

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

REX J. WALHEIM
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is June 20th, 2016. This interview with Rex Walheim is being conducted in Houston, Texas, for the Orion Oral History Project. The interviewer is Jennifer Ross-Nazzal, assisted by Sandra Johnson. Thanks again for taking some time out of your day to meet with us.

WALHEIM: My pleasure.

ROSS-NAZZAL: We really appreciate it. I wanted to ask you about your background, if you could give us just an overview and briefly explain how you got involved with the Orion Program.

WALHEIM: I'm an active astronaut with the Astronaut Office here at NASA Johnson Space Center. I've flown three times in the Space Shuttle. My last flight was STS-135, which was the final Space Shuttle mission. Between missions in the Astronaut Office we take on technical responsibilities or technical jobs we call it. After I got done with the PR [Public Relations] stuff after the end of that mission it was time to find a new technical job. I wanted to come to the Exploration Branch and work potentially on Orion, so I did. Probably in all honesty I really got mostly involved in about March of 2012, when I became the astronaut representative to the Orion Program. As astronaut representative to the Orion Program, I basically represent the interest of the Astronaut Office in the Orion Program and give advice and opinions to the Orion

Program on various issues that come up. I'm kind of a part of Mark Geyer's staff to a certain extent. I represent the Astronaut Office, but I also serve on his staff to help him make decisions for the Program.

ROSS-NAZZAL: What were some of those key issues that you were weighing in on? Do you recall?

WALHEIM: They come and go. The main things we're worried about is the safety of the vehicle. We're looking more toward the longer term of the vehicles that are going to be human-rated for flying humans on. Exploration Mission-2 mission is the first mission. We've been looking at how the test program sets up to prepare for that mission, how the systems are developed, and how safe the systems are that are going to be on that vehicle.

We go through all the different developmental boards and developmental meetings. We have a number of engineers who work for the Astronaut Office who help me out as the Orion rep. They bring issues that they've come across to my attention, and we work through those issues.

ROSS-NAZZAL: Can you pick out an issue or two that really stand out in your mind before EFT [Exploration Flight Test]-1?

WALHEIM: Not necessarily before EFT-1, because EFT-1 system was unmanned. It was the first one, and there's going to be another unmanned mission. Most of the issues, we've basically given them our opinions on them potentially, but we would not get in their way [for the

unmanned missions]. If they wanted to take more risk on the first mission, that was fine with us. That helps develop the system. We were just helping along the way and giving our expertise in various things. For the most part trying to let them run as fast as they could because these were unmanned flights.

ROSS-NAZZAL: You had flown three Shuttle missions as you pointed out. What did you bring from the Shuttle Program that you applied to Orion? Was there anything in particular?

WALHEIM: Yes, I think it was familiarity with how we did things with the Shuttle. How we handled redundancy, how we handled safety, how we handled operations. How did we launch the crews? How did we recover them? How did we talk to them? All the different aspects of how you deal with the crew in orbit and how you keep them safe. I brought those experiences back to the Orion Program.

ROSS-NAZZAL: Would you talk about some of the key decisions that you think impacted things like development or policy, things of that nature, for Orion.

WALHEIM: Some of the things were dealing with—how we made the heat shield. That was a big issue. How that was developed, how it worked out, and how it was tested. I know a lot of the engineers got into a lot more depth than I did, but I visited the Textron plant at least twice that was making the heat shield, actually doing it manually. It was a very labor-intensive process to build that heat shield. There were some issues with the heat shield cracking and things like that they had to deal with. They figured out ways to repair things that weren't turning out the way

they planned. My job, again since it was an unmanned vehicle, was to go up there, understand it, and just show the flag so to speak, just show people that we're interested. Because eventually we'll have a heat shield that we're going to use for a crewed flight.

ROSS-NAZZAL: Did you weigh in on anything like operations or cost?

WALHEIM: Not so much for EFT-1, no, but for the follow-on vehicles I have.

ROSS-NAZZAL: Can you talk about your perspective in terms of affordability and this movement toward a lower cost development for Orion. How it's impacted things, and how it was implemented as well?

WALHEIM: In respect to what?

ROSS-NAZZAL: Orion, things have been very tight compared to say earlier programs. How did you see that being implemented?

WALHEIM: It's a challenge to try to do things cheaper. A lot of times that can impact safety. We just try to say "Hey, [here] are the changes they're trying to make, do we think they impact safety to a significant degree." Not having enough money to test things early is a significant hurdle we have to get over. For instance the first three missions, EFT-1, EM [Exploration Mission]-1, EM-2, it's a stair-step fashion. [EFT-1 was] a very basic vehicle. [It didn't] have a lot of systems on it. EM-1 has some of the systems but still doesn't have all the life support

systems that a crew member would go. You couldn't put a crew member on EM-1. EM-2 has all the systems.

If you had a normal funding profile or a robust funding profile, what you'd do is you'd have EM-1, the first Orion to fly on SLS [Space Launch System], you'd have that be almost identical to EM-2, the second mission, which has the crew on it, because you want to test everything before you get the crew on there. But we can't do that because we don't have the money and the time to develop all those things in time for EM-1 at this point. So it's a challenge. We try to make sure that the testing of the things that don't fly on EM-1 are tested out on the ground adequately but with a reduced funding profile it's a challenge.

ROSS-NAZZAL: Do you have any concerns as a crew member that those things aren't being tested sufficiently?

WALHEIM: We are trying to stay on top to ensure they are, but there's always areas of concern. The areas of concern are the lack of the environmental control and life support systems on the EM-1 vehicle that will be on the EM-2 vehicle. Like I say, we'd like the [configurations of the vehicles] to be identical but they're not, because they won't be ready in time and we don't have the funding to make them ready in time. It's too far along the route anyway now to be able to incorporate those systems in EM-1.

If we had the funding earlier we could have incorporated them. One of the key items that's missing from EM-1, the first vehicle, that's going to have to be in the second vehicle, is the life support systems for the astronauts and the crew displays and all the different life support

systems for the astronauts. There's going to be a limited amount of that on EM-1. So yes, it does concern us that it's not on EM-1 and it will be on EM-2.

ROSS-NAZZAL: Do you know, were there originally plans to include that type of hardware on the first vehicle that was being tested?

WALHEIM: I think that was probably the original plan, to flight-test two vehicles that are the same. There's a natural progression. As programs come online from just a drawing board program to a real program, you realize when it's originally designed you have very very robust testing, probably more than you need. Then when you see the realities of how much all this costs and how much time it takes, you try to fine-tune it to a reasonable level, so that's what the Program has to go through. I know there were a larger number of abort tests too that were planned in the early part of the Program, but we just realized we don't necessarily need all of them or can afford all of them.

ROSS-NAZZAL: Would you talk to us about some of your regular day-to-day duties as you were working on Orion leading up to EFT-1? What were some of the key issues that were really eating up a lot of your time and attention?

WALHEIM: For me it was just to continue to go to the MPCB, which is the Multi-Purpose Crew Vehicle Program Control Board. It's our Orion Control Board basically. We would go to those on Thursdays and see what the latest issues were and work through them. Really one of the big parts of my job before EFT-1 was basically to go to some of the suppliers. This didn't take a lot

of time. [It] was to do motivational visits [and also tour their facilities]. I would go travel with the program managers to some of these suppliers and see what they were doing, what their problems are, and also to just thank them for their efforts. I did a number of machine shop visits and visits to other different companies that are involved in the Orion Program, which I really enjoyed. That was a fun thing. It's just a minor part of the Program, but at this point of the Program it was important to let those people know that there's a reason behind all the hard work that they do. They go through tremendous amounts of effort to produce these parts of the space program for Orion. A lot of these companies don't make a lot of money making these parts for Orion, because instead of building 1,000 of a certain type of item, they build 1, maybe 2 or 3, and then maybe follow-ons later, but years later on. A lot of companies aren't in this for money, they're in it because they love to be part of the space program. It was important for us to get out there and tell them that we appreciate what they do and also to show them the face behind the names, that someday these vehicles will fly with crew on them. You want to make sure they realize that the work they do has extreme importance.

ROSS-NAZZAL: What were some of the visits that you made? Obviously Lockheed Martin. What were some of the other companies?

WALHEIM: Yes, I went to Lockheed Martin. I went to a couple of machine shops out in Los Angeles. I went to Textron twice. I went to an avionics supplier up in Denver also near Lockheed Martin. I'm trying to think of any other ones. Those are some of the main ones.

ROSS-NAZZAL: Can you give us an idea of the speech you might give to the employees when you were there? Or was it primarily just a one-on-one, watching them in action?

WALHEIM: It was a little bit of both. It was one-on-one talking with people and seeing what they do and watching the processes. Another company that I went to was a battery maker up in the Connecticut, Rhode Island area.

I would go there and I would see that they do. I'd see how they make it. Get an impression just for myself what kind of company is it. Because there's a wide variety of companies that support the space program, some are mom-and-pop companies. Some are very advanced highly technical companies that make a lot of stuff for aerospace, and so it's nothing new for them.

I see what they're like, see what they're doing. Then I talk to them about the importance of what they're doing. First of all, I thank them for a couple things. I thank them for the hard work and for putting up with all the specifications and all the different rigorous procedures that they have to go through. There's a lot of military standards they have to build their products in accordance to. For some of them, they're not used to that. It's a lot of overhead, but there's reasons for all the different little specifications and requirements we have for the components that we build for the space program. There may be just a slightly different cleaner that you use to clean this thing, because you find out that it causes a real problem with another system.

I thank them for their dedication to deal with all the different things they have to comply with. I also thank them for their courage, because I think it takes courage for a company to make stuff that is this important. I tell them they could, if they want, to make boxes that house Gameboys. They could make a lot of money at doing that. If they want to be part of the space

program, they realize that sometimes they make things that people's lives depend on. I thank them for having the courage to do that, and the fact that I trust them to do that, and we're happy that they want to do that. It's a reminder that there are reasons we do these things in these certain ways, and it takes a lot of perseverance for them to comply with that. Like I say, I thank them for their courage of having the ability to put their reputation on the line where people's lives matter by what they do.

I like to also just show them pictures and video from my spaceflights to show them the adventure of spaceflight. Let them know what they're a part of, and just get them excited about spaceflight again. That's one of the more favorite things. Then just talk to folks, sign some pictures. They're good visits.

ROSS-NAZZAL: I imagine that's a nice morale booster for those folks.

WALHEIM: Yes, it's a lot of fun.

ROSS-NAZZAL: Would you tell us about the technological advancements of this new generation spacecraft? It's unique from the Space Shuttle.

WALHEIM: The modern avionics on it makes it safer. The computing power of the vehicle is much improved over earlier vehicles like the Space Shuttle. Then the Orion Program with the Space Launch System has a capability that the Shuttle didn't have, which is the launch abort system. One of the problems with the Space Shuttle, it was a beautiful, wonderful, capable vehicle, but the fact that the Space Shuttle was on the side of the stack. It was mated to the

external tank. If anything happened to the tank or the rockets aside of it, you can't get off it when you're still under powered flight necessarily. It's not easy to do if something happens. There's an inherent problem from the safety perspective with things coming off the tank and hitting the vehicle, and like I say you can't get off the tank very easily.

Whereas with this Orion Program you have a launch abort system, and the Orion vehicle sits on top of the Space Launch System rocket. First of all it's not hitting the capsule like it did on the Shuttle, which caused the *Columbia* accident [STS-107]. Also, you can always get off of the stack with the launch abort system. It pulls the whole Orion capsule off of the rocket, and you can parachute into the ocean and be safe. There's an inherent increase in safety capabilities of Orion that's really encouraging.

ROSS-NAZZAL: What did you think of those improvements that were made in comparison to when you flew on Space Shuttle?

WALHEIM: I think the launch abort system is a great capability that we just didn't have on the Space Shuttle. Now there are inherent dangers when you first fly a vehicle. The Orion may be a degree safer in the long term, but the first few flights are still going to be dangerous flights because you're flying a new vehicle. The first time you fly a new vehicle, the chance of a loss of crew is significantly increased, because you just haven't tested everything out as well as you would like.

The important part is after you've tested it out and flown it a few times, then the inherent safety benefits of the redundancy and the launch abort system, and the ability to have flown the avionics for several flights too and worked out all the bugs, that inherent safety capability kicks

in for the later flights. The first flights, there are going to be significant risks in them just because they're the new flights of a new vehicle, but we know that and that's why we try to pay attention to the issues of the first few flights in particular.

ROSS-NAZZAL: You mentioned you spent quite a bit of time with program management like Mark [S.] Geyer when you were on these trips. Would you talk about his leadership and his role in securing that first flight?

WALHEIM: Yes. Mark Geyer is a tremendous Program Manager. He did an outstanding job. He does a great job of synthesizing the inputs from a lot of different people. One of his best skills is his ability to not get spun up and excited about stuff that [is] going wrong or going poorly. He just has a matter-of-fact demeanor to deal with issues and problems that come up in a way that doesn't get people more spun up themselves.

The character of a team will reflect the character of its leader to a certain extent. When the leader gets very excited and very upset about things, [he] just passes that on to the team. Mark doesn't get excited about things [going] wrong. Obviously he's displeased when things go wrong. He has a great job of being able to maintain a good attitude despite any circumstances that may not be going always positively.

Like I say, he's just a great person to work with. I really do think he has the needs of the crew at heart. We didn't always agree on decisions we made when he was Program Manager, but we knew he would listen, and he did very heavily weigh the crew's input to what we thought was important for safety perspective.

ROSS-NAZZAL: Can you give an example of something that the Astronaut Office really wanted but Mark Geyer disagreed with?

WALHEIM: Sure. There was one, he disagreed at first, but he gave us. My favorite example is a box called the Manual Entry Survival Switches [MESS]. It's a way to deploy the parachute and do some other activities during the entry, descent, and landing phase on a real bad day when you've lost all your computer capabilities and basically you have very little power ability. You want to be able to deploy the chutes and land, do the various landing systems, things that you need to do. You need to do them with this manual box.

If you don't have this box and you lost all your computers and you didn't have much power, you may not be able to deploy the chutes. This is a very bad day. A lot of failures would [have had to] happen [to get onto this case]. The chances of it happening were pretty remote. If you did have a problem like this and there was no way to manually deploy the chutes with low power and without your computers, you wouldn't have a chance to survive.

This capability we call the MESS box. When we were going to develop it, it was in the baseline, but it was going to cost a certain amount of money. It was going to take a certain amount of time to develop, and it was going to weigh a certain amount. When it came back to the Board, I think it was removed from the baseline but we wanted to readdress it. We wanted to get this box on the vehicle. We had to find out could we do it cheaply, could we do it quickly, and could we do it without weighing very much.

Mark allowed us to work this offline, myself and a bunch of other engineers. We got together, and the first cost estimate that came back from Lockheed Martin was very high. We said, "No, that's not right, come on, let's do this very minimalistic. This is not going to be a

fully certified system. It's going to be if a terrible day happened this is [just] going to give you a fighting chance."

Some of Mark's engineers went back and forth with Lockheed Martin, got the price way down so that it was acceptable from a price standpoint. Schedule didn't look like it would be too big of a problem. Then it was a weight problem, where it was going to weigh I believe about 10 pounds. We said, "Mark, we'll find 10 pounds to take off the vehicle in order to get the system on the vehicle without impacting the weight." Ten pounds doesn't sound like a lot, but we wanted to be good partners and say, "Hey, we can get rid of this." We found a few pieces of equipment we could get rid of. We even gave up some of our sleep shirts that the astronaut crew would wear, because [we figured we didn't need as many as they had allocated]. "This is important to us. We want to demonstrate this. We're going to give these up." Line them out, we'll only get a certain amount. We gave up [some of] our pj's; they're just underclothes you can wear at night.

We figured out they don't weigh very much but if you add them up amongst the crew, all of the crew won't get as many, and we gave up some other pieces of equipment that were a little bit heavier. It all weighed up close to 10 pounds. We brought it back to the Program Manager, and he approved it. It wasn't his original desire to do this, but he turned around and looked at it. We had gotten it into a box that he could live with, and he approved it.

ROSS-NAZZAL: Were there examples where he didn't approve some changes that you wanted to see?

WALHEIM: Let me think. I guess one would be the ESA [European Space Agency] service module propulsion system didn't have the redundancy that we wanted it to have. We wanted to transition to a parallel system instead of a serial system, which means it was parallel so you could lose part of the system and still operate the other thing. The original design was serial, which meant if you lost one part, you lost the whole thing.

We wanted to try to transition to a parallel system basically on EM-1, the first even unmanned mission, and then on EM-2. He didn't approve it, so we said we would like to readdress it at a later time for a later mission. It's gone back and forth even past Mark Geyer's time as the Program Manager. We've been working with Mark [A.] Kirasich. We finally got a compromise that we're going to get the parallel system put on EM-4 potentially, or somewhere around there. At first we didn't get the approval, and we just had to move on from there.

ROSS-NAZZAL: Is that primarily due to cost?

WALHEIM: Due to cost and schedule, yes. To make the change would have been expensive. We're trying to do it now a time where it would be cost-effective and not hit the schedule too bad. We'll see where it ends up.

ROSS-NAZZAL: There's an interesting quote from Mark Geyer. He said, "We learned to persevere," meaning the Orion Program. Would you agree with that or disagree?

WALHEIM: Oh yes, persevere from a financial standpoint I think. We were constantly being asked to do what we needed to do with less. What could we give up? The funding profile as I

understand it, they can tell you better than I can. I'm not expert at it, but the funding profile is pretty flat. Normally with a research and development program like this you have a funding profile that goes up high at the beginning when you're doing the research and development, and then it stabilizes. Here we're trying to build this whole thing with a fairly flat funding profile, and it's not easy. We did learn to persevere.

ROSS-NAZZAL: It's a big challenge. I understand that this was a multi-Center program management model. Did you do work with other Centers?

WALHEIM: Yes, a little bit with Glenn Research Center [Cleveland, Ohio] when they worked on the propulsion system and European service module. We worked with them a little bit.

ROSS-NAZZAL: Did you have a chance to go over to Europe and then also to Ohio?

WALHEIM: Yes, we went to the preliminary design review of the ESA service module, the European service module.

ROSS-NAZZAL: You played the same role there that you did at the contractor facilities?

WALHEIM: Not too much there. Most of that was just technical meetings to just go over the technical baseline of what they planned on doing and get our comments in about what we thought of the design.

ROSS-NAZZAL: While you were in this role we had a presidential election. Did you play any role in going to Congress or talking with any members about the importance of the Orion Project?

WALHEIM: Mostly we did that during our postflight of STS-135, so that was back in 2011. After each mission we usually send the crews back to Washington, DC, to go to [NASA] Headquarters and to do a White House visit potentially, if that can be arranged. We also go up to the Hill and we talk to the congressmen and senators and just tell them about our flight. We're able to speak our mind about how important we think the future programs are. We did a lot of that during our postflight visits. I'm trying to think if we did any outreach since then. Not a lot, but occasionally we will do stuff like that, but we didn't have to testify in Congress or anything. Most of it is more informal.

ROSS-NAZZAL: Any meetings with [U.S. Senator Richard] Shelby or [U.S. Senator] Bill Nelson?

WALHEIM: We did meet Bill Nelson when the EFT-1 vehicle came down to the Kennedy Space Center [Florida], when the shell just got to the Kennedy Space Center, before they started outfitting it. Bill Nelson was down there with a lot of the program managers and Charlie [Charles F.] Bolden, so he was down there at the same time. We interacted with him a little bit there.

ROSS-NAZZAL: What do you know about NASA's alliance and agreements with ESA to build the service module and have that partnership? Can you share some details with us?

WALHEIM: It's an important partnership, because I think any time you bring on international partners it makes the Program a little stronger. However, it brings on complications. We learned this with the International Space Station [ISS] Program. It is somewhat harder to do with international partners. It's not easy dealing with not just our suppliers now and our contracts but a whole different country's contractors and suppliers and space agencies. It makes it more difficult, but like I say, it makes the Program stronger.

Potentially it could be a cost savings, but sometimes that doesn't even materialize. There's extra costs involved in doing things internationally. However, it can be a cost-saving method. I think more important than the cost aspect is the strength of the Program having your partners and learning from them too. They've done things for a long time their way, just like we did in the Space Station Program. We learned from the Russians and the Russians learned from us. What the Space Station Program found out, when you put partners on the critical path, if they don't produce their hardware when they say they're going to, then the whole Program is late.

ROSS-NAZZAL: It is a big challenge. What are some of the more memorable events that you remember as you were working towards EFT-1?

WALHEIM: One would be when the crew module made it down to the Kennedy Space Center, just the shell of it. It got down there, and it didn't look like much besides the shell of a spacecraft. It was amazing how quickly that became outfitted and started looking like a spacecraft again.

Recently we got the EM-1 spacecraft down at the Kennedy Space Center. Again it looked like a shell. I went and visited it not too long after it got down there. Yes, it looked like a shell, but this time I remembered this is not going to be long before this starts looking like a spacecraft again. It's a really exciting milestone when that gets down to the Kennedy Space Center.

There were a number of trips I made. I'd go down there periodically and see the progress they were making and also look at the other components, look at the launch abort system. I was down there the day they rolled out to the launch pad. They had the Orion with the launch abort system on top of the equipment that mates it to the Delta IV Heavy, so that was pretty neat.

Of course, obviously, the Delta IV Heavy launch when EFT-1 launched, that was just incredible.

ROSS-NAZZAL: Can you talk to us about that day?

WALHEIM: Yes. That day the first time we tried to launch there was some winds that kept coming up. They tried to launch, and they recycled. They tried to launch, and they recycled. I was watching from I think the building was called ASB or something like that. It was a United Launch Alliance control center building, so it was pretty close. It was a great view. I remember we would count down, we would watch, and then it wouldn't launch. We'd watch, it wouldn't launch. So it ended up scrubbing that day.

That was okay. I had a chance to drive not too far from the rocket, see the rocket on the launch pad, and then came back the next day. We got out there again early, and this time it went off pretty much as scheduled, as I recall. I remember watching it go up, and it left the launch pad

so slow. A Delta IV Heavy just doesn't jump off the launch pad like the Space Shuttle does. [The Shuttle got] out of town pretty darn quickly. [With Orion on the Delta IV it was slower, and we just kept saying,] "Go, go, go!" It was a beautiful sight to see it go.

I remember it went through the clouds. It actually poked a hole in the clouds. It went through the clouds, and I took a picture of it and tweeted it out. The picture of Orion literally punching a hole in the sky. It was just a neat picture.

Then I went in and you could see some video on TV inside the building where we were watching the launch from. You could see there were some pictures from cameras on Orion, and you could see the curvature of the Earth, and it was a standard picture that you see from space a lot from the International Space Station. Then I thought to myself, "That's not the Space Station, that's Orion. Orion is flying now. Orion is no longer just a development program, it's a flying program now." It was a really neat thought to think that here it is, it's really flying, and these scenes here are from Orion. It was just a really neat thought.

The mission was about four hours long as I recall. We went over to the Press Site there and did some interviews. Then we all watched on the TV as Orion was coming back in. It was a spectacular view, and they caught it with long-range cameras far out. It was just screaming back, and it was just such an exciting sight to see. We could see the drogue chutes come out and the parachutes come out. Spectacular view, it was just so exciting to see it come down and land right near the recovery ships and be so successful. It was a great day. I'd been down to the Kennedy Space Center several times since STS-135. It's just quiet. It's just not like it used to be for obvious reasons. They just don't employ as many people, and there's just not as much activity going on down there. This was the first day since STS-135 where it really felt that excitement of a space launch again like during a Shuttle launch. It was really neat to see that

excitement of everybody, the people down there, and see the press down there. Everybody really excited about the launch.

ROSS-NAZZAL: Would you talk about the media interest not only for the launch but also as you started working on this Program? What was the media interest like? There was so much attention [paid] to, “JSC has closed its doors. We’re not in the space business anymore; [we’ve] finished with Space Shuttle.” Talk about that.

WALHEIM: I think not just with media, with the general public there’s a lot of reeducation that had to go on “Hey, we didn’t stop the space program. We’re just changing what we’re doing.” It was a lot of education process. The more opportunities we had to do that, the better to be able to go out and just educate the public on the exciting things we’re doing.

We did that both with our public outreach that was not necessarily to the space suppliers. We did a lot of public outreach to schools or to universities. I do a standard template of what I talk about. I start out with the adventure of spaceflight I show what it’s like to fly on a mission in space. Then I talk about okay, now we’ve retired the Shuttle, what are we doing next. I talk about the Commercial Crew Program with Boeing and SpaceX and then go on to okay, that allows us to send our astronauts to the Space Station, but it also allows us to do what NASA does best, which is exploration. I talk about Orion and SLS, talk about how we’re going to go farther than we’ve ever gone before. People respond to that, they really seem to enjoy that.

ROSS-NAZZAL: Was there a lot of media interest in EFT-1?

WALHEIM: Absolutely. It was a very strong media presence down at the Kennedy Space Center. It felt like a Shuttle launch again. It was really nice to see. There was a big boost to the Program from that. It is hard to maintain that kind of momentum, just because it doesn't happen so often. The next flight is not going to be for a couple years yet. It was nice to see a shot in the arm and people realize hey, Orion is flying. It was a big milestone.

ROSS-NAZZAL: What do you think was your biggest challenge as you worked toward EFT-1?

WALHEIM: For me there wasn't too many big challenges since like I say it wasn't a human-rated vehicle yet. It didn't have a crew on that vehicle. It was actually a reasonable time for me to get acquainted with the Program and learn things we were working on and learn the systems without it being too hectic. "Hey, there's going to be a crew coming up on this vehicle before too long." It wasn't too challenging from that perspective, it was actually a nice time to start the Program, to be early enough where you're working on the unmanned version. At the same time you're looking at designs of the human-rated version.

ROSS-NAZZAL: Do you feel like you had a significant contribution to that first flight?

WALHEIM: Not a whole lot. I did like we said from the public appearance standpoint and the education, the goodwill visits to the different suppliers. I learned a tremendous amount. I got more out of EFT-1 than EFT-1 got out of me. That's just the way it is, but I was glad to be a part of it in my small part, and periodically weighing in on decisions that the Program was making.

“Hey, this is not my bailiwick, but this is my opinion as an engineer and as an astronaut, but you guys make the decision.” That was the way we worked things for EFT-1.

At the same time you got to realize it’s not a linear program where we’re working EFT-1, then EM-1, then EM-2. We’ve been working EM-2 since I started in the Program. So those issues really were important to us, and we did work those heavily, but they didn’t come up too much at first because we were so consumed with EFT-1. Then they start coming up as we’re working EM-1 and EM-2.

ROSS-NAZZAL: That leads to one of the other questions I wanted to ask. What lessons were learned from this flight that are going to be applied to future missions?

WALHEIM: One of the main ones is how difficult it is to recover the vehicle in the ocean. They were doing it very methodically and took their time to do it. Recovering that vehicle was not easy. We have to look at ways we can recover it quicker, because we don’t want the crew to sit in that vehicle for a long time in the ocean, because you can get seasick very very quickly sitting in that vehicle after you’ve been in space for several days. We got to nail that down. I think people understand that. We’re putting a lot of renewed attention on the recovery of the vehicle.

ROSS-NAZZAL: How much attention was given to the Apollo Program lessons learned and Shuttle Program, the history? Did you go back and look at those things?

WALHEIM: A lot of it, especially with recovery, that’s one place where the Apollo Program was very helpful. How did they do it? What lessons did they learn? We still have some of the

engineers around who worked that Program and worked Shuttle obviously too. There's a lot of us around from that.

We do try to make sure we make informed decisions of, "Hey, what did people do in the past." That's another way we compare stuff. We talk about safety and redundancy. What are the historical systems? How did they handle the propulsion system? How did they handle the recovery systems? How did Apollo handle the heat shield? We try to really learn from the lessons that they learned.

ROSS-NAZZAL: I'm going to ask Sandra if she has any questions for you.

JOHNSON: Yes. Just touching on that. Like you said, when they landed they did have problems with the uprighting system.

WALHEIM: Yes.

JOHNSON: That could have led to problems if there had been humans on board. I know they have been working on that and going back to look at Apollo. You mentioned the life support systems earlier, not being on EM-1, then on EM-2. Are they taking those lessons learned from the other programs and Shuttle? You mentioned that that was a concern. I guess how much are they looking at these previous programs with those life support systems and applying it to make sure that it's something that they feel is going to work right the first time?

WALHEIM: One of the ways we do it is by using a test bed [and also] testing some of the [Orion] regenerative life support systems [on the Space Station]. There are test versions of the life support system that we're putting on Space Station that we can see how well they work in zero G and learn things early. They are doing that, and they are testing stuff on the ground too.

A lot of it is a different kind of life support system. It's more akin to the Space Station than it is to Apollo or the Space Shuttle necessarily. Those systems have to work [for a long time]. Part of the way you deal with it is you test them the best you can. You make sure they work the best they can, but you also plan the mission to be able to handle what if it's not working right. We try to do what we call a buildup approach where you fly as close to home as you can for as long as you can before you make the big burn to the Moon. We're trying to figure out what's the best way to minimize the risk so that if the life support system doesn't work properly you can still get home in time to not run out of life support, get home in time where you can survive the failure of the life support system.

JOHNSON: You mentioned some of the vendors or people that you visited. I did read that it was interesting getting this up and running again, because some of the technology that was being used, the technicians that would have been useful at that or the people that were trained with building these kind of things, because we hadn't built anything in so long, that they had to build up that workforce. Were there a lot of people I guess in those places that had worked on space?

WALHEIM: Some of the stuff like the avionics, the electronics. A lot of that stuff is just advanced, but there's people that have worked on similar [projects], either on satellites or previous manned spacecraft. There are other ones like the heat shield. We haven't done that

since Apollo. Textron, they had to reinvent their processes. It was very interesting to see how they did that. It was a little bit of a challenge to try to restart these processes, and somewhat relearn some of the lessons we'd learned already potentially.

JOHNSON: As far as working with ESA, I know this is the first time we've relied on another country to actually build that part for this type of launch system. You'd mentioned that you all were a little concerned as far as that. Anything else that you can think of as far as working with those international [partners] this first time, as far as making sure everything fits correctly? We've had those famous things in the past where they used different measurements for stuff. I'm not saying that that would happen. I'm assuming from those lessons learned they're working with ESA to make sure those kind of problems don't happen.

WALHEIM: I'm not too worried about those problems. The place where that would have bit us that things don't fit is in the Space Station Program. There were several parts of the Space Station that were fit together for the first time in space. It still boggles my mind that we were able to fit everything. I just can't believe that everything fit together, just absolutely amazing. It's a real testament to the engineering prowess of the people who design and build these things that it all fit.

With the service module they'll put together, we'll put the stack together and make sure it fits together. It will physically fit together. Now whether everything responds as well as it should, we'll hopefully iron all that stuff out in testing. Hopefully that'll work out. I think it's just getting there and getting the vehicles built so we can test them is the hard part.

ROSS-NAZZAL: You mentioned that when the vehicle would arrive at the Cape it really just didn't look like a vehicle. It looked more like a boilerplate. Would you talk to us about what goes on at the Cape in terms of the MPCV [Multi-Purpose Crew Vehicle]?

WALHEIM: Sure. When Orion gets there it is a shell. It's the pressure shell. That's all it is. It's a green pressure shell, and it looks like a boilerplate, like you're saying. Then they have to put everything on there. They have to put the electrical systems on there, the propulsion system on there, the landing and recovery systems on there, all the communication systems. So they just populate the outside of it and it's not long before they've [added] all the attachment points and they start putting this equipment on there. "Now hey, that looks like an Apollo capsule without the skin on it."

Then the neat part is to see when they finally do start putting the backshells or the thermal protection system around the sides, not just on the bottom, but on the sides. It starts looking like a real spacecraft, and it's like "Wow," it's pretty impressive to see that.

ROSS-NAZZAL: About how long does that process take?

WALHEIM: That's a good question. I'd have to know when it arrived at the Cape [Canaveral, Florida] the first time. I could look back on that somehow. I would estimate a couple years almost. Let's think about it now. We'll do it backwards. Right now the EM-1 is at the Cape already. It's a good two years from flying. It can be about two years or so.

ROSS-NAZZAL: What building are they doing that in?

WALHEIM: The O&C Building, the Operations and Checkout Facility. When I first flew in space our payload was S0, the central portion of the truss. It was being checked out in the O&C Building, right underneath crew quarters. I remember I'd stay in crew quarters, and we'd go down and look at it. Now Orion was being processed in the O&C Building, that's pretty neat. Same building and process. We just move on. It's amazing. If you work long enough on these projects you see the progress that's made. I remember when the Space Station Processing Facility was just full of Space Station hardware, especially after *Columbia*, just waiting to get launched. All of a sudden it all gets cleared out and it's all up in space and put together and is working like a champ.

ROSS-NAZZAL: It's amazing.

JOHNSON: You're still an active astronaut?

WALHEIM: Yes.

JOHNSON: So do you have plans to be in the crew?

WALHEIM: It's a possibility, but I've flown three times. It's probably unlikely I'll get a chance to fly again.

JOHNSON: But you'd like to though.

WALHEIM: Yes, I would like to fly again. Now whether my family would like me to fly again is a different story.

JOHNSON: That's always a good question.

ROSS-NAZZAL: Are you still working Orion issues here in Flight Ops?

WALHEIM: Yes. In this position now I've moved over from the Astronaut Office, and I'm the Assistant Director for Operations. BK [Brian K. Kelly], who's the Chief of Flight Operations Directorate, I'm his astronaut to work various issues from an operations perspective, if it's ISS, Orion, Commercial Crew. It's a lot of fun. I get to work a lot of different stuff, but I also get pulled into a lot of the Orion discussions. "Hey, you were in on this, what do you think about this?" It's fun.

ROSS-NAZZAL: We thank you very much for your time today.

WALHEIM: My pleasure. Thanks for coming over.

ROSS-NAZZAL: Thanks for having us.

[End of interview]