# INTERNATIONAL SPACE STATION PROGRAM
# ORAL HISTORY PROJECT
# EDITED ORAL HISTORY TRANSCRIPT

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INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is July 28, 2015. This oral history session is being conducted with Al Holland in Houston, Texas, as part of the International Space Station [ISS] Program Oral History Project. Interviewer is Rebecca Wright, assisted by Sandra Johnson. We both thank you so much for coming today and sitting down and visiting with us.

HOLLAND: It's my pleasure.

WRIGHT: I appreciate that. You began in 1984 with NASA as a psychologist. Part of what you did was to evaluate astronauts as part of the selection process, but your duties certainly have changed and expanded throughout the decades. Tell us what your current role is and what you are doing for [the International Space] Station.

HOLLAND: I'm a senior operational psychologist. That is a relatively new term—operational psychology—because it has become a new designation or new subcategory of psychology practice, and it is all things which have to do with missions. These don't have to be space missions; it can be military missions or mission down to the South Pole, but operational psychology is concerned with an effective mission and the health and performance of the people on that mission. It encompasses selection, training, in-flight support, family support, in-mission

monitoring, postmission repatriation. It typically occurs in a time-bounded mission application. Lots of psychologists from different backgrounds can do it, such as clinical psychologists and industrial organizational psychologists, but the key is that you are bringing in generic techniques from all these different fields and applying these towards a more effective mission.

So, that's my title. I started in '84 looking at astronaut selection, but also doing some flight controller selection and helping to look at flight controllers and sort through the situations that they had on hand at the time. I worked as a contractor for five years with USRA [Universities Space Research Association], and during that time there was also talk about having a Space Station *Freedom*. Part of my job was to go out to the analogs of a long-duration space station and learn about what we might expect, because frankly we hadn't done much. NASA had Skylab [Program], and that didn't last as long as they wanted Space Station *Freedom*—as it was called—to run.

I went to the military and the small groups who were deployed in the military; I went to the polar people and looked at North Pole stations and South Pole stations; I went to the undersea stations and the offshore drilling rigs and all the different what are now called "analogs" to long-duration flight. We wanted to learn what situations these organizations had encountered, what problems do people have when they go on long durations, and what should we consider doing for Space Station *Freedom*. Of course, Space Station *Freedom* did not survive into the future, but we had the opportunity to fly a single seat onboard the Russian *Mir* station and at the time, that was going to be it. It was going to be a single seat that Carolyn [L.] Huntoon was partly responsible for negotiating with the Russians, and the flier would be Norm [Norman E.] Thagard. That was on Mir-18. Through the process, I began to interact with the Russians, and it afforded me an opportunity to learn from the Russians and their past spaceflight experience. Up

to that time it was a closed society and there was no information coming out on how they selected, trained, and conducted their spaceflights, very little information. That opened the door for us to begin learning from them and looking at their technique. Then, through the course of the next seven Mir missions—because it turned from one seat into a program—we were able to work with the Russians and support our personnel. It was their vehicle, but we watched their organization provide support and to understand the techniques that they used, and share information, frankly. That was very instructive and prepared us for ISS [Expedition] 1. The International Space Station inherited some of those lessons.

Now the lessons learned on Mir were dark lessons, so to speak. It wasn't all light and airy. It was a very difficult set of missions for our astronauts because Mir was in the final stages of its life, and it was basically having a lot of integrity problems and falling apart. Our intrepid astronauts did their time on Mir, and from those lessons we went in expecting ISS to be more difficult than it was from a behavioral health and performance point of view.

During this time I transitioned from a contractor into a civil servant, and within a few years was able to start an operational section for psychology and distinguish it from the research section of psychology, because up to that time I was supposed to do all those things. We added a psychiatrist and some other additional individuals at the master's level, like [Stephen T.] Steve Vanderark and some people who've been around for a long time. They were instrumental in kicking this off. Kelly [D.] Curtis was important at that time as well and is still around with the Family Support Office. There are a lot of key people that started then and continue now and so there's a great deal of experience in that group.

We gradually gained in size and capability. When ISS started [Christopher F.] Chris Flynn was the psychiatrist here. He and I worked on ISS 1, and Walter Sipes was the

psychologist on contract with I think it was called Krug [Life Sciences] at that time, but Wyle Life Sciences [Wyle Laboratories, Inc.]. Just gathered steam gradually over the years.

ISS itself actually is a phenomenal platform, just a phenomenal platform. When you look at all the space platforms, flying machines, stations that have been out there, it really tops the list in terms of a mammoth international construction project that was successful—very, very impressive from a technical point of view. The volume was quite nice, which is important from the BHP [behavioral health and performance] point of view, because volume affects people's well-being. And, unlike Mir, there were spares; there were duplicate parts; there were redundant ways to communicate with the ground rather than no way to communicate with the U.S. ground. It was just a leaps and bounds better environment than was Mir or even Skylab. This was wonderful.

Currently, ISS is in probably the top of its arc in terms of a life span. It's a good time to be onboard Space Station. It's not toward the end of its life, and all the bugs are worked out on the front end. It's just a wonderful place for people who are lucky enough right now to live and work aboard it.

ISS and long flight in general, starting with Mir, have been very instrumental in promoting BHP and our group, our discipline—psychology, psychiatry as applied to space life and work—because we really do our best work in the context of long-duration missions and long-duration confinement.

That's just a little bit about how we got into the ISS business.

WRIGHT: You talked about the environment. Was your group involved in helping to design some of the ISS environment for astronauts?

HOLLAND: Not really, not really. We were in the meetings about acoustics and vibration, and we had more of a role in the meetings about sleep stations and eating areas. We were involved in that, but we weren't steering that; other people were really doing the steerage. We were just advising, consulting, but we were more instrumental in the selection, training, in-flight support.

I learned that one of the things I abhorred as a young person was very important in the long run—requirements and policies and procedures. These things to me were always dry as dust. I learned that the way you grow a discipline in an organization that has never had such a discipline before is through gradual incremental steps, but also successfully getting your needs into requirements documents and having the procedures set up and having those approved through control boards. That's a key part of staying where you are. Personally I learned a few lessons like that and as a group we learned lessons like that which allowed us to continue.

Part of what we do still with ISS has assisted us in gaining ground, and that is that our group provides on-orbit support in flight to the astronauts. We'll be sending up the news and TV [television] shows, and in charge of getting care packages packed from home and on the vehicles, and getting those up there. Like making sure that if there's a hockey game, any clips that were taken during the game of the kids get up on orbit. All that's been seen as very positive and that allows us to sometimes sit at a table that before we weren't invited to sit at.

WRIGHT: Because there is so much that you and your group do to take care of that, maybe we could look at it this way and walk through from the process of selection all the way until they get back home. For instance, the selection that you were a part of to help choose astronauts for

[Space] Shuttle flights. Could you share with us how and when that started to change, when you knew you were going to be looking for people for long-duration flights?

HOLLAND: Selection in and of itself is a big area, particularly in the soft skills like behavior. Our role always has been and still is the front door selection, which is taking all the applications and running them through the front door before the person ever comes into the organization and then becomes an ASCAN [astronaut candidate]. We aren't involved in assigning people to flights, we're only involved in the front door selection. That has changed a great deal.

What we learned from the analog environments was very, very helpful, including Mir, and allowed us to understand the attributes that were needed to do long-duration flight in a confined environment. Then to get such a wonderful machine for them to fly on makes it even easier.

WRIGHT: While you're talking about analogs, what were those common threads that you found in these—and I'll use the word outpost—but were there some?

HOLLAND: Exactly. There are so many commonalities, it's amazing, that are transferable, as you saw with [NASA's assistance in] the [2010] Chilean miner [rescue]. You can transfer learning from one environment to another, because they're very similar, things like self-management. You *want* someone who has some proven ability in managing themselves in difficult circumstances, in long confinement, or deployments away from home or family. If they don't have that, you want to get closer in and see what challenging times have they experienced, and how have they managed themselves and their relationships with other people.

You want people who can work within teams. You want people who are able to communicate with other people, who are able to repair fences, and people who won't put up too many fences in the first place. You're looking for good judgment. You're looking for a wide range of factors. There were about 10 factors that were guiding us through the early days up until about now.

Things are beginning to shift in terms of how we select people. The way you select people for short flights, like Shuttle, is very different from the way you select people for long flights, like Space Station. Some people are very good short-duration fliers but would not be suitable for long flight. People who are suitable for long-flight typically are very good short fliers. When ISS came along, initially it was grandfathering in people from the Space Shuttle community. Some of those were excellent long-duration fliers, and some were not. That's one lesson we learned from ISS—that some people are better at short flights, and some people are okay at any type of flight.

We had basically a selection system that had a set of target competencies, or proficiencies or attributes. They were ordered differently for long flight or short flight. That way we were selecting people who would be good flying Shuttle, but we also could identify people who would be good for Space Station. We carried that forward for a number of years, and then I guess around 2009, two cycles ago, a big shift came in the way we selected. We started introducing more experiential or behavior-based problem-solving scenarios into the selection process. They had interviews and testing, but were also having these problem solving scenarios they had to work through as a team.

The emphasis we learned was that we really need to push the team thing, because we can get some very good individuals but some may not work that well in a team. This is just based on

working with the ISS over a period of years. We introduced more team things, then in the last two cycles that has grown. We now have a pretty significant behavioral observation element which puts out these scenarios that applicants must solve in teams and simulates some of the situations that people have gotten into on ISS. We'll rotate leadership and we'll vary the situations in different ways. They also have to maintain a relationship with a ground base during this activity. They have to maintain relationships within the team, as well as back at the home base. That's been a change.

Another recent change is we recently completed a job analysis on the current ISS length (which is six months) out to Mars, that length of a mission. We looked for the demands that these different mission profiles place on individuals from the behavioral point of view, not the technical point of view. We looked at six-month missions and shorter in real time, we looked at 6-to-12-month missions in real-time communications, then we looked at 12-month missions with lagged communications. Then we looked at 36-month missions with lagged communications. The idea was in the first category of six months and less, we are catching the current ISS mission profile and its demands on individuals. With the second which is 12 months, we're catching what Scott [J.] Kelly is currently doing and hopefully future people will do, which is the one-year mission on ISS. Then we're looking at the 12-month comm [communications] lag, that is the long-distance asteroids with a little bit of time lag in there but the same duration as Scott's mission; then the 36-month and what would be required to go to Mars.

It was really interesting because we did interviews with all the ISS fliers that we could find, and they began by telling us what they thought the differences were between these four mission profiles and what the differences in people were needed, and what things these people needed at selection which is the front door, and then what could be trained. You see some really

interesting things. You see a big shift. Even though 12 months and real-time communication is the same duration as 12 months and comm lag, there's a big jump when you lag your communications. It's a big change in the kind of traits that do better in those missions than in the first two missions. The 12-month comm-lag mission looked very similar to the Mars mission in terms of what was needed.

Interestingly, it helped us look forward because we can only see based on experience how far we've been, so we only know from the U.S. point of view up to six or seven months roughly. When Scott comes back we'll have a single point one-year person. Unless we get more one-year people we won't understand the 12-month scenario, much less the 36-month. We're having these people who've experienced 6 months or 12 months put into the kitty what demands are going to be made on individuals, and therefore what competencies will be required for Mars. That's where we're pushing. We're trying to use ISS as a training platform for Mars for us to learn about what we might as an organization and as BHP need to do for Mars, as well as support it in real time.

WRIGHT: The first years that you flew crewmembers on ISS, they were former Shuttle fliers. Then when Peggy [A.] Whitson was chosen she was the first nonflier to go, but Peggy did have some on the ground Shuttle-Mir experience because she had gone [to Moscow] in those early days. As you mentioned, you didn't participate in the selection of crews for missions, but you do contribute to who is selected as future fliers. Also with Shuttle-Mir, if I remember correctly, there wasn't exactly a long line of people wanting to go to Mir.

HOLLAND: There wasn't.

WRIGHT: Did you find that that changed when ISS opened and they were able to stay long-duration there?

HOLLAND: Oh yes, because it was a U.S. operation. These were U.S. crewmembers. They had different expectations that were fulfilled because of the nature of the Station, the nature of life on the Station. It's a remarkable platform compared with any platform before. Mir just happened to be in the end of its life stage. It was, I'm sure, better as a younger vehicle.

WRIGHT: When you've watched members of the crew become formed—now we're past the selection and we're into the training—how are you involved in watching how they interact? How do you help make sure that they're able to work as teams off the ground as well as they work on the ground?

HOLLAND: We were excited to have pioneered the first expeditionary skills training that we put forward in early ISS for ASCANS. Astronaut candidates do get, even today, expeditionary skills training. We started that off, and it was a three-day workshop. It's gradually evolved into something that is both instruction-based and also experiential-based. We no longer control it. We've handed this over to the Astronaut Office, [organizational code] to CB. The Astronaut Office now is in the lead seat, and we just support them. To me it's a wonderful model, and it was a wonderful opportunity to be able to develop something—they liked it, they take it, and then it takes off and it's their thing.

With the ASCANS we are exposing them to leadership, followership, communication, small group living, self-management, some of the essence of those things on expeditions. As you mentioned earlier, it doesn't have to be a space expedition. It can be a military expedition, it can be an expedition down for six weeks to collect meteorites on the ice in the South Pole. It can be NOLS, National Outdoor Leadership School; it can be NEEMO [NASA Extreme Environment Mission Operations]. It can be any of these expeditions. The idea was to use all these analog training environments—NOLS is a part of it, NEEMO is a part of it, and the meteorite thing is a part of it as well, the geology field trips—to address the same set of expeditionary skills.

Before they go out for a geology trip for instance, they'll have some instruction on, "This is what leadership and followership is like in the field. This is what it looks like, this is why we're interested in it from a spaceflight point of view. This is what you'll see when you're out there. Now go collect rocks." Then they go out there, they'll be doing their geology thing, and in the evenings they'll have debriefs that are based around these expeditionary skills. "What'd you see today? How did that go? How did your team function? What could you have done differently? What could someone else have done differently?" Just make it a habitual thing that they always debrief the day of the event. They always do it within this structure. It's been applied through NEEMO, it's been applied in the National Outdoor Leadership School, it's being applied on ISS.

The idea is to train the ASCANS that these are important issues in the functioning of a team rather than in your own happiness and your own performance. Here's how you can sustain that over time in a field environment. So, expeditionary skills training is a big part of ASCAN training. We also provide conflict management and stress management training.

WRIGHT: You think having conflict resolution is important in a tight environment?

HOLLAND: I do. I think we could do it better though; I'm not happy with the way we do it. Outside of expeditionary skills, training is a front for us right now. That's where we're trying to revise and upgrade, just as based on the job analysis we're revising and upgrading the way we select people this coming selection cycle. We're jumping into a different thing from the selection point of view so that we can start seeding into the [astronaut] corps people who might fly in 20 years. Similarly, we start our expeditionary skills training with the ASCANS to build in the habits that in 15 or 20 years will feel like second nature to them when they're doing an expedition.

This is how long-duration missions and long-duration field settings differ from the short ones like Shuttle—they're qualitatively as well as quantitatively different. You can get along with almost anyone on a Shuttle flight and make the team work. It's like an elevator. You can ride an elevator since it's a short amount of time with just about anybody, but, if you were to live in that elevator for two weeks that takes a little bit more work. If you're going to live in that elevator for six months that takes even more. For the shorter missions, they're very different qualitatively; they're not as stringent as the longer-duration missions.

WRIGHT: You used a term that we're all familiar with, leadership training. I believe your other term was followership. Explain that to us and why that's an important element of this training.

HOLLAND: It's the flip side of the coin. We've got a bunch of strong leaders, at least in their minds, when they enter the corps. They have probably been leaders in other projects before they got here. There's a wide range in the military and in the science areas that could say they've been leaders of different projects and high achievers. They may not have thought through the importance of followership, because clearly in a small-group team setting in the field you don't want five leaders. You want five potential leaders, you want five potential followers. If there's a designated hierarchy, there's a designated leader. But, everyone needs situational awareness and there needs to be the ability to have situational leadership and situational followership.

If the three of us are going on a long flight, you might be the assigned leader. If there's an area that I know real well, if I know that particular hardware real well, then you might say, "Holland, you take us through this." Then I would need the leadership skills to be able to say, "Okay, what I need is I need you to be doing this, and you be doing this, and you hold this, and we'll do this, and this is how it comes out." Then I need to have the ability to fall back and to support her as the leader. Or, if it's your turn in the situation to be a leader in a particular thing, I need to support you. I need to make sure you've got all the information you need to do your job. If there's something I see and I'm not sure you're seeing it because you're blocked off or you're dealing with something else, I might bring that to your attention. I might suggest things. So, it's important from a followership point of view that the followers feel it as a role and know that there are specific jobs that go along with that situational followership, but they need to be ready to swing into a leadership mode and know that, and swing back. They have to be fluid between the two, and that's the way western small teams work best.

WRIGHT: They also learn it's an accepted role to not be a leader, and that it's not a bad thing.

HOLLAND: It's very valuable. It would be maddening to have five leaders, everyone vying to be in charge.

WRIGHT: I think we've all been in that situation before at some point. Also, when Shuttle crews were being trained for missions, they knew that the only interaction they were going to have would be the people on the Shuttle and of course the ground crew. Now the way that the increments overlap, there's a lot of opportunity to be with people you might not have worked with much. How do you prepare your crews for that?

HOLLAND: Good point. Very, very true. Very true. Station began by launching whole crews and bringing back whole crews, which was the familiar way with doing any mission. When the proposition came up that, well, maybe they'll start rotating and we'll do half a crew and then half crew—from the behavioral point of view we were shaking our heads, "No, this is not a good thing. This is not the way you get to know people and make adjustments for long flight."

It was not as bad as we thought it was going to be; so, the dire feelings we had were wrong. It's not optimal, and the fliers tell us it's not optimal. They prefer getting to know people, launching with them, but it's doable. We learned also that things aren't black-and-white. Things aren't optimal or nothing. There's doable in-between. Our experience didn't prepare us to comment on the doables. This was a new experience from ISS for us, which was very helpful, to see that this can work and is not optimal maybe in certain ways. If you need something to be optimal in those ways then don't do it this way, launch your whole crews. But, if you don't and

you need the manpower and somehow you need some sort of circulation there because of other reasons, you can make it work, and here's how you make it work.

It sounds probably trivial, but those were important lessons to us to see. Now that widens the type of missions that we can support and the type of situations you can support. If you're thrust into a new situation then you can say, "Well, I've seen a piece of that over here and we've had experience with that. So I think my estimate is this." You can be pretty close. It's been a great lesson for us.

WRIGHT: The decision to close down the Shuttle Program impacted a lot of the fliers that were there. They were planning to be a part of a mission, and now they couldn't do it anymore. Share with us some of the impacts of that decision with the crews and dealing with the chance to fly now has minimized—something that they trusted, the transport that they used, is gone.

HOLLAND: We saw some repercussions from that. Everyone loved Shuttle. It was a good machine, it was a brilliant machine, it was a phenomenal machine. It was a good way to put people into a two-week cramped situation with high ops [operations] tempo and accomplish a large number of things in a short amount of time. Very task-oriented situation. That was very appealing to people who like high-tempo operations, who like adventure and like the diversity of moving through a series of missions.

Now, like you say, if you're going to get a seat, it might be eight years after you come into the organization before you're entertained for even getting a seat. Then three years to train for that seat. It might be 11 years out of your selection from the front door before you get to fly one. Then once that's done, if you're going back in the pool you have to make a decision there,

because you've got another multiple years to wait until the next opportunity to fly again. So what are you going to be doing in the meantime? It has to be challenging enough to stay, you have to see the worth in whatever it is you'd be working on to stay in order to get that next flight. But, you're not going to see multiple Shuttle flights. You're going to see maybe two flights in your career.

That greatly changes things for the organization in that you might have some people who will be single-flight people, but that single flight might be six months long. That did change their expectations of the organization, and a lot of people left because they didn't want long flights in the first place. A lot of people just don't care for it. They want to drive something or they want to fly something, so those people were disappointed.

WRIGHT: Then you have those few that have gone up several times with long-duration flights. Do you find that genre of astronauts to be somewhat in a different category than the rest? Or is it just they've gotten where they like to go, and they certainly are ready to go back?

HOLLAND: They're ready to go back, absolutely. We don't make the decisions about crew assignments, so I can't really talk for those people that make those assignments. The people that do sign up to go on multiple flights clearly like spaceflight, and you've met them. They're people that love being in space. You can't drag some of those folks out. There are many, but people like [Donald R.] Don Pettit and Peggy Whitson and [Jeffrey N.] Jeff Williams are just people that have thoroughly enjoyed their time on orbit, and they have living situations at home that allow them to do that. They're very fortunate, and they know they're very lucky to do that. They have independent self-sustaining families and spouses.

I think the limitations are going to be physical. It'll be radiation. We're learning more and more about the changes in the body, like intraocular changes, and perhaps we have a hint of some structural brain changes in terms of the white matter changes. That is somewhat in our area because we deal with cognition, and we've had from time to time reports of "space fog." That's what they would call it. Or memory impacts, short-term memory problems. Wasn't problematic, they would get out their paper and pencil and make a list—sort of the way I live every day. But, these are younger people and didn't do that pre-flight so the space fog issue has eluded us, the large us, in understanding that, and I think that reflects how little we understand about the brain and cognition in general. I think going forward that's going to be a big push, to understand these more subtle changes from long flight.

You don't see effects in everyone of course, but I think there will be some lessons learned that in three, four years we'll be able to say we learned these from ISS about cognition. It's also spurring us to change the on-orbit onboard cognitive battery that we have, which is actually designed to detect post-trauma cognitive decrements or post-event cognitive decrements. The event or the trauma might be hypoxia, it might be a head concussion, it might be a toxin release from a payload, it could be anything like that. Now we need something that does that but also a battery that will detect subtle fluctuations in cognitive abilities, not just due to potential pressure changes within the neural system, but also due to sleep deficits. If we can detect these subtle things then we're even better at doing prevention and anticipating problems that will occur later on. We're looking for a change in the tool so that we can intervene earlier and preventively rather than reactively.

I would say that the cognitive capability detection onboard, the way it is now, represents the old way of looking at things, which is rather blunt. If something happens to you we have a

way of detecting whether or not you're fit for duty to continue on, or whether you need another week's rest or we need to bring you home. That's a blunt instrument to the whole cognitive issue. A finer instrument is something that can do that, but that can also tell you that yes, you're a little bit down, you're a little bit off today. Now you normally will go up and down, that's normal, but today you happen to be off on working memory to the extent that when you get to this level we see interference in fine motor control. So, this wouldn't be a good day for you to be grappling a satellite. That's a finer instrument. I call that step forward fashion. I'd say ISS is directly the reason why we're able to move forward with our tools and why we're pressing forward with tools and spending the resources and the time to do it, is because of what we're learning on ISS that will apply to Mars flight when you're three years in space. It's interesting to watch.

WRIGHT: Based on what you're saying, how my brain visualized it, was to actually see the real impacts on benefits for Earth as well, when you get those instruments fine-tuned.

HOLLAND: Very much so. Once they're developed and fine-tuned you very much could use that. We're even toying with the idea of instead of improving your cognitive functioning with medication if for some reasons you needed to do that, instead add to the array of things that could intervene. Adding to the countermeasures might be certain videogame-like exercises that you could do, which do in fact show that it will improve your reaction time, your working memory, or whatever it might be. We're beginning to look at that next step, which is even further out, which is "Okay, we can detect this. Can we intervene nonmedically, like a drug? Is that possible?" It's an interesting progression of technology.

I just want to say one last thing. As we move toward Mars, different demands are going to be made on those people; they need to be slightly different people since Mars flight is going to be a much more autonomous flight. There will be less opportunity to get help from the ground because of the communications lag. We're trying to also push our technologies into their hands so that they are expected to solve their own problems. They will be expected to manage themselves individually, and they're expected to manage themselves as a team. We're not going to do it for them. Rightfully so, they should say, "Well, how can you help us do this?"

We're trying to develop the tools that we're currently using in a more diagnostic or reactive way. We're trying to push all that over into a form that the crew can use so that when the three of us go we have not only been trained to maintain ourselves in the team, but we have tools onboard which are for that. I can tell if my cognition is way off, and if it's way off I'm going to say, "You better do the whatever it is today, because I can't do that today." Make them more responsible for the decisions about whether they do something or do not do something, and what they do.

WRIGHT: When they come back, especially since some of them have gone and come back several times, are they providing additional information for you to help the next group? For so long many had that thought of, "I can't tell the doctors anything because then I won't be able to fly again." Now they have an opportunity to help build that foundation for those next 15, 20 years out from now.

HOLLAND: From my viewpoint we've been successful at gaining ground in terms of the trust relationship. We are regularly consulted from space during PPCs [private psychological

conferences] and just by IP [internet protocol] phone and by e-mail about different issues. Some of which are onboard, some of which are individual, some of which are on Earth, because they're connected with their families and things are happening here.

I think that's positive. We seem to get—not with everyone, but with most people—a pretty honest debrief post-flight. We do that in the first three days following a flight. We have one at three days, we have one at ten days, we have one at two weeks. Within the first three days following a flight people are a little hot; that is they're still available, the emotions are still as they were when they were on orbit. After three days people, "cool off" and put back on the hat that they normally wear around the office; they become re-normed [normalized] to ground. But, in the first three days if there was an issue, they're still ready to tell you about it. If there are any emotional feelings about things, they generally seem to be willing to tell you then. We try to catch them in that time.

In general people have been apparently quite open with us, but we don't expect them to be 100 percent open. There are journals for those things that don't go to us. There are private conversations with families that we set up, and we screen and we vociferously lobby against any interference in that because people need different forums to talk about different things.

WRIGHT: While we're talking about on flight, just to compare, when Shuttle–Mir had the small time in history, one of the biggest things that was missing was communication on Earth with their families. When ISS started, it's gone so much further. Talk about the impact of how much that's improved the environment for the crewmembers to know that they have such an accessible link to what they need and who they want to talk to on Earth.

HOLLAND: It's pretty remarkable when you have people who have flown on Mir, say [C. Michael] Foale, who flew on ISS. In general people say, "Well, it's very, very different. It's better." But the idea that you can communicate with ground—I remember with some of the Mir fliers that they would have to do their PFCs, their private family conferences, over ham [amateur] radio, which is not private at all. It's just a family conference, and the whole world hears it. It was short because you had to be within shot of the pass. It just wasn't through the Russian ground control. They liked that connection and they were able to use that connection, so that was the mainstay of their connectivity with home and it's really isolating. It isolates somebody to not be connected with their spouse, their usual social supports, their friends.

Connectedness is a big deal. I'm thinking Mars right now, but you're going from Mir. We can think about Mir and see the negative impact that lack of connectedness and lack of a supporting infrastructure had on those fliers. We can look at ISS as a step between, because ISS goes to multiple redundant methods of communication. I can e-mail, I can text, I can tweet [Twitter social media platform], I can get on the IP phone, call any number on Earth that I wish at any time that I'm able to do that. There are multiple IP phones so multiple people can be on at the same time. There's the biweekly audio/video conference with the family. There's lots of ways to communicate. Some people have said, "I don't need that much communication. My family doesn't do that. Me and my spouse have been deployed before and this is the way we do it. I don't need that here and I don't need that, I'm just going to use this," and been very happy with it.

It's like a buffet. You go to the cafeteria and you've got several types of salad, you've got several types of entrees, and you've got your vegetables, and you've got your desserts. You go along with your tray and you can pick whatever you like. That's what we try to do. We try to

set up a buffet of on-orbit support that they can then tailor to their own desires and that of their family, and that they can change up and down during the course of the flight depending on the course of the flight. Multiple redundant ways of communicating have been very important on ISS. We think about Mars and we think about the importance of connectedness. We don't want to take a step back and have a Mir experience going to Mars. We want to have learned that we need to incorporate connectedness. It's healthy for the fliers, the fliers like it. It's going to be harder to do because of the communication lag, but we're exploring things like virtual reality sets on both ends. We're exploring a wide variety of ways to allow one end or the other, the family end or the crew end, to keep up with what's going on in the environment on the other end.

I don't think we can have too much of that in the Mars arena because there are going to be so many limitations on connectedness. It is possible to have too much connectedness in the ISS world. In our preflight training we do caution against that and try to assess whether someone has the inclination, or the family member has an inclination that there needs to be a whole lot of connectedness, so that the crewmember cannot keep their head in the game on orbit—because that would be unsafe if they were not able to do that, and they would be unhappy if they were not able to do that. You need a balance of connectedness and disconnectedness. For Mars we don't have to worry about having too much connectedness.

WRIGHT: They have so many to choose from. They have their family, then they have ground support, then they have the medical team. How do you train? Can you share with us some of the process? For instance getting the family ready to deploy their crewmember for being gone six months. How does your team help them prepare for that space of time?

HOLLAND: First of all we try to select people who've already had that experience and who have successfully had that experience. After that, it's the short deploys for training during their ASCAN time, their unassigned time. We have annual exams with all the fliers. It's, "How's it going, how did that deployment go? You were away for six weeks, how did the kids do during that time because they were in school, did your spouse do okay at home, did they have help from family members, who's nearby, what's the relationship like."

We try to both raise their awareness of how they can build that infrastructure, as well as see if there's any way we can help them build that infrastructure. They'll do that during the annual exams. Also when we're with them on training activities, we will continue to not only ask about that, but to talk about how other crewmembers have supported their families and the different styles that families have in getting ready to fly and separating. We'll do that with the crewmember. Then, once they're assigned to a flight, we not only have regular training with the crewmember about some of these things, but we also meet with the families about this. With the families, we cannot require them to come into training. We set up optional training and they've all accepted that. But, we also set up some informal times pre-flight and during the flight where we get together for coffee or breakfast offsite somewhere and just talk about, "Well, here's some things you might want to consider as you're preparing for flight, here's the way people have done it in the past." Again, it's taking our postflight debrief lessons learned from fliers, rolling it back into the next flight. We've always done that. We always have postflight debriefs. We always roll that back into the next flight so that as the lessons accumulate we then pass that to the family, pass that to the crewmember. "If you've got kids that are young, this is the way families that have real young kids have managed separation, have managed coming home," because, that's a whole other kettle of fish, when you come back home. "Here's how families with grown

kids have handled it, and there are three different ways." Then give them those opportunities and they can tailor it to their situation.

WRIGHT: I know you don't have any control over who gets selected as crewmembers. I have to assume you don't have any control over who gets chosen as ground support. Are there training packages that you help the crewmembers learn how to deal with the ground crew, as far as the work and how they get along?

HOLLAND: That's part of our training for the crewmembers. We also do briefings for flight directors, and we're also involved in Spaceflight Resource Management, SFRM, which is training that all the flight controllers go through. We have a finger in a lot of pies, but it's not always a big finger, sometimes it's small.

WRIGHT: I was just curious, because no one ever sees tension. I have to assume there has to be some tension sometimes coming from flight crews, going back and forth.

HOLLAND: Absolutely. There's a classic disconnect between remote teams, not just in space but military, pole, climbing teams, ballooning teams, boating teams, and their home base. It's just a classic disconnect. They see different worlds, and they have different priorities. It's built in. Ground will see the world one way, ground will have certain goals. Then the crew or the remote team sees things differently. Sometimes tension can develop between the two just because of the distance. We've found that flights that had audio-only comm between crews and ground had more difficulties than flights that had audio/video between crew and ground. It was the video

aspect that allowed them to have more information and could read intent from the other person. "Is this person really a bad person?" Or, "Well, I kind of like that person." It has a way of softening tension. That's been good.

WRIGHT: It's been a constant lesson learning and a constant lesson application for you since actually you've been here.

HOLLAND: Yes, it's been great. It's wonderful to learn things.

WRIGHT: Can you talk about the difficulty of when crewmembers come back and how your team helps them to adjust, especially maybe those crewmembers who know that that was their final flight, and how they tend to transition into ground-based assignments and/or to a new adventure that they're moving on to.

HOLLAND: We do brief them pre-flight, and the families, about post-flight. We talk about homecoming. We also send them a set of briefing charts before they come back, before they deorbit. We'll send the same set of charts to the family as to the crew. Those charts reiterate the lessons that we were talking about on the front end. That information primarily came from the military, the chaplaincy, and a lot of the interventional behavioral people from deployment centers within the military who were very generous in providing us with information about deployment back in the earlier days. I was telling you I went around to all these different analogs to learn about how they selected, trained, repatriated people. They were very generous

with that, and still are involved and helpful to us as they learn more. That information is tried and true and applies to any field setting where people are coming home.

When they come home they and their spouse have had the same teaching. We do that so that we'll get all the issues out on the table ahead of time. Even if it's not an issue, they can say, "Well, that doesn't apply to us and this doesn't apply to us, but well, this maybe." All their issues are out there rather than waiting for people to get back, and when things can get tense and then somebody says something in anger. Get all the issues and prediscuss them a little bit, even if they've never experienced a long deployment, it at least alerts them to some of the issues that past crews have had and past military organizations have had, and some solutions to those. For instance, one of the pieces of advice is don't make any major decisions about your life right after you get home. Let the heat cool a little bit and let everyone get back to normal and reestablish relationships, and then start talking about changes you might want to make in your life, major changes. If someone has had their last flight or they think they may have, don't make that decision right away, but give it a little time, and then discuss it.

That's been helpful I think. There have been people who have made those decisions, but they've been very good about waiting. We haven't had anybody rush right into it. It's easy to do, it's seductive because you're ready to move on to something else. When you come back after being in a high-tempo operational setting, coming back to an office environment is not particularly satisfying. It's like you're flying along at Mach 3 and then you hit the molasses. Then you're back to, instead of getting all this attention even from groups like us, you're on your own now. You've got to readjust back to being a regular person like you were before.

There is some adjustment at work as well as at home, both for the individual and for the family member. The spouse in particular, but the kids too. Spouses often have picked up new

roles while the flier is away. For instance, maybe now the husband at home is able to do more things with the kids than he did before the flight, because he's been a single parent for the first time and likes parts of that and wants to hang on to that. The flier comes back and she's ready to reassume some of those, and there may be differences in expectations about the roles. That's typically the problem you have.

If you're going to have a problem, that would be the problem when people come home, that their expectations are misaligned. The flier is either assuming they're going to pick up new roles, or is assuming that the person at home is going to keep some of those roles, or he or she doesn't want to pick up those roles again. The same with the person at home. They'll either assume that they're going to go back to the old things, and they can't wait for the flier to get home, because I'm going to hand this stuff off, or "I like this, and you're not going to have this back." It's that misalignment between spouses that is typical.

WRIGHT: At what point do you *not* see that flier as part of that mission anymore, but just back in the routine? You talked about having a three-day debrief. At what point do they move out?

HOLLAND: Thirty days is our last one. Because of the improved exercise capability on orbit, they're coming back in much better shape now from ISS than they did in early ISS or Shuttle or anywhere else. That's made a big impact on their physical ability when they get back. They can drive earlier. If you can drive earlier, you don't have as many vestibular issues, and you're not as degraded muscularwise, so you're able to get back into the gym. This all is mood-elevating and it's more normalizing for you. They get back into the swim a little bit faster with fewer problems, more energy than they did before.

Used to be there was a fair amount of lag between the time they get back to their baseline physically, and the time that they feel motivated and energetic again. It would take much longer to get their old energy and motivation back. That seems to be shortening now, and I think a lot of it has to do with the exercise that they're getting. They're coming back fit, sometimes better than they left.

WRIGHT: We've talked about the crews and the families and the ground crews. But we'd like to spend some time talking about you and your support crew, because I was just thinking that's rewarding for your folks to be able to see some of the improvements that you all have been trying to do. Talk with us about what you and your group do for instance when crews are in flight. Are you constantly on call? Is there a person that's assigned to a person or is it a crew? How are you set up to help?

HOLLAND: How are we organized? Just let me say before that that we do have a clinical function that's in place at all times. Any flier or their dependent can come in and can talk to us informally or formally, and also to the Employee Assistance Program, which is part of our extended group, and/or get a referral somewhere. We'll see them, we'll see a family member. That's always there underlying all this other that we've been talking about which is nonclinical. It's more oriented toward adaptation and adjustment.

Basically the way we assign it is we assign one psychologist and one psychiatrist to each flier currently. If Kjell [N. Lindgren] is going to fly he'll get one psychologist and one psychiatrist assigned to him. He'll also have a support person assigned to him from BHP, a psychological coordinator, and that person is the person who will make sure that they have an

onboard webpage, and that they get the clips from home, and that family conferences are scheduled at the right time. They'll have that, then that person usually has a backup as well. The psychologist and psychiatrist function in slightly different roles. We're both responsible for their on-orbit health and adaptation, slightly different perspectives, but we'll both be involved in private psychological conferences. We'll back each other up. If I have to leave town or am out, then the psychiatrist can do that. If both of us are out then we have another set of one psychiatrist and one psychologist who can roll in as well.

We are sort of on-call all the time, in that frequently we're called at odd times because there's something happening, and that's fine, because it doesn't happen all the time. It's not like a hospital where you get a lot of calls if you're on call. It's much less frequent. We tend to be available for calls at all times. Typically if we go somewhere we have our BlackBerry [wireless devices] and people can reach us by BlackBerry if we're way out. If we're so far out as sometimes we are where we don't have phone coverage, then that goes back to our counterpart back at home. There's always somebody back in Houston.

The folks that do the in-flight support have been really critical to this operation. They have seen things evolve, often driven by technology changes. Technology improvements, we try to ride those. If Twitter is now the thing, we try to have Twitter onboard. If Internet access is important, we were important in helping get that done. We try to ride the technology and push new technology within the organization. There are a lot of people outside of our group within the organization that keep their eye on that too. We're always trying to capitalize on new technology to improve connectedness. I think they will have seen a lot of change over the years in the way we do things and improvements with things. It's remarkable. Crewmembers now can get 55 TV stations. They just need to let us know four days in advance what they want to watch.

There's in fact a TV guide on their webpage, so they can actually go to that part of their webpage and they can look down and say, "Oh, well I'd like to watch A&E *Sherlock Holmes* on Friday night." They can reserve that and it'll be sent to them. There are things that you can do with real-time communication environments that you won't be able to do for Mars. All those things will go away that present the challenge for the future.

I think these folks have seen a lot of change in their area. I've got to say that BHP approaches the issue of operational effectiveness and health in a systems way. It's very much a systems approach. We look at selection, we look at training, we look at in-flight support, we look at in-flight monitoring, and we look at family support all as pieces of a puzzle which together link and are synergistic and create the outcome we want. No one group could do it alone. You really need them all.

You need an effective selection, you need an effective training, you need an effective in-flight support, you need the families onboard, you need to be keeping your eye on the families, supporting them, and you need to be light on your feet so you can change directions. If you do that in a systems way you can have very good outcomes. If you do not—we've seen organizations who have not done that—they will not get the outcomes. I think the systems approach is one reason we've had good success in applying behavioral principles and behavioral disciplines to long-duration spaceflight.

WRIGHT: Along the way, if I'm correct in remembering, NASA has helped other organizations by doing studies. Like prior to when you went to Chile you sat down with your group, and everybody exchanged ideas. You looked for those ideas and you pulled those ideas together. Then other times possibly outside groups have had ideas. How do you pull that information

together to help formulate what you want to do in the future to make improvements and make enhancements?

HOLLAND: We are not hesitant to say, "Hey, we don't fully understand this genetic thing. We need to bring in some people that do." We'll go tag three people and say, "Hey, can we get a day and a half of your time and come in and tell us about that?" That's an important way to do that. I think if you're not open to that then you're going to miss something. You're going to miss a new technique, going to miss a new concept, a new model. You're going to miss something in your own operation that you're not seeing correctly. It's real important to have that coming through from the outside.

In the past we used to have to pretty much exclusively rely on that, and exclusively rely on our relationships with counterparts in the military and in the polar services and internationally, in the French Space Agency [CNES] and the French polar services. We used to have all those contacts very warm, and feeding information back and forth and getting new ideas. But we used to rely exclusively on that.

Now we're able to use those, but we have a BHP research function which is an entirely different organizational unit than BHP operations. I'm from BHP operations, and BHP research are the folks that are thinking way out there. What their job is, is to fund principal investigators in studies that fill gaps in our knowledge and reduce our risks in different areas as far as going to Mars. In BHP a risk might be the risk for depression beginning on a Mars trip. How do we best address this risk? Do our current techniques work? Well, we don't have real-time communication, so we're not going to be able to take calls on a real basis. How do we do that? We need to develop something they can have on orbit, or we need to develop a system, a training

package plus something they have on orbit. How do we do that? Do we use VR [virtual reality]? What do we put onboard?

Then they will go out and they will fund a principal investigator, one or many, to do research in those areas, and come back and say, "Well, we've done lit [literature] research. We've done actual research in the lab [laboratory]. We've tested our tool or our theory in HERA [Human Exploration Research Analog] over here, and we've tested on NEEMO and other analogs. We think this is the best thing. Here's the data we have. If you'd like to apply it to ISS or to Mars then this is what we recommend."

We have that function now which we didn't have before, which is a boon for us. It takes us out of the job of having to go out and constantly actively develop new ideas from other people. But, there's no replacement for talking to other operational people in these other environments and just hearing their anecdotes and hearing their rules of thumb and saying, "I tried this on this kind of person, and boy, the narcissists really float to the top." Those are the sort of things that then you can decide to try out or not. Having the research function available, which is Lauren [B.] Leveton and Laura [J.] Bollweg and their team, has just been invaluable. Our relationship with them continues to grow closer and closer so that we are able to have more input into what they're doing in research, and we're able to drive some of the basic research questions a little bit more operationally than before.

WRIGHT: That's great progress, being able to keep that in house, but yet it still spills out.

HOLLAND: Yes, it's really amazing. In fact I think they report to [William H.] Gerstenmaier.

WRIGHT: Other professionals have annual meetings or conferences. Do you guys that are involved in the analog groups get together and trade all this information?

HOLLAND: There's AsMA, the Aerospace Medical Association conference every year, which gets a lot of these people together. Then there are other specialty conferences like the industrial operational psychologists who will have conferences, or the clinicians will have conferences. The military may host certain conferences; it's become somewhat scattered there.

We used to have a regular meeting that I organized back when I was slumming through all the different analogs, which was Special Applications of Psychology, we called it. Anybody that was in an unusual analog environment had very small *n*, or very few people, very elite mission-oriented situation, we could get together. It was a very small group at first. It was 3 people started it, and then we grew to 6, and then 9, and 12. These were people from all these different analogs and we would meet annually. We would just rotate around. Sometimes we'd meet at the Navy's place, sometimes our place. It grew, it got larger and larger and larger, and it grew too large and was co-opted by a lot of the national security people and questions and issues. It drifted off into that arena and subsequently became a national security psychology conference, which doesn't have as many helpful things in it as it used to. It used to be helpful but not so much now. We don't have currently a regular conference for operational psychologists.

WRIGHT: That's interesting all by itself.

HOLLAND: Yes. There's so many tendrils out there.

WRIGHT: From the time you started in ’84, but actually once ISS got up and running, have there been some major policy decisions that certainly were out of your hands, but definitely impacted how you and your operational group did your work? We mentioned a while ago about the overlapping of increments, and how you had to rethink some of that. Of course the Shuttle Program closing down, everyone going up on the [Russian] Soyuz [crew spacecraft]. But are there others, even politically? We’ve had that issue many times coming up in the news media about the situation with Ukraine and the Russians, and how it’s caused tension on Earth but yet the International Space Station seems to keep rolling. Those factors that you have no control over but yet you have to help the astronauts move through those situations.

HOLLAND: Like the 9/11 [terrorist attack on the World Trade Center in New York City on September 11, 2001]. You talked to Frank [L. Culbertson, NASA astronaut in residence on ISS on 9/11/2001]. There have been family members of astronauts who have died while they were on orbit. There have been events, geopolitical events or individual family events that have occurred—we’ve learned lessons from these that we couldn’t have learned without ISS. We need someone on orbit in order to learn about on orbit, and to learn about their families back at home.

Those things did teach us some things; 9/11 taught us the need for video news versus text-based news. *New York Times* [newspaper] was text-based, and CNN [Cable News Network] is video-based. We learned the value of video following disasters, floods, those sorts of things as a way to give the crewmembers information in a way that satisfied the crewmember. Video is much more effective, not excluding text, but in addition to text.

We learned that. We also learned from 9/11 that when things happen on Earth that are very personal in nature—and some crewmembers on orbit lost people in 9/11—the crewmember's response besides grief is typically helplessness, and this feeling that, "Wow, I should be assisting, I should be comforting the family, I should be attending this, I need to be talking with these people, I need to be supporting other people." It's that sense of inability to do that, that helplessness feeling, that now we'll brief into our packages. That if something happens to a brother or whatever, then you are likely to feel that, and here's what we'll do. We'll open up the comm channels. We'll provide video back to the services. We've done that. We've provided the ability for a spouse to carry an iPad into a service and have the crewmember be able to participate actually real-time to see the service. Things like that are very important. It's very important to feel connected at times like that. Other times it's less important to feel connected. We did learn some things from 9/11 and from deaths of family members that were very important.

Geopolitically, we've learned that no matter what's going on on Earth typically people know that they've got to live with each other on orbit, so they will be on their best behavior. It's not likely that someone will bring up an issue in an insensitive way or a blunt way. It has happened, but typically there's a sensitivity about that and an understanding, intuition that there are ramifications if we open up this particular box of worms.

WRIGHT: We're not asking for specifics, but talk about how they deal with issues or tense times on the Station and you have to help them work through that as well.

HOLLAND: Yes. I think not everyone, but a significant portion of the folks are ready to come back when they come back. It seems like four months seems to be the optimum length of time on orbit. People like four months. At four months, they're still having a great time and they feel like they've contributed and they don't feel like they've missed too much on Earth. They can do six, and they do do six. You push them on out, and they do six, and they're fine, and they'll come back. If they could have just pulled a handle and flown back, it would have been at four probably.

There are some people that when you get to six you're dragging them out by the feet though because they would prefer to stay in there, and they'll tell you, "If I could bring my family up here we would just stay here indefinitely." That's a little bit individual, but yes, there have been times when people are homesick and we saw this on Mir as well. If there's a connectedness it can resolve, and we're able to resolve it. I want the individuals to resolve things as much as possible without outside interference. We try not to get in their knickers too much. We try to set up the thing proactively and establish conditions that allow an individual and their family to repair themselves or to work through homesickness or grief or tension or what there might be, rather than intruding first. They do know we're available. We have helped people through difficult times and still do that, but we don't jump in. I think that's an important aspect of this. You don't want to bother people. You want to be seen as a resource and a positive one. You don't want to be seen as a thorn in their side or intrusive. That's been fairly successful.

There have been people who have wanted to come back earlier and wished they came back earlier. Sometimes that's pushed by events within the family. Someone's having difficulties; maybe a teenager is having difficulties. A crewmember might be concerned that,

"Well, I really need to be there, I wish I were there." You start getting a little bit of a split. You want them to as much as possible keep their head in the game up there, have a connection with home, be an adviser to the person on the ground, and feel like the person on the ground has sufficient social supports and professional support to get them through the situation, so that the person on orbit doesn't have to get in there and solve every turn left and turn right about it. They can let that go and feel okay about it. That's how we do that.

WRIGHT: Your science is almost like an art.

HOLLAND: I think there's a component of both. It really is. I think there's a little of both.

WRIGHT: Does management for the most part stand behind your decisions on what you need to do? Or have you had situations where you've had to explain and are overruled on some issues of how you've done things?

HOLLAND: I think sometimes unfortunately—and I think this was more common in the earlier days—I'd say in the last 10 years it's less common. In the last 10 years I think we've reached a level of momentum and acceptability within the organization that people see us as a resource and in fact they start doing the things that we're doing over in MOD [Mission Operations Directorate] or FCOD [Flight Crew Operations Directorate]. They'll start doing things and initiating things using our language. Our expeditionary skills training takes off, and we just love that, because it means that the organization is accepting the importance of behavioral factors, and

not because we need it to feel better, but because we think that it's an important aspect of successful long duration missions.

In the old days it was a real scrap just to get anything going at all. It was fighting tooth and nail to establish a program, but the climate has changed a great deal over there. The climate has changed a great deal within the Astronaut Office, within all the major components, and in society. The climate has changed and it's more conducive. Long duration flight has come online, which is what we contribute best to, so I think things are better. In the early days it would take an event, it would take a negative event. In the early days we took a step forward after some catastrophe. In fact I did a presentation to AsMA one time outlining, showing the timeline, and showing the catastrophes and where we took a step forward.

For instance annual exams. There is an annual physical exam, always has been for fliers. There's never been a psychiatric portion to that just to see how they are doing. In the early days after selection oftentimes there never would be another opportunity to see how the fliers were doing in their personal lives, how the family is doing, that sort of thing. We requested many times to have a psychological/psychiatric component associated with the physical exam that would be done once a year. That was denied. It took an event for them to realize that they needed to stay in touch with their fliers. You can't just select them and let them go. People change over time; their circumstances change over time. Once that event occurred, then we were allowed to do annual exams. Unfortunately there was more of that going on, more of that kind of progress, than rationally driven progress. I think there's much more rationally driven process now. I really do. I really believe that.

WRIGHT: Society has also gotten more global, just like your office has in a sense.

HOLLAND: That's true, you're right, that's great. It's different. With social media the world is shrinking a little bit. Everybody's shifting. Something happens here, globally there's a shift, rather than just regionally. That's good and bad, but it's different.

WRIGHT: It keeps us moving, doesn't it? Speaking of moving, I'm going to ask Sandra if she has some questions for you and give us a chance to think about what else we want to talk about.

JOHNSON: It was interesting earlier on when we were talking about the leadership versus the followership, and you were talking about three people working and one person takes the leadership and that gets shared, and you said that that's the way that small Western teams work best. With the international component of course, with ISS, does that carry over with the international partners? Or do different groups tend to work differently? How does that work?

HOLLAND: Yes, it is culturally driven or culturally affected. For instance traditionally, the Russian crews are much more hierarchical and it's driven that way from top down. Top down-driven. The Western models tend to be more consensual, tend to be a little flatter in their organizational structure. They're not, "You're the top, here's the deputy." It's flatter. You have someone at the top, then you have specialists. The Western crews are different due to their culture.

Of course there are still cultural differences. You have the Canadians, you have all the European countries, you have the Japanese. There are differences. People are basically the same, and the people who fly from any culture are basically the same in that they want to fly,

they love to fly, they like technological things, they're scientists and engineers. They share a common subculture, an aerospace subculture that they all relate to. They want to fly, they enjoy flying, and they can look across, and even though you can't speak their language, you understand that they're having a good time too. You have some common goals and some similarities.

However, the differences that I've seen arise typically revolve around leadership and gender. The cultural differences in all the international partners globally, I think those things jump out, at least in spaceflight. The way different cultures define what a good leader is and a poor leader or a good follower and a poor follower differ, as does gender roles. What the role of the female should be on Station varies culturally. These two things from the BHP point of view are probably the areas in which we would expect the most tension to occur between crews. Even more so than say whether someone's a pilot or a scientist, which are two different cultures within the West.

Yes, there are definitely cultural differences. You got to remember ISS is not a single cohesive crew. It's more like a duplex. You have the Russians living on one side of the duplex and the USOS, Western, and Japanese on the other side. Basically it's like living in a duplex. You'll get together for meals from time to time. Depending on the personalities onboard, you might get together often for meals, there'd be a lot of interchange, or you might just do that once a week, have a movie night once a week.

The Station is of a volume that it's very easy for you to continue working on your side of the duplex, because there's plenty for you to do, and just get over there occasionally. The other side is the Russian side. The Russian side and the Western side. That changes the dynamics. It's not a single cohesive group that Westerners or Russians have to adapt to. It's more of a hybrid situation. That's partially due I think to the fact that there are rotating piece crews rather

than single crews going up and back, and partially due to the construction of the Station, and partially due to the slightly different rules that apply to each side of the duplex.

For instance our Safety [team] might say, "Okay, guys, you can't use this particular piece of hardware on our side because of our flammability rules." The Russians can, so it lives over here on the Russian side, but the Station still is at the same level of risk. You might have differences. The Russians may have different safety standards or other standards, food standards, whatever it might be, than the Western side. It's a funny little duck. It's not what many people think of when they think of Space Station that you got a set of people up there; it's really two sets of people.

JOHNSON: You mentioned pilots versus scientists. That's always been there since they first started selecting scientist astronauts. I was thinking that someone—we mentioned Peggy Whitson earlier, since she had done the research during Shuttle-Mir and then she got a chance to fly. Without obviously mentioning anything personal about anybody, but in my mind I was thinking that maybe scientists when they go up there, since they are doing what they love, they're doing their science, they're so devoted to that, when they come down, then you have all the results. There's going to be that continuation of excitement. Whereas, like you mentioned, some people when they come back, 30 days out, they get their last interview with you, and then all of a sudden, "Now what do I do?" Do you see that depending on their particular agenda or interest, that that is a big difference when they come back?

HOLLAND: Between those two groups?

JOHNSON: Between pilots and scientists for example. Or if there's any other groups like that that it affects them differently.

HOLLAND: I agree with you that people who are more integrated into the science that's onboard tend to be more comfortable on the Station, the science Station. Pilots tend to want to do things with their hands. They tend to want to do this [driving motion with hands]. But, those that fly to Station are those that want to do that but also like to be on a Station. Those that didn't want to sit on Station generally have left, and they've gone to do other things.

The two groups now are more equivalent than they were before Station, when there was stark differences during the Shuttle-only era. You don't see the stark differences here. The groups are a little bit closer towards alike. You do have people that come into the organization as world-class scientists and with the thought that they're going to do world-class science, and that's not true, and they don't continue doing their own science. They're now in a situation of being a formerly world-class scientist who is doing someone else's science that they may or may not particularly get excited about. That's an adjustment that generally begins preflight, but once you're in flight that's part of the deal. There's a lot of wrench turning up there. There's a lot of air filter changing and attending to the Station and maintaining the Station. It's more of a blue-collar job.

One of the things you want to do early on at the very front door, you start—but they don't hear it—you start talking about how this is a regular job. "Whatever you had in your mind about what this was like is wrong. This is just a regular job. You and all these other people are going to go do that. It involves a lot of mechanics and just routine stuff that may or may not be

satisfying to you. Yes, you do get to be in space, but at the same time you're not going to be doing world-class science. You're not going to be flying a hot jet plane."

You try to dispel that along the way. I think when they return, the scientists that are up there, I think they're in general more connected with the science projects, more embedded with the investigator communities, take more interest in that, and therefore—I can't say do better when they return, I can't say that, I don't have the data to say that, but—I do see that they are significantly invested in the payloads.

When we go to Mars I think we're going to need much more of that. We're going to need, because it's such a long way, people who know it more intimately from a systems point of view, each payload, and we need the families to more intimately know the payloads and to be involved in the work that's going on up there. I'd like them to understand, "Oh, it's Thursday, okay, so Thursdays they're going to be doing this, that, or the other, and yes, I know that. This is out of University of Pennsylvania. I think I'll call Bob and see how the data is coming back." I would want the families to be that integrated from their point of view, which is radically different than we currently do. I'd like to see the fliers a little bit more integrated in the payloads and in the teams that are providing the payloads as the payloads are developed.

JOHNSON: You've mentioned the family a lot. It's very interesting because we all need family support, even on the ground, but there are some people who have flown that don't have as much family involvement, they're single, they're not attached, or different things. Do you see a difference in people when they fly that are not attached to people on the ground as opposed to people that are more attached?

HOLLAND: Well, you see difference in just habits in terms of comm [communications], how much comm you have, what time of day. Like people with families that have kids try to catch the kids at a certain time, like before they leave for school or just as they're coming back from school, or before the spouse leaves for work. There's communication at certain times, whether there's a family in place or not. In general they're not under enough duress in this environment for those things to come to the surface. We know from prisoner of war [POW] studies and some of our connections with prisoners of war groups—that was an analog back at the beginning—that individuals with families fared better during imprisonment than individuals without families, because it gave them a reason to continue to thrive and to come home.

That was under great duress. We don't have that kind of duress in this particular environment. Now if we go to a more difficult mission or heaven forbid if an ISS flight suddenly had a debris hit and everybody comes down into one module or two modules, it's a different Station. It's no longer the Station it was. There will be different dynamics onboard, it'll be a completely different game. Under those conditions you might then see differences that the POW folks saw. We haven't seen that yet.

JOHNSON: Possibly longer duration like a Mars mission that might apply?

HOLLAND: Possibly so, yes.

WRIGHT: You've taught people how to work with each other. Are you teaching them how to deal with working with robots and what it'll be like to have interaction with nonhuman behavior? Is that something that you guys are looking at as well?

HOLLAND: They are not yet there; we're not there yet because operations has such a short term view of things. The research side of BHP, however, has a much longer term view. No, they're not doing anything there, but what we want them to do and what we are talking to people about—there's various researchers out there that are working on virtual reality. The virtual reality offers not a robot but offers artificial environments, environments different than the one you might be in. If we put on a VR headset right now we could be in any environment imagined, although we're here.

JOHNSON: Like a holodeck [fictional virtual reality facility].

HOLLAND: Like a holodeck, but cheap. We're pushing to experiment that way, but not with robotics. I just think robotics will come on probably a little bit slower than VR does, but eventually they'll have to do that.

WRIGHT: Yes, because I can see astronauts viewing robots as competitors in the future.

HOLLAND: Unless you are the one who is helping program that robot; unless that's your robot and you have a choice.

WRIGHT: Before we finish today, there are a couple of other questions I wanted to ask. It's a long time for you to have to think back, but are there some times during your adventures with the

ISS Program that you feel have been rewarding and that you believe your group has significantly contributed to the success of the program?

HOLLAND: I do believe it has been a big contributor, but whenever I say something like that I always wonder if I'm just saying something I'd like to be true. It seems to have been that way if we look at the feedback we get from the crews and the families, that the *systems approach* we take has been very effective. And, we are constantly trying to improve what we're doing. When we come up with a new thing, it's really the best thing since sliced bread. There's always that little thing, and then it's well, what's the next step going to be? I really like just the relentless pursuit of improvement. I think that that's been noticed or registered within the ISS.

The crewmembers say across the board they like BHP, or they say they like BHP better than any of the other elements. They think that we've done a better job. I don't know if that's true or not, but if we did, I'd certainly put BHP up against training, any of the other elements, in terms of providing services that are perceived as good and important by the crew and their families.

I think it's been just a general contribution. I don't think there's been a particular event. I do know that we get pulled in if there is an event or if there's an event within a family we'll get pulled in, and we've done very well. I really don't want to refer to the particular events, but there have been some events that have occurred nationally that have involved some of our crewmembers. We've spent just days and days and days on these things that are completely behind the scenes. When you ask me the question, I feel tired.

WRIGHT: Yes, you should.

HOLLAND: There is a lot that happens that is below the visibility of the public and of course the people on site, because we screen off what we do, a lot of what we do even from flight surgeons, which are in our own camp. Things are very very ratcheted down.

I can tell you that a lot of our group have spent just days and days working a problem for a family or working a problem for an astronaut, and successfully I think. Not always fully successful, but certainly showing that given all the constraints in what we can do, they are there, we are here, all the other constraints that exist, that we're batting for them. I think that's a big part of it.

WRIGHT: Sometimes the success of a crisis is just making it through, and you are there for them.

HOLLAND: Right. Or lots of times it makes it go away. We've got something coming up. Okay, it's back down. Okay, we're back on track. Then it doesn't perturb the system. It doesn't perturb the next flight. It doesn't perturb the current flight. Work keeps getting done. The mission progresses. There's a lot of prevention. That's what we're all about. We're all about prevention, and detection, so that if you detect something early on you solve it before it becomes a big problem. That's 99 percent of what we do.

If we fall into the reactive mode like some organizations have, then it's already too late. You're going to have problems, and your mission management has problems. Things go wrong, things break, people get hurt, people get killed. We've seen all that in simulations and we've seen fistfights in Russian simulations and all kinds of things. We learned from them that prevention is worth a pound of cure, to coin a phrase.

WRIGHT: What do you think is going to be the legacy of the ISS?

HOLLAND: I think the international character is a big part of it. I do believe it shows that nations can get together and can build something that is relatively untouched by geopolitical events and does keep producing something and is something you can look to and say, "Well, we did do that together and it is successful and it is a remarkable achievement." I think there's that. I think that'll be a big part of the legacy.

I also believe that it will be a stepping stone for a habitat on the Moon and of course a Mars flight. I'd always hoped that instead of a Space Station we would use the Moon as our Space Station, but that probably just shows my age. I always had hoped that that would be the Space Station. I do think we will have a lunar station one day and that this low-Earth orbit Station will have been good practice.

I'm just concerned about gaps, like the gap between the end of the Apollo Program and whenever we go back to the Moon. There's this gap. During the gaps your corporate knowledge goes away. It ages, retires, goes away. Then the new generation has to relearn those lessons that you've already learned, and I can see that.

Last weekend I had to clean out my garage. In cleaning out my garage, I located these boxes of things from back in the Mir days. Old documents and Russian documents and studies from back when I was looking at analogs and looking at some of the old, very very early behavioral simulations that were done by McDonnell Douglas and some of the others. Reading some of the studies, they had already approached the questions that we then had to reapproach when I came on, or that BHP research is approaching. They had already started that process.

Then there was a gap and there was nothing, because short flights didn't drive behavioral questions. It always went to the money, "We don't have the money for that, it's not that important, it's a short flight." There was a gap. That's what I'm concerned about, between ISS and Mars there'll be a gap that will be populated perhaps by short term missions to the Moon or to an asteroid and back. We'll get back into a population of astronauts and a population of researchers and operational people who'll be very familiar with short-term flight outside of low-Earth orbit, up to two, three, four weeks, even maybe a four-month mission on the Moon, or even a six-month mission on the Moon. But, we will not have progressed and kept the lessons learned from the one-year missions on ISS or some of the longer missions on ISS. I worry about that knowledge gap before going to Mars. That's my only concern, that there won't be a continuous learning process. We'll have to relearn this stuff.

WRIGHT: Hopefully all the lessons will get picked up, but so many times so many don't.

HOLLAND: That's right. So many lessons are in the heads of people on site [JSC]. If you don't capture them, like you guys try to do, or the lessons learned other people try to do, if they're not not only captured but documented in a way that other people then want to access them, know about them, and do access them in the future, then you have to relearn those lessons. That's a big waste of time.

WRIGHT: It is. I know that you brought some notes; are there other topics you wanted to talk about?

HOLLAND: Just one here, that a Space Station is not a Space Station, is not a Space Station. So [Russian] Salyut was different than Skylab, which was different than Mir, which was different than ISS. Typically we, the big we, think of "space station" as they are all the same. They're very much not—very much different environments that make different demands on individuals that then drive different requirements for selection, training, support, and the type of people there.

I think this was partly learned by the contrast between ISS and Mir. That's where I learned it. I went in expecting more difficulties, but then we have this volume, and getting rid of a lot of the environmental issues that we had on Mir solved a lot of the problems, and it reminded me of the power of the environment. So much of behavior is driven by the environment. Once we get through the selection and training process then it's all about environment. That was just a big thing.

One particular thing that jumped out is that the Space Station is a heavily ground-commanded platform versus the Space Shuttle. Space Shuttle was not designed to be as heavily ground-commanded as ISS. But, ISS, they thought, "Well, we're going to make this heavily ground-commanded, so the crew doesn't have to worry about flipping these various switches, and not doing as much maintenance." In fact they do do a lot of maintenance on ISS, but the fact that it's heavily ground-commanded takes away their autonomy sometimes in some respects. These type-A people who are used to and like being in autonomous situations and making decisions can't make those decisions, because it's heavily ground-commanded. It's a ground station, and they're just one part of the system that's operating up there.

Different than Shuttle—Shuttle, there was much more autonomy. That's another aspect that changed between Shuttle and ISS, was the fact that the ground command was so much

higher that the satisfaction of the crew—many of the crewmembers, not all—was less because of that. It was less attractive, and creates sometimes tension between the fliers on orbit and ground control because of that lack of ability to make their own decisions, control their own schedule.

When we look at Mars, we're going to go back to, by necessity, a less ground-commanded vehicle. There'll be more autonomy there, so that's going to place new requirements on Mission Control—the "control" may be softened in that title for Mars. That's just one thing I wanted to point out, that Space Station, the one we have up there, ISS, is unique in the fact that it's heavily ground-commanded and different than Skylab. That makes the difference for the people that are on it.

WRIGHT: It does. Are you going to share with us before you leave the one thing that all crewmembers hate to do when they're on Station? Is there something that's universal? Do they hate taking out the garbage?

HOLLAND: Oh yes—I think they all hate working on the toilet, but that's universal.

WRIGHT: That's right. Thanks, Al, we appreciate it.

[End of interview]