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ORAL HISTORY TRANSCRIPT

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INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is July 14th, 2009. This interview with Terry Clancy and Gail Hansen is being conducted for the JSC Oral History Project in Houston, Texas. Jennifer Ross-Nazzal is the interviewer, assisted by Rebecca Wright. Mr. Clancy was the flight activities officer [FAO] for STS-124, and Ms. Hansen was the lead timeliner for the flight. They are here today to talk with us about mission planning and STS-124. Thanks again for joining us.

CLANCY: It's our pleasure.

ROSS-NAZZAL: We certainly appreciate it.

HANSEN: Thank you.

ROSS-NAZZAL: I'd like to begin with you, Terry. Can you tell us what the role of a flight activities officer is?

CLANCY: For each mission we're assigned, usually well in advance, usually about 14 months away from actual liftoff. Part of the reason behind that is we're one of the integrators for the flight. We work very closely with the flight directors, the crew, engineering, and the other

disciplines to bring together all the mission objectives into a cohesive plan. So we really start about 14 months out working with the program, making sure that we can meet their objectives.

We start laying out some rough draft timelines on a high level, just pigeonhole where we think things are going to go. There usually is some work done before at a higher level that just basically says we think we can do, say, three EVAs [Extravehicular Activities], and we can transfer this amount of stuff, and this is where we think the equipment transfer is going to occur. We really get down into the depth and see how it all fits together, because typically there's a lot of constraints, both crew timewise, spatially, like before you put module X on the port, you have to clear it or inspect it. We just work closely with the different organizations to make that plan all fit together like a puzzle.

ROSS-NAZZAL: What was your role as the lead timeliner, Gail?

HANSEN: My job as lead timeliner is to work internally with all the different flight control disciplines. Whereas FAO worked externally with a lot of the major players, I worked with all the detail-level work, in terms of getting the activities right on the flight plan pages. I was responsible for developing those flight plan pages, which the crew executes off up in space. I developed summary level flight plan pages, which have bands for each crew member and the name of the activities at certain times throughout the day so they know what they need to complete. Then also I am in charge of developing the detailed pages, which have the actual step callouts and procedure names that the crews work throughout the mission. I work with the other flight control disciplines to take those inputs. I also take direction from the lead FAO as to make

assessments to see if things fit based upon the time that I have in the day, based upon conflicts with other activities and those things.

ROSS-NAZZAL: Wow! That sounds like a lot of work with seven crew members.

CLANCY: She actually downplayed that last part, which is really one of the things that really made STS-124 stand out from other flights that I worked before. We went through multiple assessments with this flight. Gail was probably the one consistent factor that we had through the mission. I was recalled to military duty for about seven months, so we had one of our senior FAOs kind of mentor her. But really, the work fell on Gail's shoulders. We did a lot of assessments before I left, and they added an extra day while I was gone. I think they added an EVA while I was gone.

This was all around the timeframe when they were really starting to look at what are the inspection capabilities with STS-124. Because, I'm sure you're aware, the module is quite large. It took up the majority of the bay. I'm sure Mark [E. Kelly] probably discussed this as well. We didn't have our inspection capabilities that we normally have with the boom [Orbiter Boom Sensor System]. We didn't launch with the boom. So we went through multiple assessments just looking at some of the different ways that we could still accomplish our return to flight and inspection criteria without the equipment. Those ranged from going from an eight-day mission with a little mini boom to going to a 13-day mission with the boom that was left behind from the previous [flight].

So it was multiple iterations, and just making sure that we could get all the major objectives completed in a short timeframe or an extended timeframe with multiple things. It's

that whole puzzle piece of you have to do this, before this, before this, before this. Gail worked on one assessment where we actually laid out the entire day to accomplish the mission, just to see if it could be done. From that, we had a functional flow that she developed on a summary level, just as a check on our understanding to make sure we had all the necessary pieces in place before the authority to proceed to the next was granted.

ROSS-NAZZAL: Can you tell us about how you developed this plan? You got this mission, you said, about 14 months out. So originally it was supposed to launch—was it in March or February?

HANSEN: April was the first launch date.

ROSS-NAZZAL: April, okay. I keep reading different dates in the Current News.

HANSEN: It may have been before April. It was April for a long time.

CLANCY: Yes, it was before April, because it went through a couple slips. As you're probably aware, the nature of the Shuttle is very serial. With only three operating vehicles, as one is being processed and being used, it delays. If it experiences a delay, it trickles down. Programmatic delays can hurt us. As we talked about, the boom was an issue, and that caused some delays. Module issues can cause delays. On any given month, we were changing launch day. When we first got the flight it was a short flight. Primary objectives: launch, rendezvous, perform an EVA to install the module, and that was pretty much it. After that's done, you're done.

This is before [the Space Shuttle] *Columbia* [STS-107 accident]. This flight had been baselined for years, so it's a little bit different. We actually went through a couple different FAOs. This wasn't your typical flight where they said, "Okay, well, we have STS-130 coming up, that's launching in 14 months, you're the FAO, go forth and plan." This flight was baselined many years before it flew. We went through a couple different FAOs, so it went through a couple iterations. You really don't get down to the nuts and bolts of the assessments on how you're actually going to plan till you actually get closer. As that launch day moved out, the nuts and bolts of the plan was just a short flight.

After *Columbia*, all things changed, and we had to take into account the different inspections that we did. We had to come up with a completely different flight day two inspection using just our Shuttle arm, which was different, and they had different procedures and different equipment that they looked at for that. We had to make sure we still had time to do that and still prepare the crew for rendezvous and a bunch of EVAs.

We had to figure out some way to incorporate the new inspection techniques, a way to check out the boom that had been left on orbit, and just make sure we just had time to do all this with three veterans and four rookies. That was also a challenge. I'm sure Mark talked about the different crew assignments, and how his major role, as he interfaced with us, was helping us decide who is the best trained person for this job and to identify candidates who would receive further training to round out our planning picture so that we can still utilize most effectively the crew resource on orbit.

HANSEN: Yes, and I would agree. Even throughout the planning phase as we got closer and closer to the actual launch day, that's when we would assess the plan quite literally daily and

publish new pages on our website, literally daily. How those priorities are determined is they're set by the program level, and then they're fed down through us, and then we determine okay, "We've got to do this activity; we have to have this EVA. Where can we put it?" Then we get with the EVA flight controllers, and everyone else who also is impacted by this EVA, and we say, "Okay, what do you need?" We find out all their activities. We get a list of all their activities, the time that each one takes, how many crew it's going to need to be performed by, and then we try to put it on the day. At one point, we had too many objectives. While it fit in the timeline, it wasn't going to be the most effective plan for the crew. It was going to overwork the crew. Crew was going to be exhausted.

At one point, we ended up presenting a plan to the program to add another day. That happened when we were in the midst of planning. So that even lengthened the mission during the planning phase. Sometimes we get these priorities up front, and then we work and we work and we work, and we find out more things need to be added to the plan. At some point, we have to cry uncle and say we need another day. Then we went back to the program, pushed for another day, got it. Then we added a day at that point.

But then, even right after we published our final flight plan, we added another day after that because we found out we had more objectives from the program to complete. We say, "This is possible, but only if you do this." We are in charge of managing the crew's time. Even though it fits on the day, it's not always the best for the crew. We have guidelines that we follow to make sure that they get enough sleep at night, that they get meals, that they get exercise. We're the people in charge of making sure that they stick to them and that the flight program sticks to them so that they don't get overworked. We watch and make sure the mission is successful from a crew standpoint in that respect, that we don't set them up for failure.

CLANCY: It's an iterative process between us, the crew, and the program. The program, they're managing their budget, and they have a finite amount of time on orbit because of Shuttle consumables. They'll ask us to do several things. Sometimes we have to say, "No, we can't do that with our current baseline duration or our current crew complement," because crew complement can also change how much you can get performed. If you don't have the right people trained, then you can't do some things together. So that plays a factor.

When we did the assessment, Gail said, "Okay, this is the current baseline, this is what we can accomplish. If you want it, you have to do this." That's when we showed that if you added an extra day, we can do those objectives. But even then, you run out of time. You can overwork the crew. We ask these people to go up there and work 16-hour days, multiple times. If you can imagine working 8:00 a.m. to 10:00 p.m. every day for 14 days, you might be a little fatigued. What we run the risk of is causing a well-trained expert crew to make a small mistake because they're fatigued. It's a known physiological factor. That's what our rules are set up to guard them against. We give the crew a safety that we can't do that because we just aren't allowed because you don't have the time for it. That's what Gail was talking about with our different rules that we have.

Our Shuttle Crew Scheduling Constraints document is basically our bible in the FAO world, and that's what we refer to. We're using that as our baseline for the Constellation work that we're doing now. We've learned a lot of things from that, and we're translating them over to the next program as well.

ROSS-NAZZAL: So you see that the crew gets what? Eight hours of sleep? If they work 16 hours?

CLANCY: For Shuttle, it's eight hours of sleep. We also give them some time before and after sleep for personal hygiene, eat some meals, very little personal time. A lot of it is dedicated to preparing the Orbiter for sleep or backing it out of a sleep config [configuration], because you'll do some things at night that you don't need to power down to save cryogenic consumables. So you have to back out of that when you wake up in the morning. Getting ready for the day, gathering your tools, looking at your plan, seeing what the great flight controllers on the ground have changed while you were sleeping. Giving you new procedures, so you have to read new procedures, update old ones. Then you usually get ready to go to work two, three hours after wakeup. We usually give them two to three hours before sleep.

We're really only supposed to work them about eight hours, but they end up working longer, because a lot of times they'll work through a meal. We give them an hour, but they'll only take 15, 30 minutes. We give an hour for exercise. Sometimes they skip that, depending on their workload. I think that's about the only safety valves we have. Other than that, if you can imagine someone looking at your calendar and timelining every minute of your day, it's pretty hectic.

HANSEN: Down to five-minute increments.

CLANCY: Down to five-minute increments. Good point. Some stuff, we give them the leeway of scheduling where it fits in their day. They're usually small tasks, like go there and check the

filter on the screen. When you get a chance, clean that. Clean the toilet area. So we give them a little bit of leeway. We try not to micromanage them too much, even though like Gail says, five minutes is pretty much micromanaging. One of the reasons why we have to do it is because we have to have stuff done at a certain time. Every 24 hours, you have to do this. Forty-eight hours into the flight, you have to do it now. That's why we get so detailed in our timelining, especially for our middeck payloads. They're really time constrained.

ROSS-NAZZAL: Tell me about—you're assigned to this mission, and then they told you, "Okay, we're going to launch this module, and we're going to launch the arm." How do you move from there to come up with this plan that you present to the program and then working with flight control? Do you start with a whiteboard? How does this all work?

HANSEN: We work with the other flight controller disciplines, who have a handle on what these activities are going to take.

CLANCY: Gail talked about a couple different products that we have. We have an overview timeline, which we use. We get Excel. Excel is real fancy. You move cells around. You can group cells together. You can move time blocks. Since we work in five-minute increments, we can set it up for five-minute increments, and we can physically move around. So it's a digital whiteboard. It's like a whiteboard. On a high level, we can figure out where things go on a day-by-day basis. Block out the sleeps.

One thing that really factors into how we plan—she has our props already. One thing that we have to factor in when we plan a Shuttle mission, unlike a Station mission, is we're going

up and we must come down. It's not an option. That is very time-constrained. Orbital dynamics, it's not just a good idea, it's a law. What goes up must come down. When we plan for coming home to Kennedy [Space Center, Florida], that time is more or less set in stone, plus or minus an hour and a half. We look at our rules from our constraints document again. We have to give the crew X amount of time before de-orbit. We have to give them an eight-hour sleep period, because we want them fully rested for that time-critical task event.

We'll start just laying it out in Excel, and we start with the sleep periods, because that really drives when stuff gets accomplished. We have our rendezvous burns in the beginning of the flight that we care about, but more importantly, at the end we have the landing time. We set everything up based on landing. [Shows plan.] You can see the sleep period moves. So you can imagine waking up half an hour earlier each day, or staying up an extra hour each night. That can also affect how you perform. We have rules that strictly govern that timelining. We start with the overview plan. Lays everything out, lays where the sleeps are, lays where the rendezvous burns are.

Then we go to the summary timeline. By now, Gail is fully engaged with the other system controllers. They have an idea where they want stuff completed. We have a couple other documents. We work with the Flight Requirements documents, which has high-level objectives from the Shuttle Program. We also work with the Increment Definition Requirements documents from the ISS [International Space Station] that also outlines their objectives. With the Mission Integration Plan, it starts to have even more details. "We need this amount of transfer. We want to clear the port before we transfer the JEM [Japanese Experiment Module]."

Once that's complete, we need to grab the boom via EVA and start setting up for our scans. Working with the system controllers, they'll have some of the details of, "Well, before we

can do that, we need to unpower the umbilical that powers the JEM, otherwise when the guys demate it EVA, it can cause a short or an arc." So they'll give us the specific switch throws or the specific actions. The timeliner starts working those into the plan to make sure that the objectives or the activities don't conflict with one another. If you wait too late with the switch, then you're going to cause that short. If you move the switch too early, then you may power down the heaters on the JEM for too long causing a thermal imbalance. So it's definitely a ballet.

We have a consolidated planning system that we use to build the summaries and details. We do most of our work on the summary level, unlike the overview, where it's just all crew, just Shuttle and Station high-level activities. With the summaries, we start breaking out to individual crew members on a 12-hour page. That's when we start moving the activities around per person. It's all in one database. When we move something on a summary level, it's moved in a detail page, which has the book and tab and any kind of item entries, any kind of detail tags or execution notes that we might want the crew to follow at that time, doing that activity.

HANSEN: You also notice on our pages there's Space Station crew members. We work with our counterparts in the Station side of the house to get their activities on these pages as well, so that our crew can reference what their crew is doing. Sometimes we involve their crew in some of our objectives because we need their help with things. Every increment has a different complement of US and Russian and sometimes other international partners [IPs].

CLANCY: JAXA [Japanese Aerospace Exploration Agency].

HANSEN: JAXA for this case. Different crew members from different countries. So depending on how familiar they are with our systems and how well they've been trained, we can pull them in performing some of our objectives. So you'll see their names are also on this page. We have complements on the Space Station side of the house, an ops planner and a RPE, standing for real-time planning engineer, who's my counterpart, who I work with to get their activities laid out on the page as well. Then also buttoned up with our pages, there's pages for ground commanding, because the Space Station flight controllers send a lot of commands to the Space Station during a mission. That's how the Space Station is set up. Where the Shuttle is more crew-controlled, the ground controls the Space Station side. You'll see that in with our pages as well.

CLANCY: When we talk about integration, we're not just talking integration between the Shuttle and Station Programs, we're talking about integration between our Shuttle flight controllers, our Station flight controllers. JAXA, we integrate with SSIPC [Space Station Integration and Promotion Center, Tskuba, Japan], their control center. We integrate with Moscow at the TsUP [Russian Mission Control Center], because we still have Russian commanding and activity that we need to coordinate around. If they want to run an experiment, and that conflicts with what we have planned, then we have to work around that. A lot of times we rely upon their motion control system to actually effect some attitude maneuvers that normally the Shuttle would take control over. But in certain situations we can't do that, so we have to coordinate through our attitude and pointing specialists with the attitude determination checkout officer in Station and to get that all coordinated with Moscow.

With SSIPC in Japan, obviously when we're installing their module they're very concerned about this, and they're in there monitoring very closely. They also have to send

commands. They have this whole command set that they're ready to execute. Once we've plugged it into the Station, they had to perform a certain amount of checkout activation before we can then send our crew to do some further installation and checkout. Our crew did a lot of reconfiguring once we got on orbit to prepare it for long term duration. That was all integrated with SSIPC through the plan.

HANSEN: It's a carefully refined plan. Combed through over and over and over again, 18 months all the way up to and through launch by the flight controllers to make sure that the sequences are correct and things don't conflict. We work with them to make sure that all bugs are out of the plan and everything looks good.

CLANCY: Do you have the contingency plan as well?

HANSEN: I do, from our final flight plan.

CLANCY: We were very concerned about this flight for many reasons, a) it's the Japanese first large module. They had the JLP, the Logistics Pressurized Module up there before, but it was just really a closet. This module is really their bread and butter. It has a plethora of experiments. It's got an airlock. It had an arm attached to the back of it. It had a port that the next Shuttle mission [STS-127], that hopefully launches today, is going to take up the exposed facility. This is the cornerstone of their module. If we did not get it activated in X amount of time, certain parts of it would start to freeze and fail. Now this is a source of pride for the Japanese with this

module. It had been sitting on the ground for many years just waiting for its chance to get up on board. They didn't want anything to happen to it, understandably.

So what we did is we also had some failure modes. That if our primary loop didn't come up for whatever reason—you get on orbit, gremlins get into the works and you get a bent pin, or some connector doesn't work, or you might have a little small short that could take out your data path—we need to have a contingency plan. Working with the flight director, SSIPC, the assembly and checkout officers, the ACOs—I'm sure you might have heard about them, they work closely with the module experts to identify what other alternate paths are available that we could perform if the primary didn't work. Gail sat down with them and developed a plan that actually outlined, "Okay, well, if you're marching through the day and the first channel doesn't get activated, what are you going to do?" It outlined basically a breakout point for the crew to execute and also for the ground to execute, if the primary didn't [work]. So we could still save the module.

Eventually through the mission we were going to activate this channel anyway, but this was our backup plan in case the primary didn't work. We could drop down, forget about the primary, for whatever reason it's not working, we have a thermal clock that we're trying to beat, so let's march down this alternate path, execute it early. It's not just a series of things. We can't just complete things in series. It's different. You couldn't just do what you were going to later, early. We had a completely different set of things that we were going to perform.

HANSEN: The crew actually trained using this plan so that they would be available to execute it should they need it. It's a time-saving event. This was a significant enough failure that we wanted to plan for it [in] advance, so that we weren't scratching our heads wasting [time].

CLANCY: Simulate it.

HANSEN: Yes, and simulate it, so we weren't scratching our heads wasting time on orbit trying to figure out how we were going to tell the crew to continue.

CLANCY: You could almost liken it to some of the generic failures that the Shuttle crew members and the Station crew members practice on a regular basis to maintain proficiency in it. Like Gail says, you gain efficiency by practicing something more than once. The controllers also learn. When we actually start to simulate and perform these plans, we find efficiencies that we didn't see before. Just based on the crew complement, we'll see how they operate. Working with the crew, we will replan the mission before we fly to gain some of those efficiencies that we learned in training. Gail sat in on many of the simulations. Mark was gracious enough to allow her into the Shuttle trainers and into the Station trainers while they were doing some of their simulations so she could observe them and pick up on some of those efficiencies that normally you don't have access to.

ROSS-NAZZAL: So you're constantly rewriting the plan.

HANSEN: Oh, definitely. Definitely, it's being reworked from day one.

CLANCY: I think she almost banked all of her vacation.

HANSEN: It was worth it. It was well worth it. When we got to the flight, things were, as our manager said, excruciatingly nominal.

CLANCY: Yes. When the flight planners get some of the accolades, it's because nothing else broke. Oh, we had such a good robust plan in place that some of the small hiccups that we—because we did have a few hiccups along the way, but the crew was just phenomenal in their execution of the plan. If they got behind, they caught up a little bit.

HANSEN: The vehicle was healthy.

CLANCY: Vehicle health is a big player in it, because if they're distracted with the Shuttle health and off and running in-flight maintenance on the Shuttle, or the Station, it can drastically change your plan. So we were fortunate.

HANSEN: Yes, we were very, very lucky on that.

CLANCY: Everybody was very aware of the time constraints that this module had and this mission had. So they were all as vigilant, as usual, in their systems to make sure that they maintained optimum health on them.

ROSS-NAZZAL: I understand that there were some problems before you lifted off. Like there were some problems with the External Tank. Did that cause any problems with your flight plan?

CLANCY: Anytime we change the liftoff day, it changes our trajectory. As I mentioned before, king for us is the de-orbit time and the rendezvous sequence. Any time we have a launch slip—like right now our planners for STS-127, that's taking up the exposed facility, they're pulling their hair out because they're changing on a daily basis. That basically means you need to reassess all the sleep cycles, and you reassess all the burns, you reassess any time-critical [sequences]. They have a couple deployables on their mission, so they had to reassess that.

We were no different. Every time our launch day moved, either on a daily basis or programmatically, for whatever reason, we had to go off and reassess and see the impacts of that. I think we did actually change our sleep cycle fairly late in the flow. We had an issue with some of our rendezvous burns, and we talked with Mark. We got a little bit of variance in how we normally schedule things because it was an off-nominal situation. So it's something that we track all the way up until we land. We honestly [don't] stop changing the plan until the moment we land.

ROSS-NAZZAL: Did you have to do much changeout of the plan on orbit? Or it was just so nominal that things pretty much stayed [the same]?

HANSEN: I didn't start, I think, until flight day—later than normal in the flight. Early in the flight still, but most flight plans are updated on flight day two and throughout. I don't think we started until flight day four or later.

CLANCY: Yes, we actually stopped sending them summary pages. Normally, at the end of the crew workday, we'll give them a heads up of what the next day's plan looks like. We were still

so much on the next day's plan from preflight that we stopped doing those. "Look, guys, it's pretty much nominal. You'll get an update in the morning with some of the detailed changes." Most of the time our changes come in with step number changes, or if someone has a new procedure they want to uplink, so they want to reference that instead. Those are usually the major changes that we have. We didn't really move a whole lot of things around activitywise or add new activities. We had a couple IFMs [In-Flight Maintenance activities] that popped in. We had to squeeze those in. Our payload customer changed a few desires, and so we had to move a couple things around based on that too. But for the most part, it was a pretty solid plan.

HANSEN: The only thing summarywise that was in the plan prior to launch and that was not during the flight was focused inspection. We have to have a four-hour placeholder for focused inspection in case we need it. We don't know until we launch and do our surveys if we need it or not. In this case, we didn't need it. So that pulls out that four-hour block that we had scheduled for focused inspection. That allowed us to move everything up. That was the most major shift of the flight, but that was a good thing.

CLANCY: As I mentioned, this was a different bird altogether, no pun intended, but with our operations where we retrieved the boom once we got on orbit and we did our first boom scan shortly after EVA 1, we were marching on time. We have flight rules in place that say, "You will not undock from Station and de-orbit until we have cleared the Thermal Protection System." Even part of that clearing comes from after that first initial scan by the boom. Again, like I said, flight day two we did it with the Shuttle arm, and that was just using the cameras. We had the

RPM [Rendezvous Pitch] Maneuver at rendezvous where the Station guys take some 400- and 800-millimeter pictures. That data is insufficient to clear the vehicle.

So until we did the EVA to retrieve the boom and do that scan, a typical process that occurs on flight day two, we did it much later, and so we still had the same clock for them to go and clear the vehicle. If they find any points of interest, then we have to go off and do the focused inspection. FAOs and timeliners are pessimists by training, and so we plan the mission with the worst case in mind and we hope for the best. In this case we got lucky.

That still causes gross replanning, because even though we had this pigeonholed to go in this spot, when it didn't occur we had to bring a lot of stuff forward. Gail did a lot of forward work working with the system controllers and the different disciplines in the program, and also with SSIPC and Moscow to fill that hole with something that was useful. So we tried to use our time as effectively as possible.

Now you'll hear that term thrown around in our group a lot. You have to be effective. You have to be efficient. You can't overwork the crew. You have to meet objectives. You have to give options. You have to give the flight director the data so he can make the decision on what we end up doing.

ROSS-NAZZAL: What'd you end up filling that time with?

HANSEN: I think we ended up pulling things forward. This flight was very serial. Everything was bam bam bam bam. You can't do this before this before this before this. A lot of times it works out well to pull things up. Sometimes you'll still have some gaps that you can fill in,

especially when we added that extra day on the end. We had BDS [Backup Drive System] work on the JEM.

CLANCY: Yes, we did some work on the JEM. JAXA, they had a bunch of secondary objectives that they were going to accomplish during the stage after we left. It was highly desired for them to get that done while we had the Japanese expert on board. So we worked that into the plan. We use electronic systems to get data, and we have electronic file transfer that we use, the flight notes system. SSIPC was consistently updating their requirements. We had worked with them, a lot of prework based on lessons learned from the previous Japanese missions, [STS]-123/1JA. Was that 1JA?

HANSEN: It was 1JA.

CLANCY: So we had a lot of lessons learned from them on how to integrate and coordinate with JAXA planners. We had an OIP [Operations Interface Procedures], and I want to say it was OIP 8.2.3.

HANSEN: I can't quote that.

CLANCY: It was just a very detailed way on how we were going to receive their inputs and give them feedback. They were right on board. They were phenomenal people to work with. Very meticulous, very detailed in their instructions to us on what they wanted done. We in turn worked with the Station planners and the different ISS controllers, because once the big payload

gets up there, the Shuttle guys really are hands off during the joint mission. We interface our Shuttle crew with the Station controllers to build this plan. So we have these new constraints from JAXA, and we filled in some of those holes.

HANSEN: We talk to them, we coordinate with them over the loops during the mission so that they're on board with all the changes we're making and the extra time we have and so that they know what they maybe can fill it with. We coordinate all that real-time. Then there was a lot of preflight development with them, getting to know them in person and just being able to communicate with them. You need to get to know someone, especially someone from another culture. I got a chance to go to Japan a year before we launched for a two-week JOP [Joint Operations Panel] there, and then they came and visited us a couple times. Terry and I got to know them better when they came here and just got to develop a working relationship with them. It was good. When we work with them real-time on console, we knew what to expect from one another. We knew what our priorities were as a team. It proved very successful.

CLANCY: There's a lot to be said for face-to-face communication. I know nowadays we're trying to save money with going green and NetMeeting and GoToMeeting, whatever. We use WebEx a lot with the new Constellation Program because we have the primary contractor in Denver [Colorado] and most of us are here. When you interface with Marshall [Space Flight Center, Huntsville, Alabama] or Kennedy, Goddard [Space Flight Center, Greenbelt, Maryland], we spend a lot of time doing telecon and WebEx type of stuff. But there's something about the human-to-human contact to forge that relationship that I think is invaluable. I'm glad that our company in particular is very good about sponsoring travel and approving travel. Like when

Gail went to Japan, you get that little extra feeling for the environment and how they operate. JAXA, this was the first time they really had their control center up and running. They had their flight directors, they had their capsule communicators, they had all their systems experts. And just seeing them learn from scratch was a pretty unique experience.

ROSS-NAZZAL: What information did you share with them, being I guess more experienced in terms of flight planning? What did you share with them that they picked up from you?

HANSEN: They're basically using NASA's space program as a benchmark for their own. So we shared with them our entire flight planning development process, mostly from a Station standpoint. Our ops planners worked very closely with them to explain to them their process, because once JAXA goes online completely, they will be planning in a Space Station incremental sense. The Shuttle flights with them are only just to bring their hardware on board. After that, they will be planning in an incremental sense. So they worked more with their ops planners to learn about the developmental process. I remember when I was in Japan, our ops planner Tracy [A.] Scott was working with them to explain the different milestones that they have on their side of the house.

CLANCY: Planning milestones on a daily basis. So each hour, like execution minus 34, we want X amount of plan laid out in the plan and blessed. As we get closer, at crew wakeup minus 12, you want to have this done, incorporated, verified, and checked out. That's part of those OIPs that we had in place.

ROSS-NAZZAL: Did you have any challenges working with the Japanese, being a different culture?

HANSEN: Because they're more methodical, and they're learning, as any new IP coming online—NASA has been doing this for years. We already had our plan in place. So we're teaching them, and we're also expecting them to be right in lockstep with us, which is hard. It's hard for anybody who's trying to learn something and also do something at the same time. I think that was difficult. Not their fault. They're just trying to learn. They're trying to develop their program. They're trying to bring new hardware online, at the same time they're trying to learn the best way to do it, which was I think a challenge for them. They came out just glowing. They performed very well. I think they've come a long way for the development of their program. After that flight, they were very, I think, proud of themselves. We were very proud of them and our ability to work with them and their ability to work with us. We developed quite a relationship with them. I think we were very happy for one another.

CLANCY: Plus getting to work with Gail, she's a very meticulous person as well. I'm sure that probably helped ease some of their pain. We did have a little bit of difference between—Gail has brought it up a couple times—the difference between ISS planning and Shuttle planning. We work with more of a sense of urgency because we have a short time on orbit. As opposed to them; they're always up there. So when something doesn't go quite their way, they can push it out to the next day or maybe even the next week. We typically don't have that option.

HANSEN: They can think about it longer.

CLANCY: They can think about it longer. They can run a problem to ground, think more thoroughly. Just I think because they have that option. In the Shuttle world, we don't really have that option. That's why we spend so much time being pessimists and thinking about the worst case scenario and when this happens what's next, what can we bring forward; focused inspection, optimistically we're not going to do that, so what are you going to bring forward and cover that hole, because they're not just going to sit there. We do give the crew some time off to rest and relax, especially before a critical operation. But we just can't just give them a couple days off here and there because things just turned out well.

HANSEN: Right. We have limited consumables on orbit. We have to be ready for things to fail, and we have to have a plan ready to execute very close after that happens. Terry always says "Good is the enemy, a good plan is"—say it.

CLANCY: Better is the enemy of good.

HANSEN: Better is the enemy of good, because if we have a perfect plan but we have it three days from now, that's not going to help us.

CLANCY: It might be two and a half days too late.

HANSEN: Yes. So we'd rather have something that we know is feasible, we know it doesn't adversely affect any of the crew members or the plan in general. We'd rather just go with that.

A lot of times we are very well prepared for that next worst failure. We don't waste time that way.

ROSS-NAZZAL: It's amazing what you guys do.

CLANCY: It's a lot of fun.

HANSEN: Oh, it's a lot of fun.

ROSS-NAZZAL: I think I'd be pulling my hair out.

CLANCY: Well, you see what happens. I used to have a real thick head of hair.

ROSS-NAZZAL: Were there any lessons learned that you picked up from this flight? Or just because it was so almost vanilla—.

HANSEN: Oh, no, you always learn something. You always learn, I think, a lot on these missions. Terry, I think he's had four leads, five leads?

CLANCY: This is my fourth lead.

HANSEN: I'm sure he can tell you more about how he's gone through that process and what he's learned. For me, it was my first, and I learned an incredible amount just by being able to take the

role of being a partner with Terry as opposed to just being his second in command sometimes. Because he was away, I had to step up so I learned an incredible amount. I think it's advanced my position within the group. It's allowed me to [grow].

CLANCY: I like to think that's the mentor, but, you know.

HANSEN: Yes, because of all his mentoring of me, it's enabled me to go further quicker than maybe somebody who was just the timeliner for a flight. I've learned a lot from it. I've learned so much. It's not just one thing. It's a lot of little things, and a lot of big things as well, but it's all added up for me.

CLANCY: This was a unique flight. I know we mentioned it was a very serial flight, and I think that added to its robustness because we worked real hard to make sure that the ducks that we had in a row really were in a row, and that we understood the serial nature, and while accepting it we tried to make sure we had some backups to it. We worked on this flight more on the contingencies than I had before, just because of the criticality of the time constraints that we had and the thermal constraints.

Some of the things that were the same, like I said, any time you change a launch day it changes your trajectory. We had minor hiccups here and there with the sim [simulation] guys working, training on one plan but having trajectory for a different plan and trying to mesh those two, because we always want the crew to train on the latest and greatest plan. Sometimes our data didn't support that. Generally it was all based on simulator loads and how the data was stored. That didn't change.

Any time you bring a new international partner online, that increases the complexity of your planning process. Sometimes people resist a plan simply because they had no agency in building it. So you deal with some of that too. Anytime you bring another partner on board or you have another partner within a partner, because you had some Russian-Japanese interaction as well. By now *Columbus* [the European Space Agency laboratory] was on board, so we had ESA. That was also a player. I didn't mention those earlier. ESA was also playing with their *Columbus* module while we were doing all of this other stuff. It was definitely a unique flight. I hate to say it, but I think it's probably one of the last great flights. Because from here on out, we're adding little pieces here and there. Even this next flight, they're adding an important part of the Japanese Experiment Module, and it has some complex things in it as well, but I think taking up the JEM was the feather in our cap.

HANSEN: I don't know if it was—maybe not the largest but the heaviest module? Or vice versa?

CLANCY: It was the heaviest module that we ever launched in the Shuttle.

ROSS-NAZZAL: What sort of complications did that have for you in terms of flight planning?

CLANCY: Well, it actually made things a little bit easier.

HANSEN: It did, because it limited what else we could take. If we can't take a lot, that means we can't transfer a lot.

CLANCY: Just in that one vein, it made transferring payload a little bit easier for us to manage. Shuttle, we always try to maximize space and time. You'll have some secondary and tertiary payloads jump on board, or you'll have some deployable satellites that'll jump on board. You have to factor those in when you're doing the plan. In that way, it made it a little bit easier, because we didn't really have that up-mass available for them to use.

HANSEN: As Terry talked about earlier, because it was so big, it limited certain robotics operations with it being in the payload bay and where it was situated.

CLANCY: Not flying the boom really hurt us timewise, because it's not as simple as you plug into Station and grab the arm. It was plugged in. We had to do an EVA to unhook it. Then we had to hand it off to their arm. Then we had to hand it back over to our arm. You're just looking at two people per arm, two spacewalkers, you got one commander having oversight. So right there, you've already got seven people involved in one little activity.

ROSS-NAZZAL: Is there anything else? We're getting close to time. I want to make sure we stay on time for you.

CLANCY: I can stay a little longer if you need.

ROSS-NAZZAL: Do you have some questions, Rebecca?

WRIGHT: I have one question. I think it's going to be an easy question, but it may be a complicated answer. I'm listening to all these parts that are woven together and all these partners that are woven together. There's got to be a time, maybe even a small one, that sometime you came to a point where as you mentioned, people resist the plan or don't agree with that plan. Who gets to figure out which way you go forward? Is there a final say? Is it internal with you guys, or do you have to elevate it up? Can you give us an example about those conflicts? I use that word loosely, because that's what it is, conflict with planning or activities. Who gets to be the big guy that says, "No, this is what we're doing, and we're going forward?"

CLANCY: You want to talk about us first?

WRIGHT: I'm sure there's many levels.

HANSEN: There's many levels, there's many levels.

CLANCY: It was nice working with Gail. She's a very smart person, and she can grasp the different concepts fairly quickly. She was new to our planning group when they put her on this flight, but we had seen things, and we knew she would be very meticulous and well suited toward our job. I learned early on in my younger days to relinquish control sooner [rather] than later when you're developing someone new. So I did that with Gail. I would try to give her high level and steer her the way that I felt the plan would go, but, I thought, I was trying to leave the door open to allow her to think outside the box and to approach it maybe from a different angle.

But I would leave the details on how things were implemented to her, to develop her and to have her start going down the path of a planner instead of just an implementer.

We can hire people to do the work. If I give you a set of pages with a bunch of red lines on it, you can move that stuff around. But do you really understand it? With her, I wanted her to go into comprehension. First of all, I knew I was leaving several months before I announced it. So I was trying to set her up for success instead of just leaving her open to failure, because I didn't want to leave it to anybody else to train her. She was very instrumental. We worked, and she would push back, and I welcomed that. I didn't always agree with what she came up with. We would spend many minutes, sometimes hours, going over the reason why we disagreed, but we would come to a consensus. Once we, within our group came, to a consensus, then we would elevate it to the control team and the flight director and we would get their buy-in. We'd get the crew buy-in. We were on the phone with Mark almost daily. Gail would shoot e-mails back and forth. They're very familiar with Gail. All the crew knew Gail very well, because she was such an integral part. We got those people to buy in as well, then we elevated to the program.

The program would sometimes push back a little bit. We'd have to do some justification. We looked to them for their high level guidance on what they thought was most critical that day. I say that day, because it would change on a daily basis as we weren't able to accommodate what was at one point a lower priority, turns out it was a higher priority, they just thought that they would get a free one. So then they would reorganize their priorities, and so then we would have to reorganize our plan. As long as we played within the flight rules and played within the mission objectives and the priorities, the plan that we developed was the plan that we executed.

HANSEN: It was great having Terry as a mentor. Learned a lot. But I pushed back a lot, too, because I was learning. He was more than willing to explain things six different ways if I needed it, and some days I really did.

CLANCY: Some days.

HANSEN: Some days I really did. I'm very detail-oriented.

CLANCY: Extremely detail-oriented.

HANSEN: Very willing to put the time in, and sometimes too much. Terry always wanted to make sure I wasn't overworked or wasn't overworking myself. He knew I was sometimes my own worst enemy, but I learned a lot.

CLANCY: It got to the point where I'd have to start withholding information from her so that she would not work on it. Because my whole mantra is, "You can work hard, and you can work smart." I prefer working smart.

HANSEN: Sometimes I was still trying to work too [hard].

CLANCY: Pacing ourselves. We can put a lot of brainpower, a lot of time into working very hard on something. Or we can just sit back, think about it a while, wait for other things to come into fruition. Sometimes we were waiting on outside data before we could proceed. I'm a big

proponent of not doing useless work or throwaway work. I'm not a busywork type of person. If it's not useful, then we'll sit back and we'll wait, wait till someone higher up makes a decision, even if it's withholding products that they're waiting on. They want to see an assessment. Well, you tell me what the priority is, then we'll go off and build a plan. I'm not going to just do busywork for you.

HANSEN: I think I had some first flight syndrome when I wanted to overwork everything, because it was my first flight. You're really excited about it, it's your baby. First lead flight. Having my second lead flight, I'm much more relaxed and reserved. My new FAO, it's his first lead flight. So he's doing a lot of the things that I see that I used to do, and it's funny. I'm thinking about who really made a lot of the decisions when we had maybe more minor issues within the flight control team or the IPs. Annette [P.] Hasbrook, our lead Station flight director, she worked on that flight for 12 years or something.

CLANCY: Long time.

ROSS-NAZZAL: Is that how long it's been in the queue?

CLANCY: Well, if you think about when they first came up with the design, the Japanese were right in there. Back in the [President William J.] Clinton days when they made—.

HANSEN: I want to say it was something like 12 years. She could obviously give you the exact number. She worked very closely with their flight directors, and she came to decisions. She

explained things thoroughly. She was a part of every single meeting. She was very passionate about this flight.

CLANCY: That was one of our hardest things. When we came up with something different than what she had, we spent a lot of time convincing her, this really is the way we need to go. Sometimes we didn't always win. She's a very, very strong person, and she has her opinions. As the lead ISS flight director, who has overall authority for the mission from a planning and execution standpoint, she had a say and we went with her. It was ultimately her decision to execute the plan.

WRIGHT: That's such an interesting statement, because it's good to know who that person is. How much influence does the commander of the crew have in planning and making their observations or their preferences known on the day-to-day planning?

CLANCY: They have a high priority. You want to build a plan that the crew wants to execute. The best way to do that is to make them a stakeholder in the building of the plan. He is the only source of information for us once they get on orbit about how well his crew is executing. We sometimes, oftentimes, offload the commander so he can maintain situational awareness of his entire crew. He is the only one on board that can tell us, "Well, the time that we had scheduled was way too much, and we could have done that time in half the time," or, "You didn't allocate enough time for this; we're behind. I don't want my people staying up late working through the night to try and get this done, because then they'll wake up in the morning and be extra fatigued, and so then it's a trickle effect." In many ways, his real-time planning input is invaluable to us.

He communicates with the flight director, and then that gets passed. Sometimes they'll communicate to the surgeon, if it's a crew rest fatigue issue, and then we'll get told to back off a little bit or generate some more open space in the flight plan so it gives them a little bit of buffer that they didn't have before.

HANSEN: He can also help direct us to who's best trained to do what or best suited to do what. A couple times throughout the planning process, we would get e-mails saying, "Can you put this activity on this crew member? Can you switch this activity to this crew member?" Because he could see strengths in their training. Someone was doing something a little more efficient than another. Someone else had a skill or strength in another direction.

CLANCY: Someone needed a backup.

HANSEN: Yes, he was able to make that decision, because we didn't know. We weren't involved in the training, and we didn't have a say in that. We were just going based upon the original crew task matrix that we sat down early, early, right away right just after the crew gets assigned, we sit down and—.

CLANCY: Pigeonhole people.

HANSEN: Make those decisions. But sometimes they don't always work out to be the best decisions. So throughout the process the commander is saying, "No, I want this person doing

this." Mark was really great to come to us and tell us those things. He also was very clear in what he wanted.

CLANCY: We have some iterative processes as well. This person isn't good for this reason. We'd have to justify, and we'd have to have a good reason why we can't do it. He's a very rational person. He'd listen to us.

HANSEN: Right, he was very willing to be flexible but also tell us what he really wanted.

CLANCY: You can tell when he really wants something. Mark is a quiet guy; he's [got] a little dry humor. … He's an extremely intelligent guy. You can tell when he really wanted something and when he felt strongly about it. If he said it twice, then he really meant it. "This is what I really mean. I really want this to happen." We would bend over backwards to accommodate his requests.

HANSEN: He would have good rationale, never just because he felt like it. Some crews I think I see the opposite, where the crews want to do everything the way you want it because they want to be what they think the best astronaut is, just agreeing with everything. We don't like that because we want to know their opinion.

CLANCY: That's the young person's point of view. I think that's the exception, not the norm.

HANSEN: I just don't always think that sets them up for success, for them to just always agree with the way we plan things. We're not in there. That's probably not the best way. Can you tell us how it's really going to go? We want some of their opinion. If they're afraid to give it to us, then we can't help them. We can't create the best plan if they don't provide opinion sometimes.

CLANCY: To answer your original question, like Gail mentioned it's really the flight director. Annette Hasbrook is the lead ISS flight director. She is responsible and accountable for the planning and execution of the plan. It ultimately comes down to her decision and approval.

ROSS-NAZZAL: I think you guys have really hit on practically all the questions that I had just typed up pretty quickly this morning. So I think that's about it, unless you guys have anything else in terms of how this flight was unique or any other information you want to pass along about flight planning just generally.

HANSEN: No. I could show you some things from my goody book if you just wanted to know some of the products that we [created], but it certainly doesn't have to be online conversation. I can just show you this. If you're interested.

ROSS-NAZZAL: Oh, no, absolutely. The more that I learn about the flight, the easier it is for me to work on the chapter.

WRIGHT: Would you like to end by saying what it was like to know that you had such a vital part of the success of that? It's got to be really neat to start out with blank pieces of paper and know that you watched its success up in space. Especially for you, since it was your first one.

HANSEN: Yes. For me it was amazing from start to finish. Something I think that in a way I fell into. I started out in the systems flight control world and eventually moved to planning and wasn't sure. You never know if it's going to be your niche or not. I got this wonderful opportunity. At the time, I didn't realize how wonderful it was.

CLANCY: Some of us did.

HANSEN: Just didn't tell me? I don't know. Then I ended up being able to be a partner with a great mentor and learning so much from him. It was great to be able to be a part of seven crew members' dreams, putting that into reality. It's amazing when the flight launches and it is so successful, and all that is complete and you can always hang your hat on that. You've got that module in space, and you were a part of it. It took a lot of things, but you were a part of it. It was part luck, and it was part hard work, and it was part diligence and just being there for the team every day. I will forever be thankful for my opportunity just to work with really great people here at NASA and within USA [United Space Alliance] and within all of our organizations.

CLANCY: I was fortunate to be selected for this flight. I had worked with Mark Kelly on STS-121. I was lead on that flight, and that was his first flight as pilot. Also Mike [Michael E.] Fossum, he flew on [STS]-121, so I got to work with him again. Of course Aggies, gig 'em.

WRIGHT: Had to get that in.

CLANCY: Had to get that in there sometime. When you know these people and you get to learn, you become an emotional stakeholder in the success of the mission. The crew does a real good job of bringing in the controllers to develop that because it's a very strong tie, the team mentality. A good commander can go a long way in building that camaraderie. The flight directors also, they embrace it. It's one of our tenets in flight control. They're our friends. We're looking after our friends on orbit. Be diligent. Be tough and competent. I think as an organization, I think we did a phenomenal job building this mission. As a group we did, we—Gail—did an exceptional job putting this plan together. The meticulous nature of our job is evident in our products. We were recognized at the conclusion of flight, as being instrumental in the success of mission, and we got to hang the plaque, which is a high honor, at mission control.

So it's very humbling when you look around the control room, and you see all the experts and system controllers and the flight directors and the different program managers and all these different people. You're in their company. It's a very humbling experience.

HANSEN: We were very fortunate in a lot of ways to have such a great crew and such a healthy vehicle and such a great team to work with. If their inputs to us were wrong or off by a little bit or incorrect in any way, that flight plan could have crumbled. We rely heavily on them, in some

ways, to provide us with the correct data. They came through. The whole team came through. Then for us to be selected was, like Terry said, a very humbling experience. Just to know that your flight directors think that you were such a significant part of the team. I often would tell people, and I think I told Terry throughout the process, that launch day or that flight to me was going to be like Christmas, because I was really looking forward to it, but at the same time once it passed I would miss it. I would always tell Terry that. Sure enough, when it passed we missed it. We move on. We've got other things now. I think we'll always be very thankful and have a special place in our heart for that mission.

CLANCY: You look at the module, at the conclusion, when we did the flyaround. It is such a large addition to Station. It's a piece of history that other people that are outside of the industry just don't get to be a part of. We can look up. We can say "Yes, we had a small part in putting that piece of hardware on orbit and building the relationships that are going to last several years down the road." Long after assembly missions cease, we'll still have the foundations of the relationship that we started years ago when Gail went to Japan and when Tracy went to Japan and the planners, Osami Eda would come down here from Japan, building the relationships and those processes. It's a continuing effort.

ROSS-NAZZAL: You continue to work on the Shuttle Program today? You're working Constellation?

CLANCY: I'm working mostly Constellation now. Last November I got retasked from working [STS]-119 into working on Constellation, because they're starting to step up the effort. In fact,

there's a meeting going on right now with the system module review. I'm heading back over to University of Houston-Clear Lake [Houston, Texas] where we're using their auditorium to present a lot of our data.

ROSS-NAZZAL: Great! You're working on a new mission?

HANSEN: Working on a new mission. STS-130 will deliver Node 3 and the Cupola next February, hopefully. I guess we'll see the actual date once these delays all trickle through. After that, I think I'm going to eventually either move into the Constellation realm or start to get trained on the Space Station side of things. It depends on where the opportunities open up.

ROSS-NAZZAL: We thank you for taking time out of your day today to talk to us about the mission. We certainly appreciate it and we've enjoyed it.

CLANCY: Sure. It was a great mission, and we still share the same office, even though we're working different projects now. We reference [STS]-124 at least once a week.

HANSEN: We do, we do. We do, the greatest mission ever. We have our picture from hanging the plaque in our office so that we can always remember that.

ROSS-NAZZAL: I'll have to use that quote, "the greatest mission ever."

(Break in audio)

WRIGHT: You were talking about having shifts.

CLANCY: Yes. As leads, we're also responsible with training our own console team. High level, we use the plan during simulations to train the control team, but leading up to that—each shift we have six to seven people on three different shifts. We have to have a continuity of planning process and planning effort throughout the entire day, throughout the 24/7 that Shuttle is flying and they're docked to Station. We put together this walkthrough as a training tool for our team members to give them a little heads-up on high level what they're expected to do. Then for each of the different days, we have multiple team meetings where we'll do a walkthrough of the actual activities and display some of the different constraints, like you can't exercise while you're moving this piece around. The crew can't exercise. I guess we can always exercise on the ground. But the crew can't exercise on orbit while we're doing certain operations. We care as planners so that we don't do anything stupid like schedule exercise during that timeframe. So we'll give that kind of information to them and train them before we actually go through the simulations in MCC [Mission Control Center]. Then of course on orbit.

ROSS-NAZZAL: So this is given to the flight control team.

CLANCY: We give that to our flight control team. Of course, we're always available for consult. We have a website now that we have a lot of our data that we'll put out there for our team members to look at and reference for constraints and lighting and DTOs [Detailed Test Objectives] or secondary constraints. Communications planning is probably one of our biggest

headaches nowadays, because you have multiple users and multiple modules that need com [communications] and data. So we're always trying to factor that in.

HANSEN: We do a lot of the little things. Worry about scheduling satellites for com. We work with OCA [Orbital Communications Adaptor], which is another officer in our back room just to make sure that pages are going to be printed the way the crew likes it on board. We have a lot of little jobs within just the big planning.

CLANCY: We try to make the astronauts' job a little bit easier, if there's a small thing that we can do. We manage their e-mail, so if they get e-mail in orbit, we do that too. We schedule their private family conferences and coordinate with the crew office. If somebody has small kids, we try and plan during the daylight hours. Try and just integrate all that. That's really our job. We're integrators. We're project managers and integrators. That's all we do. It is nice. Except for the couple things with the Orbital Communications Adaptor, the OCA, we really don't have any system that we monitor for health except for the crew. I call the crew our system. Sometimes jokingly when we're in our handover period with one shift going off and another one coming on, I'll mention, "FAO systems, the crew is performing nominally, no hiccups that we know of."

We have to know a little bit about everybody else's system. If you're a PROP [propellant] officer, all you have to care about are your jets and your propellant tanks and that's it. You don't really have to care about how the guy sitting next to you, how his system is performing or how your system integrates with his or the ECLSS [Environmental Control and Life Support] System or the MMACS [Maintenance, Mechanical, Arm and Crew] Systems or the

INCO [Instrumentation and Communications Officer] systems. They really don't care, because they have the luxury of focus. One of the reasons why they're like that is because it is such an important system that that's all they need to look at. They have the luxury of not having to look at anything else but that. If someone has a failure, we have to think about how it affects everybody else and what we need to replan and change based on that failure. Luckily, on this mission we didn't have to do that, because they didn't really have a whole lot of failures. We had a couple minor hiccups, but nothing we couldn't work around.

HANSEN: Which made it excruciatingly nominal for our flight planners, who were bored to tears most of the day.

CLANCY: Yes, by end of flight I think we planned out the rest of the mission like four days ahead of schedule, which is good. That's the kind of flight you want. You want a flight that's boring. Things go according to plan. We have spectacular things that we did, but it was very—what did they use to call it? A simple but extremely complicated plan. We had a simple plan with some complicated stuff that we did.

HANSEN: I just want to show you real quick our flight day six, which was the hardest day to plan. That's when we had an EVA and then all those rack transfers and umbilicals. See all the activities that the entire crew has to perform? Terry and I combed through that many times.

CLANCY: We talk about our spatial constraints a lot in planning. If you can imagine, if we wanted to move this table through that door, you can probably only do one of these at a time. If

you have five tables in here to move, you have to move them one at a time. If they have certain connectors and one had to be connected before you could take the other one off, that's where we really start working in how these things are all pigeonholed, because it's on Station the same way. We had to move a bunch of racks from one location through one hatch into the same approximate area. You had bodies bumping each other. Some modules you can't have more than two people in, because the air exchanger isn't that good, or it wasn't designed for that. So we have to monitor that. They had to slow things down and space things out. Just because you can't have that many people in there, or you're just worried about them bumping into each other.

A lot of times one of these people is the system expert. So on all the important stuff, like hooking connectors or umbilicals or doing power or data or fluid line connections, they have to be involved. If you need that one person to do all these tasks, you can't do two or three at a time. You got to do them real serially. Again, we go back to we want to be effective and efficient in our planning. We try and get as much done as possible still meeting the spatial and training constraints. That fits somewhere in that interview in the middle.

ROSS-NAZZAL: Well, you're always welcome to move things around. That's okay. Thank you so much for bringing all this information.

[Break in audio. Hanson is describing her STS-124 compilation book.]

HANSEN: My team gets involved about three months prior when we start flight-specific sims [simulations]. Like I said, there's about eight to ten flight-specific sims for each flight. Sometimes that includes a long sim, which runs anywhere from 24 to 48 to 72 hours depending

upon what they want to accomplish. A couple EVAs sometimes are in there or a critical module activation day. That's when our team gets involved. They participate in the flight-specific sims. Everyone by then is assigned to a shift on the mission, and they have a particular role.

FAO is the flight activities, that's the front room position. In the back room we have timeline, which I was the lead timeline for this mission, so I worked orbit three. We also have a MATS [Message and Timeline Support] position, which is a position in itself but is following along with the mission, making sure that we tell the FAO how far ahead or behind we are in the timeline. Then also we have an OCA support position. They uplink and downlink everything to the vehicle. Just to go back, MATS also develops all the messages for the OCA member to uplink and downlink. They format them, make sure they're nice to read for the crew and that kind of thing.

My team doesn't really get to know the crew. So I put pieces in my goody book with regards to who they are. This is just a high level mission overview. We end up giving a pitch to our group leads, our branch chief, and then we go all the way up to Paul [S.] Hill, lead of MOD [Mission Operations Directorate], and we pitch them the plan for our mission. We get them to sign off on our final flight plan book, which was the orange book I had shown you. They actually sign off on this. We have their signatures on it that they've blessed and approved this plan. This is part of the process, that we get the appropriate signatures that our plan is a valid one. So when we go and we get their signature, we also run through the basics. They want to know, "Okay, can you tell me about this mission?" They don't want to know the nitty-gritty details, but this is something that we present to them. I also put it in here. It just talks about mission duration, priorities, that kind of thing. Brought some pretty pictures of how the payload bay looks.

As a lead, I end up giving a timeline presentation to the entire team, and it just talks about the high level aspects of the mission. What's special about this mission, a lot of these missions are canned to a sense, but what's particularly different? I talked about the contingency timeline development, which is something that Terry talked to you about. The focused inspection plan. What if it goes away? What are we going to do instead? Talk about the payload activities. Some of these payloads for these flights are flown over and over and over again. Some are new. This is when I would tell the team, "These are the ones that we're flying, you guys are very familiar with these, but these might be new to you, and this is the plan for them." I provide some miscellaneous info and crew preferences items. The crews told me that they want to schedule exercise on certain days or at certain times on the day.

Mark was really good about telling us that he wanted the locker locations on the detail pages so that he could easily find the hardware. A lot of times the crew will tell you, "The hardest thing about doing these activities is finding the hardware which I need to do it with. That takes me the most time. So if you could just write in the detail plan which locker I need to go to, it'll save me time." Yes, unfortunately a lot of the activities during the docked mission, a lot of those activities occur on Station, installing the JEM module. But there are some activities on the Shuttle where they actually will pull hardware out of the lockers to inspect during certain parts of the Shuttle. They'll actually need to go into those lockers. It was a good idea, and we will accommodate them on that.

We always have some open issues going into the flight, just things that we might need to wait till we launch and actually get there to be able to figure out what we're going to do with it—water dump situations, priorities. When we were going into this flight, I think a lot of times when you're planning a Space Station mission you don't know the configuration of Space

Station when you get there when you're planning a mission. You don't know what's going to be broken when you get there. For example, in this case there was a broken toilet on the Space Station that when we docked we had to deal with. We couldn't plan for that eight months in advance. We didn't know that was going to happen.

This is part of why we continually rework priorities, and why we continually add to the timeline. Things break on Space Station. All of a sudden, something really important is broken. Something else falls off the plate, or we have to consider adding that extra day. That's when we make the pitch to the program office, we develop charts, we present in a JOP-type setting, and we say, "This is the way the timeline looks. You need to prioritize what you want to go first, or you need to consider adding an extra day."

ROSS-NAZZAL: Did you add an extra day?

HANSEN: We added an extra day at one point. Then we added another day just before flight, when we found out that we had the consumables and we had a better estimate on whether we could support that just based on from a consumables perspective. Also the fact that we had some higher priority objectives that we did want to get done, but we didn't have those before to provide us with the rationale to add the day earlier. So we had to wait till we got there. That's how a lot of these missions end up being planned. One minute you're 12 plus two, the next thing you're 13 plus one, then you found a way to get to 14 plus zero. Constantly adding days and working with the program. They make the final call whether we're going to do it or we're not going to do it.

They're also looking forward. We've got eight missions left at this point. Back then, maybe we had 12 missions or whatever. They're able to say, "Okay, well, we need to get this much done because we only have eight left. So we need to fit this in to fix it."

We have a system that helps us create the timelines, and we call it a database. That database includes all these activities and all the information and how it prints out on the pages. So I just provide my team with some information about how my database is built, just extra details on each day and why things are scheduled the way that they are. This is the timeline walkthrough that Terry told you about. The overview I gave you, you're welcome to keep if you want.

ROSS-NAZZAL: Oh, great. I think that would be helpful.

HANSEN: This is a summary. This is the overview.

ROSS-NAZZAL: Oh, okay.

HANSEN: If you wanted that, that shows like a higher level look at how we start the planning process. This is just a picture of the module. This is how it all is going to look. When we got up there, the JLP, which is what we considered the closet of the JEM module, it was already up there; it got brought up on [STS]-123, which was the flight before ours, but it was moved. It was attached to something else, because this wasn't there yet, so it couldn't be attached to it.

So we brought this up. We installed it. Then we relocated the JLP on top of it. That was a part of one of the objectives for our mission. This mission coming up that we're having a hard

time launching, [STS]-127, is bringing this back porch exposed facility. That's what this mission is going to do. We also in our mission brought up the robotic arm and deployed it. It's there as well. It's just waiting for the payload to come. This is how everything looks.

ROSS-NAZZAL: Did you have any additional experiments in the middeck or anything? Or this was the only payload that you had, the *Kibo* and the arm?

HANSEN: We did have some middeck payload experiments that I think I detailed in this information, but they were ones that the crew routinely does. Payloads can be anything from taking blood samples to performing sleep logs or wearing Actiwatches. We also did have a cell wall sample and return. We were bringing up I think microbes from cell walls and watching them grow on orbit and then bringing them back in what we call a double cold bag. It's a freezer bag that keeps the sample cool until landing. So we did have some different payloads, but they were small. They were lightweight. They were small. They were easy for the crew to perform. The crew didn't have a lot of time to focus on payloads, but we did have some.

We received a list from our JAXA counterparts, a get-ahead list. So the timeline is built for this amount of time, and it can fit all these activities based upon how it looks right now. When the flight controllers provide us our duration for their activities, we think it's going to take an hour to hook up the umbilicals for this workstation rack, they don't know exactly how long. They're making an estimate. The crew has been trained, and the crew has probably performed it a couple times on the ground, but they don't really know how efficient the crew is going to be out in space. The crew could be better. The crew could be worse, but they have to make a guess. So we often ask for get-ahead tasks, either from our IP if we're working with them on a

mission, or from ourselves, or from our Space Station counterparts. We see what can the crew get ahead on if they end up getting things done early.

We were able to pull some things ahead, and that was the BDS stuff that we talked about earlier, to help JAXA complete more of their objectives. They were going to do these in stage, and these activities were okay to be performed in stages, but their crew member was up there with us, so they thought, "Okay, we've got the brains of the operation, let's use it." So we ended up getting to some of the activities on the sheet. We launched knowing we had the sheet to pick from if we got better. The ACOs, they develop a contingency Channel A activation flowchart that goes along with our contingency timeline. So the crew has the timeline. They see how those activities play out. Then they follow through this little chart and it tells them what to do. We didn't develop this, but this goes as a counterpart to our timeline. I have that as reference.

This is a list that we get from our JAXA counterparts with all the different activities, and it's really teeny because they have lots of information. They write things differently. Instead of writing "this comes before this" or "this comes after that," they write like predecessor and successor. This is the way that they refer to it. These are things that we had to learn over time, and if we would have been dropped flight day one working with them, we probably wouldn't have known what they were talking about. They probably wouldn't have understood us either, but we were able to work through that.

This is the contingency timeline. This is the way that I taught our team about what it was used for, what the plan was, what the assumptions were. So this was just a chart that I used to tell my team member, "Okay, this is when we expect the failure to happen. This is basically going to replace this and this is how we're going to continue." This is the timeline itself.

This is our critical period spreadsheet. Like I said, we work with another flight control group called ground control or GC. We help to work with them to work with the network. The network is the folks who actually help schedule TDRSS [Tracking and Data Relay] Satellite [Systems]. They're scheduling satellites for everybody. DoD [Department of Defense] customers, us, other people who are using these satellites for uses we're not even privy to. We help work with them, and we determine during the flight there are some critical times in which we really need com. We define these times as critical. We base it on the flight plan where they fall. Okay, they fall on flight day two, from MET [Mission Elapsed Time] 16 hours to MET to 18 hours. We deem this as critical, because it's an inspection, and we really need to see this data to determine whether the vehicle is safe or not.

We define these periods as critical. We hand them over to GC, and they work with the network to get us these satellites. They do a pretty good job of it, but it's based upon our planning. We're the only people who can tell them where these activities are. That's why we need to be in the loop. So it's a detailed look at some of that.

We get a list of the PAO [Public Affairs Office] events. We work with the PAO Office, and we get a list of PAO events that they want planned in the timeline. Usually ahead of time they work with us, and they send us an e-mail and say, "We'd like to have six events, we'd like them to occur on." They'll look at our overview and they'll see. They're not going to ask for an event on an EVA day, they'll know that's not possible. They'll look at the way the timeline is laid out, and they say, "Okay, well, based on what you have we'd like one on flight day two, we'd like two on flight day three, we'd like one on flight day six." They would pick them, and we'd say, "Okay, this is how we can accommodate."

They also have to look at what time of the day, what time of the night they'll be. Because if they have customers at 3:00 in the morning, maybe the crew is up, but it's 3:00 in the morning on the ground where they want to have the event. They take all those factors into account. They provide us with the very detailed information. They say who the customer is going to be, the crew member [that] needs to participate. We work with them. There's give-and-take on that. If there's high priority objectives that need to occur that day, we'll just tell them, "We can't do that, but we'll try to accommodate you in another way."

This is our payload summary document that we get that tells us the constraints for each of those payloads I was talking to you about. They're pretty small. At least for this flight, they were pretty small payloads. So they were five-minute activities here, ten-minutes there.

ROSS-NAZZAL: I didn't read very much about that.

HANSEN: Yes. It wasn't hours at a time. This is the PGSC [Payload and General-Support Computer] usage chart. This tells about what is the function of each of the PGSC computers, what is it going to be used for. One in particular is used to take the wing leading edge sensor data from the wings, and essentially load it and house it all on this one laptop, and then we downlink it for the WLES [Wing Leading Edge Sensor]. When I say we, the OCA officer downlinks it for the WLES engineers on the ground. Then they look at it, they analyze it. So one computer in itself is totally dedicated for that. The KFX [K-band File Transfer] machine is totally dedicated to receiving their messages from the ground. Also working on their e-mail. Sometimes they do PFCs, private family conferences, off that laptop. They set up a NetMeeting

where they put a little camera on top of their computer and have a NetMeeting conference with their family. We tie them in.

This lists the re-planning milestones, when we expect preliminary summary pages to be posted with relation to crew wake the next day. The pages were so good, we didn't have to send them any preliminary summaries for the next day because the plan was the same. It also defines different milestones we have as we get closer and closer to wake so that the team knows when they are expected to get their changes by us. If we get things too late, we can't put it in the plan and get the plan out on time. They need a drop dead deadline, and also when we take changes on orbit three especially, that's the replan shift, when we take those changes, they have to be approved by the entire flight control room as well as the flight director. We have to walk through the timeline and say, "Okay, well, this activity moved over here, this is now scheduled on this person, this one got deleted, this one got added." We have to justify why these changes were made, so that the whole team is aware. Then they can identify any constraints that they didn't see before. This just makes sure the whole team is on the same page, and the flight director who's in charge blesses the plan.

This is some of our launch information. I think also within here I have information on burns. This is the time the burns will occur. As Terry was telling you, burns happen on certain times. On certain days, a lot of burns happen. On flight day one, one happens. Then on flight day two some happen. In order to set us up to rendezvous and to be in the right position to dock, we have to burn up and get closer and closer to Station in certain directions. The FDO [Flight Dynamics Officer] dictates that. Those burns can only occur at certain times. We can't just say, "Well, we want a burn at this time." You need to burn at a certain time in a certain orbit to get to the certain place. That tells us where we can have the other activities occur around it. Those

burns are so high priority. We have to move everything else in relation to it. When all of a sudden we start slipping weeks at a time, those burns drastically change. Now we have to rework the whole timeline. We can't just shift everything to the right by ten minutes. A lot of times the burn shifts 30 minutes, some things have to come before it, other things have to go after it. We have to keep our eye on the ball in that sense and make sure that we don't forget about any conflicts that were originally there.

We get our attitude information from our pointing officer. He's also in our back room, the pointing officer. They speak through the FAO, but they're a different group entirely. They just don't have a front room position on the Shuttle side. They are a front room position on Station side, but on the Shuttle side they talk through the FAO. We have an attitude tab at the bottom of our timeline, and it says what attitude we're in. This attitude tells the flight director whether we're belly-down, or we're tail-up. It tells just to a certain degree the attitude of the vehicle. It just gives the whole room SA, some situational awareness, as to where we're maneuvering to next and for what reason. This lays out the plan.

We work very closely with our lead pointer to get that information correct. He also checks the Ku-band that we need. Because based on going to certain attitudes, we'll be able to have different communication with the satellite based upon our position. Our Ku-band antenna is on the starboard sill, I believe very close to the front of the vehicle just before the nose. It sits on the starboard sill of the payload bay. So based upon where that vehicle is, it has a certain line of sight to those satellites so they can tell us whether we've got communication or not.

You'll see this in here. Middle to end of the flight, we start building our wave-off pages. So assuming we don't land right on time. Before the flight, we always build the timeline to the end of mission time. We're going in on this day. But what if we wave off? There are certain

activities that need to be performed for the systems folks to keep their systems in check. Maybe we need another water dump, because if we wave off a day or two, now EECOM's [Emergency, Environmental and Consumables Operations Manager] tanks are going to be too full. So we start working. There's some standard activities that every flight, on EOM [End of Mission] plus one we need to have this, and on EOM plus two we need to have that. We also work with the other flight controllers to make sure that's still the plan. We start doing that. We've got a list of activities. I think the wave-off pages are in here for you to reference, if you want to see what those days look like.

We have a checklist that we use on our shift. This tells basically high priority objectives of each shift. Each shift for timeline does something a little bit different. Orbit one is focused on updating com. We constantly are refining our com to make sure that the activities that we really need to have com scheduled for are constantly sitting over those com bands in the timeline. That's their focus. Orbit two is making summary level changes based upon the inputs that the team provides them. Really, the team doesn't start providing inputs until beginning of orbit two, because they haven't really seen what's happened in the day yet to provide information on tomorrow. Things need to either break or things need to go better than planned before the flight control room can really assess how it affects them.

Then on orbit three is when we really refine the detailed page look, which is the step callouts and the actual procedure names and that type of thing. I don't think I have an example of detailed pages for you. I wish I did, but I don't. That's the latest. A lot of times the latest summary timeline, this is what we launch with, is different than what we publish the final flight plan for, because between that time we added a day. It's almost completely different. We actually publish a basic as well. A basic, a final, and then you're supposed to launch with that,

but things change so much. There's so many iterations. A lot of times the joke is why do we publish a basic, because it's practically a different flight from what you actually launch with. Days have been added. In some cases, crew members have changed, depending upon the situations.

Oh, actually I do. These are detailed pages. I do have an example of detailed pages. These are detailed pages. So you'll see, we got three crew members in vertical columns, as opposed to the bands on the summary level pages. Our detail pages only have detail callouts for Shuttle crew. We do not have Station crew members' callouts, because they work off of a plan called OSTPV [On-board Short Term Plan Viewer], which is on a computer in the Station. It's a computer-based software that they can look up their plan. On the Shuttle we're still paper-based, which we have to be in a way. This is the way we do business. We're limited on orbit to doing it this way.

This provides very detailed step callout information. The crew member could go here and say, "Okay, I need to do this activity and it's scheduled at this time." So they come in here and they're like, "Okay, well, that's in this book and that's in this tab, and I need to omit steps three and seven but I need to perform this step." This is where they find this real detailed information. It looks very busy. Some blocks just have the activity itself, because postinsertion is its own book, so they just go to the book and they perform what they need to do. Some are very specific. They fly with all this FDF [Flight Data File], all these books they fly with. They unstow them, and they're able to reference them and such.

So this is just an example of what these detail pages look like. There ends up being for every flight, maybe 150 pages of information. They constantly need to be combed, because a step can't be off. That affects everything. This is where we rely on the systems disciplines to

look at that, tell us the right number of steps, because we don't know. We're not the systems experts. They're constantly helping us refine, comb through these pages, and provide the right information for the crew to perform.

Terry talked about our SCSC, which is our Shuttle Crew Scheduling Constraints document. This is a Reader's Digest version. We've pulled off the important points and put it on two pages. We have a thick document that actually defines rationale for why these rules are the way that they are. We reference this. This tells us different constraints we have on how much time the crew can be awake on different days, launch day, entry day, on-orbit days. The sleep cycle. How much can we shift them forward or back? We can't shift them grossly like three hours earlier every day, or it would just be too hard on their system. That would be risking mission success.

Exercise constraints. Meals. How often they're required to have meals. Workday guidelines. Some missions in themselves, because of the way that they're laid out, they have to incur certain violations, but they have to be preapproved by the Shuttle flight director. The Shuttle flight director will then determine, "You know what? This priority is an acceptable risk to violating one of these rules, and I'm going." So they sign a waiver preflight, but there are very few exceptions written for every flight, because we try to follow our guidelines as best as possible. Just sometimes everything cannot be accommodated, but this is what we run off of.

ROSS-NAZZAL: You guys really are like the orchestra. You've got the violins, the flutes, the tubas. You've got all these groups.

HANSEN: We do, we do, and we work very closely with everybody. This is a copy of the as flown pages, which I gave you. Then this is our final flight plan that we published May 8th [2008], but we launched May 31st [2008]. Then this is I think a JOP panel meeting minutes that I had saved. Mission highlights. Lessons learned. After our flight we get together, have a JOP, lessons learned joint operations panel, lessons learned meeting. We sit down with the JAXA folks. We sit down with every discipline and go around the room and talk about what went right, what went wrong. Really, we talk about more what went wrong. We don't want to belabor these things. If it went well, let's not talk about it, because these meetings can get really long.

So we go around the room and say, "This is what we've learned. This is what we need to do better next time." From our standpoint, we had very few lessons. I think it went very well. We always will learn something new, but nothing went so wrong that we really needed to talk about it.

It went pretty well overall. We had a good flight. We also sit down with our group, and talk with our group, and debrief with our whole FAO team, and talk about how well things went and how can we improve our processes. That's really it from my goody book. If you want copies of anything, I can give you copies. I have everything back at my desk in electronic format. So it's very easy for me to reprint from my book. So if you want anything now, or if you think of something later, "Hey, it'd be nice if I actually had that piece of information." … This is an example of our shift schedules. Just to give an example of how we work. This is constantly rewritten. Every time we scrub. I've gotten five of these in the last five days for whatever. This is our team.

ROSS-NAZZAL: This is the 67 people that he was talking about? Or 67 with just people on console in the back room?

HANSEN: See, I don't really know what he was referring—did he say six to seven? I don't know if he was referring to our team. Within our team itself, we have an FAO sitting out in the front room. We have a pointer in the back room. Again, they're not a part of our group, but they talk through us. We work very closely with them, but we don't actually get trained in that. We also have a MATS, a timeline, and an OCA. Sometimes we have two MATS, because the replan shift is so busy at night developing that big execute package full of messages and timelines for that next morning the crew wakes up that we need sometimes two people. So two people there sometimes. One timeliner, one OCA. That's four. A pointer is five. FAO is six.

Now I don't know if he was talking about those six members on every shift. Because every shift, we have five to six members. I think that's what he was referring to. This is how it lays out. We've got the flight days at the top. These are all the last names of everybody in my group and who's working what. I was orbit three lead timeliner, so I'm right across here. Terry was always orbit two, the lead works orbit two. That's an overview of who's working what.

Then we get a more refined schedule that tells when we're off, when we're on. There's an overlap. You've got three shifts, but there's an overlap by an hour so that you can hand over. I can't just get up and someone else gets on. They don't know what I did. They don't know.

So there has to be an overlap so that we can say, "This is what we've accomplished. This is what's still left open. This is what failed." So that's just how that looks. Like I said, if you want any of this, you can have it. I can easily repopulate it. I have it all back on my desktop computer. …

Anything we can do to help you. Happened to work out that I'm not doing anything today but waiting for us to launch, making our next attempt tomorrow. I would go on at about midnight. They have us all over the place, especially now that the Shuttle Program is coming to the end. We are getting some attrition. People are moving on; they're either moving up, or they're just doing other things or whatever. We're not refilling those positions, because [that's] setting ourselves up to have to cut more. So because of that, less people are working more jobs. I'm working OCA, and then I'm also working a little bit of timeline, and then I'm in the process of training to become an FAO like Terry.

ROSS-NAZZAL: Oh, are you? How exciting!

HANSEN: What's accelerated me has been having this experience. So that's allowed my management to say, "You know what? You can have this opportunity."

ROSS-NAZZAL: Fantastic.

[End of interview]