constellation Program was maturing. I need to look back at the time line, but at some point Mark Geyer left Constellation, and he became the Program Manager for Orion, and that's when he called me again, my second phone call from Mark, and asked me to come over and work for Orion as the Crew Module lead. That was in 2008.

JOHNSON: Let's talk about that time period, the cancelation of Constellation. Did you know that that was coming? Or did you have any inkling that you were going to hear that?

LUNDQUIST: The cancelation occurred in 2010, February 10. It's one of those dates that you always remember because we didn't see it coming. I remember where I was when we heard the news that the program was going to be canceled. It really was an eye-opener. Obviously a depressing event. But the team came together. It's complicated. We were canceled by the President [Barack Obama] but Congress still had authorized funding for us, so there was this very difficult time while that legislative process was ongoing and the debates occurring at the high level over what our ultimate fate was. In the meantime, rather than bemoaning our fate, the Orion team continued to press ahead with building hardware and testing hardware, making progress, figuring that that was the best antidote against cancelation is to continue to make progress. The farther you are along, the more progress you show, the more results you show, the less likely you are ultimately to get canceled.

My particular situation changed after we received word of the cancelation, as I was able to secure a detail at NASA Headquarters during the ensuing transition period. While the Orion team continued to work on their progress with the funding that we had for the remainder of the fiscal year, I went up in support of the transition team. That was a very valuable experience. I was there about six months. The new plan that had been introduced by the NASA Administrator [Charles F. Bolden] at the request of the President had a much heavier research and development focus to NASA's budget. That's why the Constellation Program was canceled – redirecting those funds towards R&D. We started looking at the detailed ramifications and implications of that.

There's basically two possible paths the Agency could have gone. One was the path we had been on with utilizing existing technology and modifying it. NASA does this a lot. We design a rocket. The Shuttle rockets are a derivation of the Apollo rockets, and the Constellation rockets were a derivation of the Shuttle rockets, and Orion's are a derivation too. You don't start from scratch. You build upon what you have developed in the past, so it's incremental technology development. That was the path we were on.

There was another path. You might have heard the term game-changing. Very innovative approaches to rocket propulsion and space travel that required significant leaps in technology. Those are much more difficult to predict and schedule. It's like trying to put a schedule or budget on curing cancer. It's a large leap. I think NASA had a choice between investing in these game-changing technologies that could have had huge payback, but they were also lower probability of success, versus a higher probability of success using what you call the tried and true evolutionary approach of technology development.

Of course ultimately the path NASA eventually wound up on was, as you'd expect, the best path forward is to have a portfolio of both. You want to have the evolutionary approach

because you are making commitments to Congress and the [Presidential] administration on your capabilities and ability to meet certain milestones by certain dates. You need to have a higher confidence in order to do this. But if you really want to make those significant advances and leaps in technology that ultimately we'll need to explore the solar system, you need to be investing also in the advanced technology areas as well. NASA's dollars now covers both of those types of areas in its current portfolio.

I supported that effort at Headquarters where we formulated the new Exploration Program, which ultimately wound up with the Orion, Space Launch System [SLS], and Ground Systems Development [and Operations] organizations, which is currently the exploration enterprise that we're on today.

JOHNSON: After that you came back into the Orion Program?

LUNDQUIST: Yes, I was a Crew Module lead, and my deputy, Kathy Schubert, was acting for me when I was on detail, and then I came back and thankfully was allowed to return to my former position. At that point we were well on the way to getting agreement that we were not going to be canceled and that we would be able to continue the program. Around that time when I came back we were trying to determine our best way forward in a new paradigm. It was becoming obvious as the transition occurred that our budgets were going to be significantly less than what we had hoped for and planned for.

Typically with a development program you have a bell curve funding distribution. You have a higher funding need in the time of the program where you're doing the detailed design and

the production and build and test. Whereas our funding was looking like a lower level and a flat budget profile.

Looking at what that budget profile did to us, and trying to consider various options, we could have continued on the path we were, which was build the human-rated vehicle. It would have taken a really long time to do that. Or we could build a little, test a little, learn a lot, and apply that forward. We chose the latter, so that was the timeframe that the Exploration Flight Test 1 [EFT-1] concept was developed. We basically revectored the team to focus on a flight test. We would learn an incredible amount by going through and building an Orion that would fly a couple times around the Earth, about a four-hour mission. We would validate a lot of our critical flight systems, in particular our structural mechanical assembly, critical flight separations, on-orbit control systems, thermal protection systems, and our landing and recovery systems.

It was about the late 2010, 2011 timeframe when we changed paths to go with this flight test. Obviously because of the fact that we weren't building a human-rated spacecraft, it was a key enabler in fitting within our budget constraints. We were able to cut corners if you will, building a spacecraft on a shoestring budget type of thing. Ultimately we were successful and the team had a great flight test back in December 2014.

It really proved out a lot of our flight systems; not only the flight itself, but all the lessons we learned on the ground just building EFT-1. We learned about our drawing system, our supply chain, all the manufacturers. It was like a practice session, a dry run if you will. I don't know about you, but every time I do a project like tile the floor or put a roof on the house, after I've done it once I'm going to be a lot better the second time. That's how we are. We've been through this now once before. We've built something. We've flown something, and we learned a tremendous

amount. All those lessons we're applying now on our next flight test, and so we're going to get better and better at this. That was really the value, the beauty of Exploration Flight Test 1.

JOHNSON: Let's go back to that time. During that time also you had a pad abort test in 2010. Then as you said the decision was made to work on the EFT-1. Can you talk about that decision to go ahead with that when there were so many unknowns, whether you were going to have funding, but you were still working toward this test?

LUNDQUIST: It was a gutsy call because we didn't know what our future was. I remember the meetings the next day after we heard the bombshell news that we were canceled. The options were, do you gracefully shut things down? Do you try to salvage pieces of your program? Like our heat shield development. Obviously any future human-rated program is going to need a heat shield. Would we try to salvage that as a technology development program? There were various options that were floated around as to how we would move forward.

It just seemed like the best strategy was the proposal to use the resources that we had on a flight test article that would demonstrate as many systems as possible. We had our budget constraints, so we had to design to cost, if you will, the EFT-1 mission. Of course you're cost-constrained and you're schedule-constrained. What maximum amount of return can you do within that box that you're in?

There were several months where the configuration and the mission objectives of that flight test were fleshed out so we could sync all those aspects up and get the team off moving in a consistent path. You were turning the ship on a dime, and efforts of thousands of people had to be

changed. We had to get everybody on board with that. Everybody's coming at this from a different place. Some people despaired, "Oh, we're canceled." Some people were enabled by it.

In many cases we had people that were much more willing to take risks. When you're canceled, that does wake you up, and it allows people to think outside the box. NASA is a very risk-averse culture. Since we were doing an unmanned flight test on a canceled program, we don't have to do all those tests, or we don't have to do all those analyses, we're willing to take a higher level of risk.

Part of that is if we're going to try to do space travel cheaper, less expensive, we do need to address our risk aversion. We do need to talk about NASA's risk culture. It really boils down to getting the most bang for the buck with the safest mission we can with the dollars that we have and trying to reconcile those two.

EFT-1 was really the first exercise in that. Those first several months were hard getting the entire team, with it's engrained culture, onboard. Sounds easy now, let's go fly EFT-1, but we had to figure out what was in it, what was on it, what was the timeline, what were the requirements, what were the flight test objectives. All those precursors to getting a 1,000-person team off and moving had to be pulled together pretty quickly, because when you're changing direction you need to give people a new plan to change direction to. Mark Geyer did a super job leading the team through that transition period. He really exemplified great leadership in that time period.

JOHNSON: You talked a little bit about that in the ISS interview. You talked about being on the shoestring budget and how it limits management's flexibility to react and respond to problems. You talked about the affordability initiative. Like you said, it forces you to be more frugal and

you can take more risks, but are there any downsides? Obviously safety would be a downside. But would you talk about some of those things that you considered during that time?

LUNDQUIST: Sure. We live in the real world, and the real world has financial constraints. As much as we can hope for more funding, what we're going to get is a different matter. Just like you and I, we have to live within our means, our personal finances, NASA needs to live within its allocated budgets from Congress. We have to match our program to the dollars. When I used to go out to eat when I was a kid, my dad said my eyes were bigger than my stomach, because I would load up all these things I wanted to eat, and wound up I couldn't eat it.

A lot of us want maybe a Rolls-Royce space program, but we can only afford a Volkswagen space program. So part of it is trying to tailor your program to live within the means. But of course we want to explore. There's knobs you can turn, and one of those knobs is the level of risk. You can spend a tremendous amount of money just making a tiny risk improvement. It's trying to figure out how to use those dollars to give you the most risk reduction value.

JOHNSON: Did you have any involvement with the Exploration Systems Development Division and that cross-program system integration? I know part of that was they were pushing decisions down to the integrated products teams, the sublevel teams, to get the decisions down to that, so that things could be done quicker and more efficiently.

LUNDQUIST: I have some observations for that. My job assignment during that period was primarily as the Crew and Service Module lead and hardware development. Most of what you're referring to is the cross-program integration activities. I think that's one of the things this program

has done a fantastic job with, because having lived through Space Station *Freedom* and ISS and then Constellation, you had very large program offices. Frankly, that adds another level of bureaucracy and inefficiencies. Whereas the concept here that exploration has adopted and implemented has basically been to utilize the expertise residing within the programs and use that skill set to self-integrate. Although there is a thin veneer which we'll call level two management provided by Headquarters, they're really relying largely on the expertise and resources within the three programs, and they are stepping up and they're doing a great job, and they're doing it with a fraction of the resources that it's taken in past programs, where you had a large dedicated cross-program integration teams. I'm really sold on this concept because I've seen both ways of doing this business—I wish I had developed it, but it was really good idea and my hat is off to the ESD management team for coming up with it, and I think it's shown a high degree of effectiveness because the programs are integrating very well together, and it's being done with a relatively very small amount of resources.

JOHNSON: Let's talk about some of the technological advances with Orion. You read articles or you see when people talk about, "Well, it just looks like Apollo." But obviously there are so many things that are much more advanced. Talk about that and some of the heritage hardware or historical hardware that has been used or reused or redesigned with this program.

LUNDQUIST: When I give people tours and show them what Orion is, the most frequent question I get is, "It looks like Apollo." I tell them, "Well, okay. Apollo was 50 years ago, but the laws of physics haven't changed in 50 years. The blunt body shape of a capsule is the most efficient shape

to go through the atmosphere, just like a dolphin and a shark are very different, but they both glide through the ocean, and so the external shape is driven by the environment that you're in."

Obviously though there are external similarities, the guts inside are very very different. This vehicle has a tremendous amount of capability as you can well imagine, because materials technology, computers, metallurgical engineering, manufacturing techniques and strategies have progressed tremendously in the decades since Apollo. It's a very capable spacecraft that we're quite proud of.

As far as technology development is concerned, we went through a phase early in the program where we were developing the technologies needed to perform our mission. Where did we need to push the state of the art? We needed to push the state of the art in heat shield, thermal protection systems. You're talking 4,000 degrees Fahrenheit heat of reentry. There's no known material that can survive that and have the mass characteristics that we needed. We needed technology development in landing and recovery systems.

We allocated resources early on in Orion to go tackle those, and actually NASA had a lot of skills, more so in those systems than industry. We had a very heavy NASA involvement in those technology development phases. At a certain point though you need to stop researching and you've got to start building. Those technology development programs phased out, probably about five or six years ago, as they then were turned over to the prime contractor or whoever was providing the hardware and said, "Okay, we've developed the technology. Now you need to convert it into producible, machinable product. Get a contractor with cost and schedule and get it built."

I would say that our technology development pieces of Orion are largely in the past, and now it's a matter of implementing, building, testing. Of course there are other elements of the

exploration architecture that we're going to need downstream once Orion and SLS are in the field, like surface systems to the Moon or Mars. Those technology development efforts are under way today as we speak. So you've got this rolling wave of technology development at one time supporting Orion, but now supporting the downstream architecture elements of exploration.

JOHNSON: Let's talk about EFT-1 itself. Were there any memorable moments that you can recall, or events, working towards that launch? And did you get to see the launch?

LUNDQUIST: Yes, I did get to see the launch. Always very satisfying and fulfilling to spend years working so hard, diligently on something, and then to see it successfully happen. Memorable moments. I certainly have some memorable moments during the mission itself. I was with my team. We had watched the launch. Then we came back to the big conference room in the hotel to watch the landing, which was going to occur several hours later. I was surrounded by hundreds of folks that I had worked with for years together sweating, toiling to get this to happen. Then we're all together watching this wonderful reentry. When it landed everybody was cheering and slapping each other on the back.

The one thing I do remember was turning around and looking at all the happy faces, and there was one very sad face in the crowd because when we landed the uprighting bags did not deploy properly. That was the one very unsmiling, panicked-looking face in the crowd, the one guy who was responsible for that system, because he was seeing real-time that his baby had not worked the way it was supposed to. But that was about the only thing that didn't work as it was supposed to on that flight.

JOHNSON: You mentioned that there were a lot of lessons learned from EFT-1 that you can apply now to EM-1 [Exploration Mission 1]. The uprighting system, obviously fixing that. Right before the launch a problem was found with the heat shield. Are there some other things specifically that you want to talk about? Maybe some of those lessons learned between that you'll be applying to EM-1.

LUNDQUIST: Sure. There's been a lot of talk about the Orion heat shield. It's one of those technologically demanding aspects. It's the largest heat shield ever produced. During the manufacturing phase of EFT-1, we did encounter difficulties. We had some cracks that occurred in the ablative material. Those were all repaired, all fixed. We had positive margins of safety. So we launched that feeling pretty comfortable that we had solved the problem, and it worked. It worked fine.

But just building it, we learned that this is a pretty intensive manufacturing effort. It was a very manually intensive build. We had literally dozens of people working around the clock for about six months. Highly trained, very skilled labor force doing this work. Unless you have another heat shield right behind that one, that highly skilled workforce then has to sit around waiting another year for the next heat shield to come through, so it's a very inefficient cost model. You train people, highly skilled. They're going to go off and work somewhere else if you're not using them. They're going to leave. So it was an unsustainable manufacturing model too. In addition to the cracks that we saw.

Taking the cost model inefficiencies, the manufacturing inefficiencies, and the lessons learned through the manufacturing process, all those factors conspired to make us think about the different ways of doing things. So we have modified our heat shield from a monolithic structure

that's all built at once, with a block-like tiles that you can build offline, stack them up in a warehouse, and install later. Therefore you can have a low level of production that feeds your flight production. It's much more efficient. We had to solve a few technical issues to get there, but those have been licked now. We're pretty confident that this system is going to be superior technically by not being prone to cracking, as well as in the manufacturing and cost areas to the heat shield that we flew on EFT-1.

I mentioned some of the intangible areas. Step away from the actual spacecraft itself, but just exercising all of the people and processes and companies. We have literally hundreds of companies that build parts of Orion. Many of these companies don't even know how they're contributing. I'm building this part, but they don't know where it fits or what it does. You just give them a spec [specification].

We had growing pains obviously. When you engage thousands of people across hundreds of companies, you're going to experience difficulties along the way. All those lessons learned, all the scar tissue, you would find a vendor who had a problem with this material, or this part. Literally thousands of lessons learned that now are factored into the hearts and minds of people that are building EM-1. It's going a lot more smoothly this time because we've done those things before.

Ultimately that's where we're going to go – a well-oiled machine. We want to get this to be a very cost-efficient production so we can lower our costs and have Orion's being built for a low production cost and free up dollars so NASA can go spend money on things like an outpost or Asteroid Retrieval Mission or solar power platform, other pieces of exploration architecture that we need to do more ambitious missions.

JOHNSON: You talk about integrating all these companies, but now also we have an international partner. You have experience working with international partners. You worked in the ISS Element Integration Office previously, and now that you have an international partner with this, what are some of the pros and cons of working with those partnerships?

LUNDQUIST: Right. NASA uses international partners for a number of reasons. For one, space travel and exploration is very expensive. You get other countries aligned with your exploration objectives, and they work together and pitch in resources towards a common goal. Certainly there's that advantage. Another advantage is sustainability. Having an international partner involves commitments. Our country makes a commitment to work with other countries, and so it becomes more difficult for us to unilaterally just say, "Well, we're going to slow this down, or we're not going to do that anymore." Heck, we've engaged in bilateral agreements or trilateral, whatever international party agreements, and those countries have committed their resources. So now you're affecting other countries. You don't want to be seen as someone who steps back from your national promises and commitments. It actually helps us in that area too.

It helps us also in bringing in additional expertise and skill sets. Of course this country has a tremendous skills and knowledge infrastructure. The Russians have a tremendous space program. The Europeans do as well. Bringing those expertise into the fold and trying to solve your problems is yet a third reason why we benefit from these partnerships.

Now with anything there's pros and there's cons. You add the element of increased interfaces. Now you have to negotiate these interfaces. You're going to have increased complexity because now that you've got interfaces spanning the ocean you've got to document all these agreements. You have increased cost for integration. You have to have all these meetings and

reviews. It's one thing when people are down the hall or in another state. Now they're in a different country, and they're going to be speaking a different language, and they're using metric system, we're usually using English. So you add organizational complexity to the program.

Then you have issues associated with aligning your various priorities and schedules. While we might think Orion is the number one priority, the European Space Agency [ESA] may have other different priorities. We have to work together to stay aligned with those; building a spaceship is a tightly choreographed effort. All the parts have to show up at the right time for it to all come together to support a mission. Those are all cons, but when you weigh those, obviously the pros outweigh. It's in NASA's best interest to engage with international partners going forward. Orion initiated that relationship with ESA for the Service Module, and I know we value that relationship, even though there are some of those organizational headaches and complexities that go along with it. To the most extent, we're getting a lot more out of this than we're putting into it.

JOHNSON: Do you see the Orion Program working with any other international partners in the future or the possibility of that happening?

LUNDQUIST: I'm not aware of any other international partner discussions at the moment, no.

JOHNSON: Let's talk about some of the most significant challenges that you've had, beginning with Constellation, working with Orion, getting that EFT flight going. Anything that we haven't talked about?

LUNDQUIST: Certainly one of the wonderful things about working on Orion and at NASA, you're here to solve problems. There are no boring days here. Designing, building, testing spaceships that are going to the Moon and Mars is hard, it's challenging. I'm surrounded by thousands of some of the brightest people in the country here. It's tremendously satisfying to be working amidst that brain talent, somewhat humbling. That piece is great. The challenging parts, we wish we had more money, we wish we had more resources. We have to be innovative and think outside the box, outside our comfort zone. We'd love to be able to have this design or do these tests, and when you're forced to live within constrained resources, you have to think harder about what you have to do versus what you'd like to do.

Probably the hardest part of this job is balancing the risks across our entire portfolio. If you look at any individual thing, you can think well, I really need to do more for that. But it's a zero-sum game. If I do more there I'm going to have to take something else away from somewhere else to pay for it. You really have to think hard about balancing the risk. It's always changing, the landscape is never the same. As you mature your design or you complete a test, you'll find problem areas. You're constantly having to potentially shift resources from one area to another as your risk landscape changes not only during time but also during the life cycle of the program. During design, during build, during test, during flight, during operations the landscape changes then too.

It's a very dynamic environment. You never can just rest on your laurels. You always have to think about how to do the job better every day you come in the job.

JOHNSON: You have a unique background probably within the group you work with because you have that biomedical science degree. Do you look at things, and especially with risk and going

from EFT-1 going to EM-1 and then the EM-2 human-rated? Are there any risks or anything about that that coming from your background you're more concerned about? Or do you feel like it's right on track working towards carrying humans?

LUNDQUIST: I wish I had a crystal ball, and I knew what the problems are that are going to bite us, because it is a complex spacecraft, it's a complex enterprise. Despite the brilliance of the team and the workforce, we will have problems, and so we need to be brave and keep going forward, and try to live within the resources that we have. The safest spacecraft is going to be the one that never gets off the ground – so we need to accept risk. I would like to expand humankind's presence out beyond low-Earth orbit, and I think I work among a team that everybody's dedicated to the same end. Where there are differences is everybody has their own risk acceptance levels, and people come from, like you said, different backgrounds, different perspectives.

If I were to talk to my thermal protection guy, they'd want a heat shield that's a foot thick. Or if you talk to your structures guys, they'd want to have great big beefy plates of metal in the structure. So everybody has their own areas. If you were to design a spacecraft based on those desirements, you'd have something so big and so heavy it would never get off the ground. The saying is, you're doing your job right when everyone is screaming equally loud.

You asked me about my unique background. In some ways I view the spaceship almost as a human body. It's very complicated, and if you were to envision a human body designed by doctors, a cardiovascular surgeon might want a really big heart, and an orthopedic surgeon might want very large bones. You can see what this person would look like, and they probably wouldn't be good at surviving, because we are maybe not optimal in any one thing but as an integrated system human beings are pretty darn successful.

I look at the spacecraft the same way. I'm trying to optimize the integrated system, and I may have to suboptimize the parts in order to make the integrated whole work together better. That to me is how I tie that biological aspect of my training to a spaceship.

JOHNSON: That's very interesting. What would you consider to be your most significant contribution to EFT-1?

LUNDQUIST: I think my most significant contribution to Orion was probably when I went to Headquarters. The program was very vulnerable at that point in time, and nobody knew whether we were going to live or die. As part of that transition team, I was the one person supporting that who knew what Orion's capabilities were. Bringing that crew vehicle expertise into that team, which ultimately shaped the direction the Agency was going, I feel like I was able to help influence it. It's like maybe a drop at the top of the hill. It could go a lot of different ways. During that transition phase there were a lot of different ways the Agency could have gone. Even though I was just a little person helping, I think I was able to help push it the way that's close to where we wound up, and so I feel like I was the right person at the right place at the right time to help with that.

Insofar as the rest of what's going on here, I can't take credit for it. It's more the efforts of the hundreds of people that are doing great work every day. I'm just helping to keep the wheels moving along as smoothly as possible.

JOHNSON: Are there any decisions that you feel greatly impacted the program itself, the development, the policy, operations, costs, or anything, that we haven't talked about?

LUNDQUIST: There are future decisions that are going to be hard. We are resource-constrained. We have a schedule urgency to get this thing built on time, and we have technical issues and hurdles ahead of us. There will constantly be trades moving ahead where we try to balance all those various factors and come up with the best path forward. Those decisions happen quite regularly now, and the decisions seem to be getting harder and harder and harder. Once you get closer and closer to launch, those decisions become more and more meaningful and more and more difficult. I'm just looking forward to the ride ahead because we're going to have our hands full pulling this off.

JOHNSON: Mark Geyer has said that the Orion Program learned to persevere. Do you agree with that statement?

LUNDQUIST: Yes. Absolutely. Having the team go through a trial by fire together, being canceled, the hard work and effort to fly a successful flight test, that is a bond that gets the team—it's like maybe a platoon that's gone through a couple of battles together becomes much more effective as a team by that common shared experience and overcoming difficulties. I think that's where the Orion team is today. We've overcome difficulties successfully together as a team. That's why I feel much more confident going forward because of that demonstrated teamwork.

JOHNSON: Is there anything that we haven't talked about that you want to mention?

LUNDQUIST: I think we talked about more than I even thought we'd talk about.

JOHNSON: Okay. If there's not anything else, then I certainly appreciate you talking to us. Thank you.

LUNDQUIST: Sure. Thank you.

[End of interview]