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DR. PEGGY A. WHITSON
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is August 3rd, 2015. This oral history session is being conducted with Dr. Peggy Whitson in Houston, Texas as part of the ISS Program Oral History Project. The interviewer is Jennifer Ross-Nazzal. Thanks again for taking some time out of your training schedule today to meet with us.

WHITSON: No problem at all.

ROSS-NAZZAL: We certainly appreciate it.

WHITSON: As always, happy to help out.

ROSS-NAZZAL: Well Dr. Whitson, you were named as Project Scientist of the Shuttle-Mir Program in 1992. You became a member of the Astronaut Corps in '96. Since that time, you've served in a number of capacities for the space agency, including lead for the crew test support team in Russia and chief of the Station Operations Branch in the Astronaut Office. You've been deputy and chief of the Astronaut Office. In 2002, you flew on Expedition 5, and you were named the first NASA Science Officer during your stay. Five years later, you commanded the Expedition 16 crew, and most recently you were named to the Expedition 50 mission. That's

quite a history associated with ISS. You've trained extensively for those assignments, spending more than a year in space and nearly 40 hours of spacewalking. I wonder if you can explain some of the significant challenges that you faced during that time with ISS.

WHITSON: I think the training flow is very challenging. We spend a lot of time training in other countries. It's an international community that we're working with, so we spend time training in Russia for the Russian segment of the International Space Station. Plus if we happen to be launching and landing on the Soyuz vehicle, we train there for that as well. In Japan, we train for the Japanese elements, and in Germany we train for the European Space Agency's element, the Columbus module. Also, we train in Canada for the robotic arm training. There's a lot of travel time associated with the space mission that doesn't involve actually being in space. There's a lot more travel time going all over the world and being in these places to get the training flow completed. It's actually one of the biggest challenges, I think.

When I was assigning crew members, I always said, "Welcome to ISS training. Be prepared not to be sleep shifted for the next two and a half years of your life," because you spend two or three weeks somewhere, halfway around the world. Come back, and you spend two, or three, or four weeks here. It's interesting because everything is associated with the trip number, so you end up calling your time at home the US trip, versus the Germany trip, versus the Russia trip. It kind of becomes a different mentality.

It's very challenging for families, and you have to learn how to be apart. I think it's good practice, because you get to find out what works and what doesn't work, and how to reintegrate when you get back home. I think most of us have a tendency to try and overcompensate. We've been gone for a month, and we try to do so much more, so it makes even your time at home not

very relaxing, because you're always trying to compensate for the fact that you're not home and trying to do a little bit more around the house and taking care of things. It's a challenging time.

ROSS-NAZZAL: How has training evolved since you first flew on Expedition 5? Now you're training for Expedition 50.

WHITSON: It's actually changed quite a bit. When I first started training, most of the crews were going through flows that were about four years long. Up through Expedition 4, I think they had four-year training flow. For Expedition 5 and my 3 backup, I actually had a much shorter training flow. I was assigned late, and I trained only three years for those missions, the combined backup 3 and prime for Expedition 5. Then for Expedition 16, again I was assigned late. I did Expedition 14 backup and 16, and I trained a total of two years for that flow, which was actually a very short time period to be training.

Shortly after my training flow for Expedition 16, we went to the single flow to launch, so that we didn't have dedicated backups. We have training flows that include you being prepared to fly six months prior to your prime flight, and that's the crew you're backing up. It's not a dedicated backup, but you're training to be ready six months early just in case something happened to someone on that previous crew and they needed to be replaced. That shortened the training flows down to, on average, two and a half years for a rookie coming in to be training.

In the last year couple of years, I've been working with the rest of the FOD [Flight Operations Directorate] team, trying to reduce the training flow even further. We'll probably get it down to somewhere between 18 to 20 months, which will be a huge reduction. My training flow this time around is going to be approximately 18 and a half months. We're a test case, but

I'm a flown crew member, so it's not exactly the same as a non-flown crew member going through it in that amount of time, so we have to make sure we're not undercutting unflown crew members by shortening it too much. We need to make sure we get the appropriate amount of training.

The big challenge with the long training flows like that is that we don't end up remembering. We have so many crew members who complain, "Well, I never trained on that," and the investigators will say, "Yes, you did." There's some tradeoff between just the sheer volume of information you're getting and how do we retain information. I think the training for ISS will continue to evolve. I think we were flying Shuttle for 30 years, and the training flow was evolving even at the end of that. We got very good at some parts of it, but I think when you stop evolving, the training is going to stagnate, so it's important to keep changing.

A lot of the things we're doing on Space Station to improve training include things like the just-in-time training. We call it JIT training. Those involve little video clips as refreshers and reminders. "Hey, this was the hard part of this procedure. Remember, do this, in this order specifically." Then it'll have the procedure in words, but it'll have a little video clip, just as a reminder, refresher. You're like, "Oh, okay. I remember that." Just to help folks train more effectively—not only train more effectively, but work more effectively while they're on orbit. Hopefully making fewer mistakes, because they don't remember things. Having that short term refresher will help crews, I think, on orbit as well.

There's been a lot of changes in training flow since the beginning when I started going in there. There was a lot more theory, a lot more background. Now we're much more focused on, "Here's what you have to know how to do to operate the Space Station. Here are the tasks that you're going to be expected to do," and focusing more on those actual operations. It's been a

gradual shift. There's some of that background information that's necessary, and some that we only need to know in certain scenarios.

ROSS-NAZZAL: As a flown crew member, do you take a condensed training, maybe of the RMS [Remote Manipulator System], for instance, or EVA [Extravehicular Activity]—you're not required to take such an expansive course?

WHITSON: Some types of classes we take condensed versions for. Last October I did assessments of all the systems: the life support system, the electrical system, the thermal control system. I took those system assessments, and from those assessments, then they determined how much training I needed to do. Which actually, in the end, allowed them to decrease the total training time for me. I was incentivized to do well on the assessments in order to reduce the total training flow.

ROSS-NAZZAL: Are there specialists on board ISS like there were on Shuttle where you had a mission specialist, commander, pilot? Are there those type of roles?

WHITSON: No, actually, since we've gone to the ISS paradigm, everyone's an astronaut. You're expected to perform all functions. You're expected to be able to do robotics, expected to be able to do EVAs, expected to be able to do the science program. You have to fulfill all functions. A commander versus a flight engineer role is slightly different, but the same skill set has to be available to everyone. That was particularly important when we had three person crew. Now that we have six person crew, we still need to have skill sets that encompass everything. It's

important that every crew member can do everything. I think it's a different change in that mindset as well. You don't have the capability to just specialize in one field or another. You need to be able to be good at everything: good at maintenance, good at science, good at EVA, good at robotics.

ROSS-NAZZAL: You've got a talented pool of people who can do all that.

WHITSON: Yes, it's pretty challenging, and everybody's going to have skill sets—hey, this is easier for me, or this is harder for me, but that's true of all of us. We train up the skills that each of us does not have so that we make that same minimum level of capability in all areas.

ROSS-NAZZAL: Would you share with us the evolution of science on board Station? You started out as the project scientist on Shuttle-Mir. How has that evolved since that time in '92 to today?

WHITSON: The Shuttle-Mir Program was a specific science program that was done jointly with investigators in Russia, so we had investigators here in the United States and here in Russia working together on the science program. For each investigation, there were investigators from here and from Russia. It was a good experience for me, because it gave me my first significant interaction with the Russians. I think that I learned a lot about negotiating during that process. Initially the first phase, the Phase 1A, was all quid pro quo, so I only got what I could negotiate for, and it was, "I'll trade you this for this." It was definitely a learning time for me in terms of learning how to negotiate. As I progressed then I think it helped me in the long run.

I also think in retrospect, in looking back, that in '96 they were selecting astronauts that they were planning to have fly on the International Space Station. The fact that I had all that experience with the Russians, I think, was beneficial to me. It made me probably look a little bit different to the selection board and probably helped me out. At least that's my speculation. I have no idea if that was really the case or not.

ROSS-NAZZAL: Can you share with us how experiments have changed on board Station?

WHITSON: At that time, it was the Mir Space Station, the Russian Space Station. So we were limited by hardware that could interact with their power and had limited thermal controls. The science hardware was a lot more limited. Today, on board the International Space Station, we have whole rack facilities, much more complex hardware, much more complex systems, and cadres of hardware. We can go after investigations that have much more complex, multidimensional questions that they're trying to address and answer. I think the complexity of the science that's happening these days is much higher than it was before. I really enjoyed being the hands of the scientists, because I enjoyed the diversity of the science program that's going on and enjoy seeing all of the different aspects, whether it's physical sciences, combustion science, looking at electromagnetic fields and colloidal solutions of iron. It's just a huge diversity, and for me, that's very interesting.

ROSS-NAZZAL: We've talked about how training has changed and how science has changed. Are there other ways that ISS has changed since you first got involved?

WHITSON: ISS has grown a lot since I first started. Even since the last time [I visited]. It'll be interesting to see. The Cupola module wasn't there when I was there last. Node 3, with all the U.S. life support systems wasn't there. I tested out one subset—the oxygen generation system during Expedition 16—but it wasn't set up and integrated with all the other life support systems. I'm looking forward to interacting and working with that.

The biggest change, I think, for me, will be going from a crew of three to a crew of six. I'm looking forward to working with a bigger group of folks and seeing how that changes just the interpersonal interactions, because the Station actually is quite large. You can spend a lot of your time working solo, even though the first question everybody always asks me is, "Do you feel confined working in such a small space?" Most of your day, you work solo in a module and then you join up with folks at lunch and supper. You might not have a lot of interaction. I think with a crew of six there will be more opportunities for interactions and working with folks. A lot of the tasks that we do on orbit, though, are still very individual.

ROSS-NAZZAL: Does that translate also into your training? For a Shuttle crew, you would train together. What about Station crew? You work individually?

WHITSON: Station crews, we still train primarily individually. We do have, obviously, emergency training and training in our launch and entry vehicle together as a crew. We do do a lot of training individually. I would say more than half is done individually. It's not as much fun, in the sense that those few opportunities where you actually go to a class with somebody that you're going to be in space with, it's kind of novel and unique. I think that that's probably a disadvantage, but when you're trying to schedule six different crew members all over the world

to do all different tasks and have various different responsibilities on board the Station, that's hard to arrange in a very efficient way. The overlap is very limited, so when we do overlap and we have all six crew in one place, it's usually here, and we're usually practicing the integrated emergency response for a six person crew. I'm looking forward to the September training, because that's when we're going to do our first integrated emergency response training with our crew. Everyone will be in town for that.

ROSS-NAZZAL: Very interesting. Your U.S. trip, as you call it. Can you share with us some of the decisions that you believe greatly impacted ISS in terms of budgets, costs, or policy operations?

WHITSON: Post-*Columbia* [STS-107], it was a big deal. I was a part of a [NASA] Headquarters [Washington, DC] team that was doing an assessment about whether we should continue building Station, whether we should stop where we are, because we didn't want to use the Shuttle. We didn't know how safe the Shuttle was going to be. I think that was a very critical time. I think the decision to continue to build the Space Station largely is a result of we still hadn't met our international partner commitments to the European Space Agency and the Japanese Space Agency. I think it was important that we did continue. We did add those additional modules. It wasn't necessarily a bad thing that we went through this reassessment to try and refine the flight schedule and optimize it. That was not a bad thing. I think it was an important decision point.

I saw that there was a potential there that it was going to stop where it was, which would have meant it would not have changed from my Expedition 5 point. I was very glad that we

made the decision to honor our commitments to our international partners. I think that was important for us and important for our future. For future international collaborations, we needed to not lose that trust with our partners and to continue to propagate that trust so that we will have future endeavors, whether Moon, Mars, wherever it is that we end up going, it will be advantageous to all of us if we do it as an international community. It was important, I think, that that decision was made to honor those commitments at that time.

Other important phases of the ISS, the construction itself was very complex and every part was very much required for the final complex. It's hard to point to any one particular thing and say that it was more important than the others. I think getting the final life support systems up there in 2009 was key, because that allowed us to go to six person crew operations. To me, that transitioned us from a construction and assembly focus to the science focus, which is what Space Station was about. I think that was a key turning point for us as well.

ROSS-NAZZAL: Are there any moments or events that took place, either on board ISS or while you were training that really stand out in your memory?

WHITSON: During Expedition 16, for me, the big event was while STS-120 was docked on board. We were redeploying a solar array that had been in a temporary location to its final location out on P6. When they had retracted the solar array, they'd had a problem with one side. They'd finally gotten it retracted, and they'd done that on STS-116. They'd retracted it, but there had been problems, so we had, of course, done simulations on it and hoped that it was going to work fine, but had plans if it didn't.

Unfortunately, when we did the deploy, the first half deployed normally, and the second half we ended up tearing the solar array before we could stop the deploy. We saw the tear before we could stop the deploy. It ended up being probably about a five-foot tear in the solar array. We stopped the deploy, so it was only a partially deployed array. The Shuttle couldn't undock from the Station unless that array was either fully extended or fully retracted. We knew couldn't retract it because it had this big tear in it, and the blanket box that [holds] these arrays—it's 239 feet worth of array, I think, and it fits into a blanket box about this big [demonstrates]—and with a five-foot tear in it, there was just no way that that was going to ever happen again.

The folks on the ground came up with a solution. I think a very elegant solution. I call it the Apollo 13 moment, because they had to use only what we had already on board. That was what we had to work with. We ended up cutting pieces of metal and punching holes in it and attaching wires with special bolts on it and then taping over it so that they could install these on either side of the tear, so that as we continued the deploy, the tension across the tear wouldn't increase. There were integral holes in the array, and they figured out a way for us to build what they called "cuff links" and stick it on one side of the tear and the other side of the tear, and it would hold the array stable and not allow that tear to propagate any further.

It was some of the sportiest robotics we'd ever done. We used the Space Station arm, and we grabbed the Shuttle inspection arm that we were using for inspecting the bottom side of the Orbiter for damage post-*Columbia*. So we used that arm on the Station arm in order to get a crew member close enough to this array to actually install these cuff links that we had built. It was, I would say, probably for me, the most stressful time, because we knew that if that array didn't get fixed in some form or another, that we would have to jettison the array so that the Shuttle could undock. If we jettisoned the array, the next Shuttle, which was bringing the

Columbus module up, couldn't arrive because we wouldn't have enough power. It was a big deal that it would potentially impact, again, that whole Station assembly sequence. That was probably one of the most stressful times that I was personally involved with, from that perspective.

I've had the privilege of working on numerous Team 4s. These are the teams that when the real-time operations are going on, they have what they call "three orbits." It's a team that's working in Mission Control for the eight-hour shift, and then the next orbit is working the next eight-hour shift. Team 4 comes on when the real time team is just working to keep operations on board going. This other Team 4 is working, again, 24 hours a day, with three groups of folks trying to solve a problem so that can be implemented on orbit. Being a part of those teams and seeing how it works is just an amazing experience. Watching the teamwork, the leadership, the problem-solving, it's just really special.

ROSS-NAZZAL: Can you give us an example or two of working on those teams, and some of the things that you were working on?

WHITSON: On one Team 4 that I worked on—I was actually in training for Expedition 16. The computer system on board had failed, and we were trying to figure out how the major command and control computers on board the Station had failed. We were docked, and so the Orbiter was holding the orientation of the Station because there was not the capability to do that without the Orbiter on board. On the ground they were working various different scenarios: if we have to undock, how would we undock? Do we undock the Soyuz with the crew and undock the Shuttle? Then the Station would be left tumbling. I was on the team that was figuring out if we

had to go back, what would we want set up on board prior to departure to make it possible to reenter an uncontrolled Station. That was just the small portion of the team that I was working on. There were, of course, other people that were working on the actual problem with the computers and various other systems for undocking sequences and how to do the timing, etc. It was very complex.

Another example, I worked on a Team 4, where we lost half of the cooling on board the Station because of the pump module failure. Cooling actually is a limiting function for that heat rejection capability, [it] limits how much power we can use. With only half the heat rejection capability, that meant you could only do half as much in terms of powering the Station, so it was a big deal to try and get that loop back up and running.

There was EVA teams, there was robotics teams, various other teams. I was on the next worst case failure team, where we were looking at what's the next worst case failure that can happen to us that would cause our situation to be even more dire than we are now? These guys are trying to figure out how to do the EVAs and the robotics to get this fixed, but if in the meantime that's going to take a couple of weeks to do, if we had another failure that could make it worse so that we couldn't do those EVAs, what would we do? It's just very intricate, the level of detail that these teams go in to problem solve, and all the minutia that gets looked at, examined, and figure out the best solution. I actually think that's one of NASA's biggest assets, is solving problems.

ROSS-NAZZAL: I wonder if you could share with us some organization and technical lessons learned related to ISS.

WHITSON: I think for problem solving, I really like how they have organized the Team 4s to go after the problem and not impact real time operations but get a group of folks and interact. Although they were independent teams working on different specific aspects of the problem, they met twice a day, morning and evening, resynced. Each group was like, "Okay, we think this, this, or this could be our options. This has this limitation." They would go through, and then other teams would say, "Well, this impacts us, and we think this option would be better." To resync up twice a day, and say, "Okay, we're going to go forward with this idea, and this idea, and we'll have this one as a backup." Just continue that iterative process, and that communication was key in making it successful, because not only did you have to have the small teams solving the specific details of the problem, but it was really important that the teams synced up again, multiple times in a day, or a couple of times in a day, to make sure that we're not making a decision that's going to impact some other aspect of the problem and make it worse for somebody else. In some cases, well maybe we need to choose to make it worse for this system or group, and then they've got to figure out, "Okay, here's how we're going to work around it." That communication was key in making it possible for the problem to be solved.

ROSS-NAZZAL: Were there lessons learned while you were on orbit, or perhaps in training, that you passed along to folks, and asked that perhaps changes be made?

WHITSON: I'm trying to think of lessons learned. We do a 45-day debrief process, and we had the opportunity to provide what we consider our top five issues for trying to solve problems or to improve the crew's efficiency on orbit. Things like that. The crew themselves can make comments to the program office, which then they can choose to try and fix or not, as they

prioritize based on how much money it might cost to change or fix something, weighing the pluses and minuses of whatever the issue is. So I think there's a lot of opportunity to try and fix those types of things.

I've been involved personally with trying to go post-flight and fix some of the training issues. I've done that on two different teams after a mission to try and do that. I've worked on trying to optimize the efficiency of the work on board by some of the products that the ground team was sending up. We tried to optimize how that data was presented for the crews. That's gone through a series of different changes over the years. I'm looking forward to what I think is going to be a huge improvement in that information processing that helps the crew do the job a little more efficiently and effectively. There's lots of ways I think we implement our ideas. Of course, not all of them are selected to be implemented, but it's important to put the ideas out there for improvement and make the decisions based on balancing out the cost of everything.

ROSS-NAZZAL: Can you share with us what you think was your most significant accomplishment to date for ISS?

WHITSON: Most significant accomplishment? During Expedition 16, we had to install the Node 2 into its final position. That enabled the ability to add on the Columbus module and the Japanese modules. Without having Node 2 and the EVAs that we conducted at that time, that wouldn't have been possible. As I mentioned before, I think having all the international partners be members of the ISS in a very active, visible way like that was important.

As a crew of three, we did all the spacewalks and the robotics involved for what normally would have been done by a Shuttle crew. The Shuttle crew weren't able to do it because they are

docked to the port that we needed to put the node module on, so the Shuttle had to leave in order for us to do the spacewalks: to disconnect that pressurized mating adaptor, and reconnect it—robotically move it and reconnect it to the Node 2—and then robotically move that to the lab forward, and then install the umbilical trace that would connect up all the power data and the thermal connections between the modules and get it to the Node 2, which then provided that capability to the two European and Japanese modules. I guess from a technical perspective, that was probably the most significant accomplishment. That's all I can think of right now.

ROSS-NAZZAL: What do you think about being the first female commander of ISS?

WHITSON: I honestly think a lot of that had to do with timing, and the fact that I was selected as a rookie to fly during Expedition 5, so it just happened to be the timing was such that I was in a place where I could be selected to be the commander on Expedition 16. It's one of those things where, yes, I wanted to be. After my first flight, I wanted to be the commander on ISS. I didn't care if I was first or not, but I did know that I thought I could do that job. I wanted to do that job. I had told the chief of the office at the time, Kent [V.] Rominger, "I'll do whatever job you need me to do to prove to you that I could be the commander on Station. If you believe me that I can already do it, then I'll just take a cake job in EVA."

He made me the deputy chief of the office, so I guess he didn't trust me. Had to prove it. He also assigned me to be the commander on a NEEMO [NASA Extreme Environment Mission Operations] mission. He tested me, per se, to convince himself, I think, to train me to be ready for that particular role. Again, I think it just happened to be timing. I just happened to be in the

right place with the right training and capabilities at the right time to be the first one. Being first was not my goal, being the commander was my goal.

ROSS-NAZZAL: We talked a little bit about STS-120. During that flight, you had another female commander up there with you, Pam [Pamela A.] Melroy.

WHITSON: That was fun, primarily because it was coincidental. Her Shuttle was supposed to arrive before our Soyuz was arriving. There was a Shuttle slip, so then I arrived first, and then shortly after that, her Shuttle arrived. It was just really a neat coincidence that we had two female commanders on orbit at the same time. I thought it was pretty special.

ROSS-NAZZAL: There's the great photograph of the two of you shaking hands. We talked a little bit, before we started this morning, about social media campaigns. Can you talk about how that has evolved since you started working on ISS?

WHITSON: Yes. At the time when I was up there, I did what would now be called blogs, but I was just journaling some of the things that were going on on board the Station. I know other crew members were initially doing blogs and then social media's come about. Crew members are trying to share as much of the experience as possible using different social media formats. It's just evolved with how social media has evolved here on the ground, and we're trying to fill as many blocks as we can and get different people, different interests, seeing what we're doing on board Station. I think every crew member offers a slightly different perspective based on their background, and will probably have a different set of followers based on where they're

from, and their backgrounds, etc. I think it's good to build on that diversity of backgrounds and get the diversity of people knowledgeable about what we're doing at NASA, so I think that's important.

ROSS-NAZZAL: Any plans to shoot a music video like Chris Hadfield?

WHITSON: I'm not musically talented, no. No, our big plan, and hopefully we'll be able to pull it off, is we would like to highlight all the people that it takes to make space exploration possible. It still amazes me to this day. I go through all this training, and you learn so much about the hardware, so much about what the engineers had to design and plan for, so much about what the trainers do to teach you how to use this hardware. Then there's the real-time flight control team that's supporting you 24 hours a day, 7 days a week. The team is amazing. It's just always mindboggling the number of different people: the divers at the NBL. There was a young lady I met over in the building who was working on spacesuits. She was doing the heat sealing of the inner bladder of the spacesuit. Her degree was in fashion design. It's just really neat, all these different stories. All these different people bring so much to the space program and from so many different directions.

ROSS-NAZZAL: How are you showcasing all of it?

WHITSON: We're going to try and use social media to tell the stories of the people: where they came from, what inspired them, the fun stories about what they work on, what they enjoy the most about their job, what their biggest challenges are. We're hoping to give young people an

idea. You can be in the space program. You can be a part of exploration without necessarily being an astronaut. Not every kid wants to be an astronaut. Less than one percent of the applicants get selected, so it's nice to be able to share with them all these other STEM [Science, Technology, Engineering, and Mathematics] education backgrounds that are actually involved, not even STEM, but other backgrounds as well. I think showcasing all those will help young people, hopefully, be inspired by what we do, and hopefully want to participate in the next generation of exploration.

ROSS-NAZZAL: That's a great idea.

WHITSON: Hopefully it will work.

ROSS-NAZZAL: It sounds like a lot of work. What do you think is going to be the legacy of the ISS?

WHITSON: For me, I think the legacy of the ISS will be the international partnership. I know there are other things that we do, globally, but this is the most technically difficult, complex thing that we've done as an international community. If you just even look at the construction of this engineering feat on orbit, most of these pieces never met before. They never crossed borders here on Earth, but we constructed them on orbit. Seventeen thousand, five hundred miles an hour, we put these pieces together.

ROSS-NAZZAL: Yes, that's pretty amazing, and NASA makes it look easy. Well I think we've touched on all the questions that I had. I certainly appreciate you taking some time today.

WHITSON: Oh, not a problem at all. No problem at all.

ROSS-NAZZAL: All right. Well, thanks.

[End of interview]