

# NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT

## ORAL HISTORY 3 TRANSCRIPT

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INTERVIEWED BY JENNIFER ROSS-NAZZAL  
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ROSS-NAZZAL: Today is March 23<sup>rd</sup>, 2005. This oral history with Dr. Bonnie Dunbar is being conducted for the Johnson Space Center Oral History Project, in Houston, Texas. Jennifer Ross-Nazzal is the interviewer, and she is assisted by Sandra Johnson.

Thanks again for joining us for our third session. We really appreciate it.

DUNBAR: My pleasure.

ROSS-NAZZAL: I'd like to start by talking about STS-50, and this flight you were actually selected as the payload commander. What were some of your duties as the commander of the payloads?

DUNBAR: Payload commander helps to organize the execution of the flight, along with the payload community. In this case, it was a flight that was organized out of the Marshall Space Flight Center [Huntsville, Alabama], because USML-1 is the other name for the flight, United States Microgravity-1 flight, and I actually had a relationship with that that dated back to 1987.

During the post-*Challenger* time frame, we had a number of studies that were initiated by the NASA Administrator to look towards the future, and one of those studies was conducted by Dr. Sally [K.] Ride; it was one of our exploration reports that came out of her group. She and the

Administrator asked me to look at what we might need to do on Space Station to get ready to use Space Station research, particularly, as it turns out at that time, in materials research.

So I led a task group called the Microgravity Materials Research Task Group, to kind of paraphrase it. What we had recognized was that there was a gap between what we were flying on the Shuttle and what we planned to put on the Space Station. The only Spacelab flights that were really being organized were being organized out of Europe and Japan for the physical sciences, and the U.S. was focused on two life sciences Spacelab flights, SLS-1 [Spacelab Life Sciences-1] and SLS-2, which meant we had no furnaces in development, no fluid physics combustion research facilities in development.

So our task group put out its report in, I guess it was 1987, late '87, and proposed a series of Spacelab flights, and we had called it US-1, United States-1, US-2 as opposed to D-1, which I flew in '85, and then D-2 came along, and then we had the European and the Japanese flight, which was called J-1.

Out of that flight actually came a program. The time that we published the report until the time I flew that flight was five years, and in those five years, Teledyne Brown [Engineering, Inc.] developed a new variety of furnaces. We had a new fluid physics module that came out of JPL [Jet Propulsion Laboratory, Pasadena, California]. We had new life sciences experiments for countermeasures, for health for the crew members, such as the lower-body negative-pressure device, the next generation. We ended up with a flight of brand-new hardware that had two purposes: one, to do science, to advance the state of the art, but the other as a testbed for Space Station, ISS [International Space Station].

So it was my job as payload commander to take the requirements for the crew training, divide them among the crew, and to work with the crew activity planner on the time line. It was

a wonderful experience. We had a thirteen-day flight, two shifts, 'round the clock, and when we did our shift handover, this was sort of a source of pride for me, which may not mean much to many people, but based on the fact that we were able to train as well as we did at Marshall, we never had a shift handover that was any longer than fifteen minutes late. There had always been a problem in Spacelab flights with not getting everything done in a shift, being late, or having people stay up late, and we never had that on our flight. I was really pleased with the way it was executed and with the ground support, both in Johnson and Marshall.

ROSS-NAZZAL: Can you talk a little bit more about training? You said you trained at Marshall. Did you also then train at contractor facilities?

DUNBAR: Well, some. Some. But the training for a flight as intricate as a Spacelab flight, when you have researchers from all over the United States, it's conducted at many locations. The research primarily comes from universities and contractors, so you start there. You go out to University of Alabama, in Birmingham [Alabama], for protein crystal growth. You go up to the University of Wisconsin [Madison, Wisconsin] and you study plant growth, and you actually go in and see what they're doing on the ground, how they're designing for space, and you visit Astroculture. You actually go out to Jet Propulsion Lab and you do fluid physics. You go to Yale University [New Haven, Connecticut] and you do fluid physics. You understand what the researcher wants to find first, because you're their hands, eyes, and ears, and if you don't understand what they're looking for, then when the unexpected comes up, you also don't recognize that either; you're part of the research team.

That then is translated into multi-user hardware, so that is built by a contractor. So Teledyne Brown built a furnace, and into that furnace went experiments from Marshall Space Flight Center and from a couple of other contractors and universities; the same with the fluid physics module. So you go to the contractor site to learn how to work the actual hardware before you get into the simulator. We started training that Spacelab flight, flight D-1, eighteen months prior to the flight.

Once we have all the research trained at that preliminary level and a set of sort of basic procedures on how to operate a furnace or other instruments, then we start integrating that into a simulator facility, and in this case, Spacelab was simulated at the Marshall Space Flight Center. So at about launch minus nine months or so, we started kind of part-tasking it, and by the time you're six months from flight, we're doing full integrated simulations. That means we'd pick a day, the worst day of the flight, the busiest, the most cables, the most communication with the ground, other things going on, and we would simulate that, we'd choreograph that, because you train like you fly, and you fly like you train. You don't have a chance to start over on orbit. I'm a firm believer in training well on the ground and training in a high-fidelity environment, because it directly relates to your success on orbit. I know we've been kind of pulling back on that investment, but I think we end up paying later. You can be overtrained, maybe, I don't know, but you have to be intelligent about when to make the best decisions on how much to train.

Then as we get closer to flight, launch minus three months, for example, then we start bringing in the rest of the Shuttle, because the Spacelab subsystems were actually part of my job as well as the mission specialist, but the subsystems, the electrical, the communications, the

computer systems are actually trained at the Johnson Space Center here, and they are then plugged into an integrated simulator with the Shuttle.

So I had two roles and you bounce between two Centers, just like we did for the German Spacelab mission, and within those last three months you're running integrated simulations. Now you've got the Mission Control Center, you've got the pilot, the commander, and the mission specialist 2, or flight engineer, and you run through different days of the mission.

ROSS-NAZZAL: How difficult was it? I've read that there were over a hundred investigators for this flight. How difficult was it managing all of those different investigators and their needs?

DUNBAR: Well, I mean, we're a big team, so we have a training group that of course schedules the training, tries to ensure that we train on everything we need to train. If it's an experiment that had very little interface and maybe it was just throwing a switch. You didn't have to necessarily fly to that site. You'd meet the investigator, hopefully, in a meeting or something, but I didn't need to go to their university. If there was a great deal of hands-on involvement, though, and you needed to understand the theory, then you would go the university site. And it was up to the training team, starting well before that launch minus eighteen months, to work out a schedule that would fit within eighteen months. So they made it work. Sometimes you make compromises, but you make it work.

ROSS-NAZZAL: How did you determine who would be working on what experiments?

DUNBAR: Well, I have my own methodologies. I was payload commander for two flights and I knew that we were first of all screened for a flight on the basis of what we could contribute to that flight, and availability, a lot of other things, but they would try to fit maybe some skill backgrounds with the flight. I know when I was Chief of Mission Development and worked with Dan [Daniel C.] Brandenstein, who was chief of the office, that's what we did. So if it was an astronomy flight, you might want to pick Steve [Steven A.] Hawley. Maybe you don't have to be an astronomer to run the instrument, but having that background and working with the investigators prior to the flight can sometimes optimize the flight. So on the USML-1 I'd had the experience off of D-1, my background was in materials and life sciences, and I was very fortunate to have been on that research group or the team, the task force team to pull it together. So once you get on the flight, there's a certain amount of filtering.

Then as payload commander what I would do is try to match, again, skill and interest. If you have a crewmember that is passionately interested in fluid physics, you should put that person on that experiment, because they're going to be interested in the success, they're going to bond with the researchers, they're going to bond with the payload developers, they're going to go home and eat, breathe, live it, and that has a better chance of succeeding than trying to match a crewmember with no interest in the research.

Then you balance time. You also try to spread what I called level of difficulty, as well as the fun factor. If something is really interesting, everybody can do it, you'd like to give everyone a little piece of that pie as well.

ROSS-NAZZAL: Do the pilot and commander have any experiments that they were working on?

DUNBAR: I always try to get the pilots and commanders involved, and I was lucky to be on flights where they always did want to get involved. So when you're on orbit in a Spacelab flight and your primary duty is on the flight deck or maybe attitude control and systems monitoring, there is often time for them to do some of the research, maybe the medical research or experiments that are on the middeck. So if we could work it into the training flow, which is also another factor involved, we would. And if they were interested, then I always involved them. It always contributed to the success of a flight to have the flight deck crew involved.

ROSS-NAZZAL: As I was looking through some of the mission summaries for this flight, I noticed you spent a lot of time actually talking with the news media about the flight, showing them around the Spacelab, answering questions for them. Can you talk about the interest of the press and the media in this flight?

DUNBAR: I think there was quite a bit of interest, but when you're on one side of the camera, it's a little hard to judge. I am a firm believer in the way the Space Act is worded in terms of our mission for educating the public, especially in areas they're not familiar with, and to put it into terms they can understand, because they have to understand how they're investing in our nation's future and in its new technology and in its economic health. So I don't dumb it down. I always am amused at—we've got children using words like "quasars" and "black holes," which is what the scientists use, because we use it; we don't try to make another easy word for them. So I tried to talk about crystal growth, because it's how your radio works. You've got a crystal; you know, crystals are part of life. How do you make a substrate? What's a silicon dioxide material? Is it sand? That's what it is on the beach. And help bring that home to them, and I think the press

was interested as well. Why is that research we're doing up there in a microgravity environment important to us here on the Earth, as well as how does it help us explore into the future?

ROSS-NAZZAL: What were some of things that the press was most interested in, do you recall?

DUNBAR: I think they were fascinated with the protein crystal growth, because we actually had a microscope on STS-50, so we could send pictures back of the crystals as they were actually growing. It's a little hard for me, being on orbit, to judge what's of interest on the ground. I think the life sciences part of it, when you explain how the body changes in microgravity and how you study it in that environment; always the Earth pictures. A picture is worth a thousand words, and the pictures you could take of the Earth always bring something home to people. It always did to me, sort of our place in the universe. Ecology is tremendously interesting to people, and so getting a big picture of what's happening, something you can't see in the visible range from a lot of satellites and especially in a moving environment. I have talked to university professors that have used our Earth photography in class to introduce the subject, because it gets the students interested, and if there's a little piece of the Shuttle in it, even better, if its tail or wing, because, "This is taken by a human being," and, "Here's a picture of the southeast coast of Texas," and they're discussing the wetlands, and that gets the students interested, and there's science in the picture as well. So there's always a lot of interest in our Earth photography as well.

ROSS-NAZZAL: What experiments were you working on during the flight?

DUNBAR: I worked on a little bit of everything. What I did is after I had the tasking done, to make sure divided among the crew on a particular shift, and that it was well balanced. You also have to make sure it's trainable. The amount of training time isn't always related to the amount of time on orbit, so you have to make sure that the person has the time to train for it. Then I would take sort of what was left over, and I always made sure I had some time to back up as well, put a little more pad in my time, so that if someone else that was a rookie, for example, needed some help, where I made it a two-person operation, I would do that as well.

ROSS-NAZZAL: Were there any challenges that you faced during this mission?

DUNBAR: During STS-50?

ROSS-NAZZAL: Yes.

DUNBAR: Challenges. I'm almost guilty to say it. It was an extremely smooth flight. It was on *Columbia*, with the Spacelab. There were no failures of anything. The only event we had in the flight was that one of the furnaces had a large power switch and a switch guard was not narrow enough to preclude somebody's toe from getting in and turning the furnace off, which was a great disappointment to the investigator, but we were able to load some backup samples in. That was, as I recall, the only big event. Everything else was extremely successful. We eventually flew a follow-on flight to that, called USML-2, with a lot of the same hardware, but now flying the next generation of research.

ROSS-NAZZAL: I'm wondering if you can compare this Spacelab flight with your first Spacelab flight.

DUNBAR: Well, let's see. Both Spacelabs, different countries, both eighteen-month flows, both very successful in terms of the output of the science. You executed the research; the researchers got results. The vehicles, *Challenger* and *Columbia*, both performed beautifully. We didn't lose any research due to any failure on the systems level. Different cultures for training, one I was very familiar with, the NASA culture. The German culture I became familiar with, and it was a learning journey for them as well. The D-1 mission had many purposes, and science was one of them. In fact, the Spacelab was built in Germany by MBB [Messerschmitt-Boklow-Blahn]/ERNO [Entwicklungs Ring Nord Organization], but it was also a national symbol, and they were hoping to galvanize and rejuvenate their youth, stimulate their youth into education and exploration.

ROSS-NAZZAL: Can you talk a little bit about the crew relationship, what that was like, especially being on two separate teams, on STS-50?

DUNBAR: When you start out, you don't really divide into two teams on the payload side of it until you start simulating. Actually, you never divide into two teams; you're a crew. You're on two shifts on orbit, but we trained together. In the training flow, we had no night shift, so we trained together. I have a philosophy about teaming and bonding. You're a family when you're up there, so if there are any problems to resolve, you need to resolve them on the ground. So I remember we had two payload specialists that flew, but we had four that trained, and eventually

we picked the prime and the backup. But I remember when we got everybody for the first training session, I think it was at Glenn Research Center in Cleveland [Ohio], and so we had two mission specialists and four payload specialists. We had a training session and I suggested we all go to dinner that night, and all four of the payload specialists were great guys, but they didn't know each other, and they kind of said, "Well, together?" [Laughs]

I said, "Yes, let's do it together. We'll make it a bonding experience," and they teased me a great deal about that, but I think that we started out as a team and we tried to bond. You have to get through to that so when you get on orbit, you know exactly what the other person is going to do and how they're going to react, and can pick up for them in a task. So for me, that was a lot of fun in that role.

ROSS-NAZZAL: Besides going out to eat, how else did you bond with the other crewmembers?

DUNBAR: Well, as crewmembers you bond with your families as well, particularly close to flight. The families get to know one another; you're in quarantine, you see your families together as well. So it's more than just the crewmembers; it's the families that do that as well. So it's social events. You spend all day together in classes and simulators. It's a natural process of getting ready to fly.

ROSS-NAZZAL: Any interesting anecdotes from the flight that you recall?

DUNBAR: Oh gee, I'd have to really think hard. There probably was, but I can't think of them right offhand.

ROSS-NAZZAL: You were up there during the Fourth of July, did you have any sort of festivities or any markers that this was the Fourth of July and you were in space?

DUNBAR: Yes, actually. We played some music down over Fourth of July. I can't remember which one it was, but it was maybe a country-and-western song. Then we'd taken some video across the U.S. and ended up looking right down at the Cape [Canaveral, Florida], it worked out just right, and we played that down to mission control. There were also a couple of passes over my home state, Washington State and the Yakima Valley, and I still show those pictures when I go on tour.

ROSS-NAZZAL: Did you get a chance to work with SAREX [Shuttle Amateur Radio Experiment] while you were up on the flight?

DUNBAR: Yes, I did. Not very much, because mostly that was the flight deck crew, but I did a little bit. I did most of my SAREX or ham radio work actually on a later flight, on STS-89.

ROSS-NAZZAL: What was your call sign, do you remember?

DUNBAR: Oh, you're going to ask me. I haven't used the call sign in five years, I think, so I don't have that memorized.

ROSS-NAZZAL: What do people most often ask you that you recall?

DUNBAR: From STS-50? Well, it's 1992, so it's now, what, thirteen years in history. It's hard to believe. It seems like yesterday to me. I think we're losing our corporate memory. We're talking about building a capability for Station, and with a lot of people doubting the promise, and it's because they've forgotten we've already done most of that; we're trying to go the next step. This isn't about an if; it's about a when. We know we can go these things. We've built a framework; we've built a platform, and now it's important to do it.

ROSS-NAZZAL: Your flight was actually scheduled to land on July 8<sup>th</sup>, but you ended up landing a day later. What did you do with that extra day?

DUNBAR: Oh yes. Well, actually, we relaxed. Because it was a twelve-day flight and we had planned a half a day off, everyone got their half a day off, but we were still working pretty hard. You work seven straight days without a day off, and even though you're having fun, it will catch up with you. So suddenly we had this day off. We could look out the window, take pictures, catch up on the crew notebooks, finally record something into our flight recorders. You know, we all carry them, thinking we're going to keep an onboard diary, and most of us never get time to say anything into them, so you come home with all these empty tapes. So it was a chance to do that.

I guess, if anything—and I imagine that Larry [Lawrence J.] DeLucas will probably kill me for this, but that day off, looking out the window—that's the favorite hobby, is to look at the Earth and take pictures of the Earth, because that's when we catch up on Earth photography. Larry was up there and all of a sudden he was gone. He went down to get some film, I think, for

the camera. He didn't come back and he didn't come back and he didn't come back, so I went looking for him. We had put a lot of our loose stowage in the airlock. By that time, we'd already closed up Spacelab at the tunnel, but the airlock was still open. That's where we had a large stowage bag and we'd been kind of temporarily stowing a number of bags in there. I looked around and I saw sticking out of these bags, two feet in white socks. Larry says that he went in looking for the film, and it's a weightless environment, and he sort of closed his eyes and he fell asleep. [Laughs]

ROSS-NAZZAL: Did you get a picture of that?

DUNBAR: No. So he was just floating among the bags, with his two feet showing. I don't know, I think maybe I pulled on one of his feet. But that was easy to do. If you were tired and you were floating, you didn't have to lay down or sit down; you could just sort of nod off once in a while.

ROSS-NAZZAL: That sounds nice.

DUNBAR: I enjoyed it.

ROSS-NAZZAL: One thing I also noticed about this mission is that STS-50 helped lay the groundwork for Space Station Freedom science operations. Can you explain how this mission did so?

DUNBAR: We actually experimented with a number of concepts that worked out quite well. We had a fluid physics module that was built by JPL, and a large number of investigators, some from Vanderbilt [University, Nashville, Tennessee] and some from Yale [University]. Now, fluids are such liquids, if you will, they were suspended in an acoustical chamber, and of course, when you do fluid physics on the Earth, you have to deal with very small drops due to gravity, looking at surface tension, for example, in response to dynamic modes. But here in this chamber you could deploy a drop very large. We couldn't practice it on the ground, so we would simulate procedures as if everything worked, but we thought we don't know where the science is going to go, because there's branching decision trees there and so I couldn't do exact procedures for the science. We could for the instrument: "How do I power it up? How do I get the cameras going?" because it had charge-coupled device cameras down. But when I finally deployed that liquid, and I start down the research decision tree, and the video's going to the researchers on the ground, I didn't have exact steps.

So what we did is we gave each researcher a four-hour block and nearly continuous communication and video, and in that four-hour block, they got as far as they could in the science, and it worked extremely well. That was something that we wanted to take to Space Station, where we might not know what's happening every second, but you'd have a block. Our training philosophy worked out extremely well, and I think that showed by the fact that we had integrated simulations on the ground, but very few conflicts on orbit.

Estimating how much time something would take. How do you know, unless you train it on the ground, how much time it really will take, hooking up the cables, starting the instrument? So we did have a lot of up-front training, but it paid off on orbit.

There's a lot of debate right now on time-lining for Station. There was a philosophy going in that said, well, we'll have so much time on Station that we won't need to do all this training preflight. But as it's turned out, we have much more research than time, and so where do you make that trade? I maintain that time is money and there's a cost-per-hour on Station. If I'm going to invest in the training time, I'd rather invest on the ground preflight than to use my valuable resource up there, and I think we've proved that in our Spacelab flights.

So now there's going to always be a situation where something new comes up and you have to train on board, and we can do that now; we can uplink videos. You still need to have some sort of core training. I would never take an astronomer, for example, that's never dissected a rat, and then go ask them to extract the part of the inner ear of a rat based on a training film. That's a hands-on laboratory skill that you'd want to train people to. But I think we exercised some of those limitations on USML-1.

ROSS-NAZZAL: Those are good lessons learned. What did you do after this flight?

DUNBAR: After STS-50?

ROSS-NAZZAL: Yes.

DUNBAR: Well, it was June of '92 and through July of '92, and then I came off the flight and did quite a bit of speaking, went back to Marshall. We had a very nice celebration after the mission. Then in late '92, I was asked if I would go to [NASA Headquarters, Washington] D.C. and help with two things, the Space Station redesign, because they were getting ready to redesign, and

also one of the outputs of this task force had to do with the Headquarters organization. We actually recommended that the research that's going to go on the Station be separated from the organization. It was in Headquarters at that time, which was the equivalent of Space Science. So we had Medicine and Microgravity Materials Research and Fluid Physics, all the physical sciences were all under the Director of Astronomy and Astrophysics or Robotics, but they were the anchor tenants of Space Station and so we felt they really needed to have a separate organization. So I was asked to come help set that up. It later became Code U, or Office of Life and Microgravity Sciences and Applications. People know it as OLMSA.

Harry [C.] Holloway was brought in as our Associate Administrator [AA], and he'd been with the Uniformed Armed Services Medical Group prior to that, and was the head of one of our advisory groups before that. Then Arnold [E.] Nicogossian also came in, and Arnold and I shared the Deputy AA job; we each had different functions, but we shared that. Then we worked with the Space Station redesign teams. Arnold and I co-chaired the research assessment for each of the options. There were three teams, Option A, B, and C, each that had different accommodations for research, then we evaluated each one, and led a team of external researchers in that evaluation.

ROSS-NAZZAL: What were some of the options that you were given? Can you give us some examples?

DUNBAR: Yes. There was a derivation of Freedom. There were two that were modularized and one was more like a Skylab that was called Option C. Options A and B had a number of small modules, but one was I think a Freedom derivative and the other was slightly different.

ROSS-NAZZAL: Do you recall what some of the benefits were of each one of those?

DUNBAR: I recall there were compromises all down the line, and the way that Arnold and I executed this is we wanted to make sure that the stakeholders, the people doing research in the universities and the commercial centers, actually were part of the decision process. So when we had a telecon [teleconference] to review volume, power, microgravity level, atmosphere was one of them, we actually had telecons that reached from coast to coast. I still don't know how they put them together. We'd say, "Okay, here we are. This is where Option A is, Option B, and Option C, none of them with as much accommodation as Freedom at that time, so what are the trades?"

Very early on it became evident that we were going to stay at 14.7 psi [pounds per square inch], because if you plan to use plants with closed-loop life support in the future, plants need a higher pressure and an optimum oxygen CO<sub>2</sub> level or you're not going to be able to support them. There were other types of research which had a decades-long research base at one pressure, maybe the animal side. So if you suddenly changed that, you compromised that entire research base and then you had implications for how the animal model was going to support human exploration. So that was very early on a decision about pressure and air composition.

Then we started going into volume, the research racks, power, communication, which was a trade. We didn't win that trade. On Station today, we still have as much communication capability in bandwidth as we did on Spacelab, which is not very much. Up until the redesign, we had a fiber-optic capability on board; we went back to a 1553 data bus. So I think there's some decisions that if we could redo—I mean the research community didn't buy into them, so I

was hoping they'd listen to us. We needed the communication capability, the capability I think fiber optics would have given us, as well as more bandwidth on the downlink.

ROSS-NAZZAL: Besides working with researchers, did you have any contact with congressional staff members?

DUNBAR: Yes.

ROSS-NAZZAL: Can you talk about that?

DUNBAR: On two fronts. First of all, congressional staffers were very interested in the redesign process. They wanted to also ensure that the research initiatives that were funded could be implemented, and, of course, part of their constituencies are the universities, the academic and the commercial ventures that were involved in this.

Also because of my dual role of having been on STS-50, I was asked to come brief them on what happened on that flight and how that was relevant to Space Station, and I did that frequently on everything from protein crystal growth to the fluid physics, the combustion, the life sciences, and the instrumentation we were using for life sciences as well.

ROSS-NAZZAL: Did you have to deal with any budgetary matters at that point?

DUNBAR: Yes, I did. Mr. [Daniel S.] Goldin had just come in as Administrator, and each time we repopulated a design, we had to decide how many of the racks, middeck experiments could

be accommodated, and actually the demand outstripped the supply. We would take the accommodations that were allowed, or being considered at that time, and we ran a payload model. We had all the physical requirements and characteristics of those models in a database, because our organization also integrated all the Spacelab flights, so we knew what it took to integrate, and we had it on a computer base and we'd run the model to see what it could accommodate, and there was always something left over. Then we came up with a cost, you know, "Here's the cost that came with it."

It was clear to me that contrary to a lot of public misconception and—I can't remember the name—is it Dr. Parks who said we never published anything in orbit. It was very clear that the Station was going to be well subscribed, but we were limiting the actual output we could do. So I ran another model that I wasn't asked to run; I ran an unbounded model, and what I did there is I took all the requirements and said, okay, if we did everything that everybody wanted to do and we funded the facility as a government, like a wind tunnel, what would this look like on a five-year budget. And I ran it out, and it was called the five-year unbounded budget model, and it was a billion-dollar budget.

I took that in to Mr. Goldin, because we'd had a discussion about, well, is there enough research to put on the station. I could say there's more than enough. And to show it, I ran the unbounded model and took it into him, and he could hardly believe it. He says, "Well, we can't afford a billion dollars."

I said, "Well, I know, but this is here to show you that if you go out to the research community, and those people, on their own, who would like to use this platform to do research, this is what it would take to do it."

ROSS-NAZZAL: Was there any discussion at that point about including international partners, especially based on your formula?

DUNBAR: The Space Station Freedom included our traditional partners, but it did not include the Russians. So we finished up our redesign in June of '93, and I presented to the Vest Committee our assessment of Options A, B, and C, how much volume, how much power was required, the microgravity levels and so forth. The Vest Committee took all that information in, wrote their report. Dr. [Charles M.] Vest was President of MIT [Massachusetts Institute of Technology, Cambridge, Massachusetts] at the time, and he was asked to do the independent review of not only the redesign, but of our assessment of the redesign.

Within about two months, Mr. Goldin and Mr. [Yuri] Koptev had signed their agreement, and then the Russians came on board after the redesign process was complete.

ROSS-NAZZAL: Before you went out to NASA Headquarters and you found out about these positions, what was your reaction about leaving JSC and going to Headquarters? Were you told it would be a temporary position, and you'd be back in the astronaut corps?

DUNBAR: I wasn't thinking about that. I was looking at myself as a good soldier; I do what I'm told. You always hope that you get to fly again, but you can't expect it. I was asked to come to Headquarters, and I said yes and I went.

ROSS-NAZZAL: What was it like working at Headquarters? Could you compare that with working at JSC?

DUNBAR: It was almost like being in a war mentality. [Laughs] It was an unusual time. I'd been up there post *Challenger* and that was an expected unusual time, you know; you're working after an accident, and I was one of about three astronauts working for Admiral [Richard H.] Truly at that time, kind of rotating up there. I'd sort of expected it to be a little more structured this time, but it wasn't, because we had a new Administrator; we were redesigning the Station; we had continual congressional committees to support. There was a new vote on the Space Station; we won by one vote. So we were doing a lot of work, seven days a week. I was living in Crystal City [Virginia], and I can recall not seeing daylight a lot. I mean, from my apartment I could go down, get into the subway, get out two blocks away from NASA Headquarters. That's the only time I was outdoors. Get in the building; work all day. It'd be dark when I got out. Go to the subway. Get up in my apartment. [Laughs] And did that for nearly a year, as I expect many people did.

ROSS-NAZZAL: When you found out that you were coming back to JSC, what was your reaction?

DUNBAR: Actually, I helped make that decision. It was almost a year. I knew there were a couple of things where I had to precipitate a decision. Your tax status changes once you're there longer than a year, and we had sort of everything up and running. We were transitioning the Station management back down to Johnson Space Center. Code U was up and running, and I was ready to come back. So I said, "It's probably time," and they said, "Okay." So I came back in I think it was December of '93.

ROSS-NAZZAL: Around that time Dave [David C.] Leestma approached you.

DUNBAR: Oh yes.

ROSS-NAZZAL: Can you tell us that story?

DUNBAR: Well, I came back. I thought, “Well, I’m going to get a breather and take a job in the Astronaut Office.” I was helping, actually, with Soyuz, because that was going to be part of the new Russian implementation. When I say “helping with it,” I started taking Russian. I was becoming interested and I started taking Russian. Then Dave Leestma called me in—I’m pretty sure it was December of ’93, and he said, “I need to have you do me a favor.”

I said, “What is it?”

He said, “Well, the Russians are insisting on having a backup for Norm [Norman E.] Thagard, and we don’t have one, and I’ve asked several people and they have refused. I need to have you go do this.” Well, Dave is a classmate of mine. He came in in ’80, and I think the world of him. He’s just a great person, and I couldn’t say no to Dave.

So I said, “Well, okay. I don’t mind being a backup. This will be a great opportunity from an engineering point of view to learn about the Russian systems,” but I did say, “I’ve been taking Russian, but I can’t speak it fluently.” He set up a meeting, I think it was either him independently and then Dr. [Carolyn L.] Huntoon, and Mr. [George W.S.] Abbey, and I said, “You know, I’ll be a backup, I’ll take as many notes as I can to understand their system more as an engineer,” because I didn’t expect to fly, “but I don’t know the language that well.”

They said, “Well, you can learn the language,” because I’d learned German for D-1, but I knew the experiments. I looked at the experiments Norm was training on. I’d trained in almost every one of them through my other flights, so that wasn’t going to be the hard part. So we said, “Great.”

I said, “Fine,” and I went to Russia.

ROSS-NAZZAL: I read in a '94 *Roundup* article that indicated Russian crews typically did not include women. When Dave Leestma told you this, did you have any sort of feelings of *déjà vu* of what happened in West Germany might happen also in Russia?

DUNBAR: No, I think, like a lot of Americans, I misinterpreted some of the Russian history. I thought, well, Valentina Tereshkova, first woman into space. Svetlana Savitskaya, first woman pilot in space and first to do a spacewalk. It wasn't till I got to Russia that I realized that those were first meant to beat the U.S. Women weren't really fully integrated into the cosmonaut corps.

ROSS-NAZZAL: So when you arrived, you simply thought things would operate as they did in the U.S.?

DUNBAR: Yes, I did. I did.

ROSS-NAZZAL: Can you talk about working in Russia and then compare it with working in West Germany and here in the United States?

DUNBAR: I don't want to simplify the comparisons. There's so many different facets in the mechanics as well as the culture, and sometimes you can't separate the two. Obviously the Germans do wonderful engineering. Going to MBB/ERNO and seeing the Spacelab, and they built SPAS [Shuttle Pallet Satellite], for which I'd been a payload officer. I remember going into the high bay area there and seeing maybe seven engineers, and all of them excellent craftsmen as well. It was an extremely well designed free flyer. We launched that on STS-7 and they took the first pictures of the Shuttle remotely. So they had excellent engineering, very precise, and to do that you have to sometimes be fairly rigid.

Culturally, though, in terms of things like sense of humor, I was closer to the Russians. I could tell a joke in Russian and have it be funny, and not always in German have it be funny. So we have a lot of links together, but there were some cultural differences.

On the other hand, the Russians have been very successful in space. Some of their approaches have been where you don't have to worry about the cost per pound; we call it a little bit of brick-and-mortar engineering. I mean, it was successful, but maybe way overdesigned, because they didn't know where the margins were. Just to give you an example, when we were looking over the Priroda vehicle before it was launched, before its outer meteoroid shielding had been put on, the wiring bundles, if there had been a piece of wiring with two connectors on it that was too long for the space, rather than giving the correct length, they actually tied up the center with tie-wraps, so you had this big knot there. They said they just got the cables in the standard length and they made them fit. You know, we wouldn't have done that; neither would the Germans, because it's a weight penalty, and there might be other things to it. So in some ways

there was a difference there that was attributable to their circumstances. So there were some different philosophies.

ROSS-NAZZAL: What about living in West Germany compared with living in Russia?

DUNBAR: Living in Russia at that time, the Russians will tell you, they were having a very difficult time in the transition to democracy, so the economy was extremely poor. Star City, when we showed up in February, there were no fresh vegetables on site. The Russian women who would talk to me, maybe because they felt a kinship there, told me how hard it was, since they were tasked with shopping. Whether they had a full-time job at the Center or not, they were tasked to—not on the Center so much; they had to go into Moscow—how hard it was to find fresh vegetables or other goods, and there weren't very many in the department stores. So Russia was undergoing a tremendously stressful period at the same time that we were starting this joint venture. So it was hard for a lot of people.

ROSS-NAZZAL: Where did you end up living in Russia?

DUNBAR: Lived in Star City in an apartment house. Dome Chiteri [phonetic], I think that's what we were in, or Dome D\_\_\_\_, I think it's House Four. It was an apartment house, and we did what the Russians did. On Saturday we had a driver. When Norm and I showed up, we were sort of restricted. See, the U.S. didn't pay for our training; it was part of the quid pro quo of the Russians flying on the Shuttle. So the Russians provided transportation into Moscow. Star City is outside the ring of Moscow, and if we went into the embassy, we had to use their car and their

driver. The first day we showed up, we were told that we had to tell them who we were going to visit. We thought, “No, this isn’t going to work especially if we go to the embassy.” [Laughs]

“No, we don’t need to report our every movement,” once we get out past the guard with the rifle, and it was a military base. But the driver was definitely there provided.

So we had to go in on Saturdays and buy our food, do whatever shopping we could do. Laundry was a challenge at first, because there were no dryers, so we hung everything on lines in the bathroom. We have life very nice here in the U.S., for the most part, although I grew up in those kinds of conditions, with an outhouse and so forth, but it was for them a struggling time, and we were part of the economy. Actually, though, we were better off than a lot of Russians, being at Star City. There were many people out in the rural areas there that were really struggling.

ROSS-NAZZAL: When you went out to do shopping and things like that, did people know that you were American astronauts?

DUNBAR: We had someone come up—not astronauts, but we had somebody come up and say, “Well, we could tell you’re American,” and we asked why, and, “Well, because your head’s up and you’re smiling.” I had several people tell me that. There’s a demeanor, a little bit of the cultural part of Russian is struggle, so everything is hard and a struggle and you’re supposed to personify that. At least this was back eleven years ago, and Americans were off sightseeing and smiling and waving at everybody. [Laughs]

ROSS-NAZZAL: How different was it living in Russia compared to living in West Germany?

DUNBAR: It was very different. I had my own apartment in Russia, because we were there continuously almost for a year. West Germany, we'd go for a few weeks at a time. The longest time was seven weeks, and we were living in a little hotel right off of DFVLR [Federal German Aerospace Research Establishment], owned by a family, a really nice little family. So it was a room with a TV. We ate in the little restaurant there. So it was a very different environment.

ROSS-NAZZAL: Can you talk a little bit about some of the training that you underwent in Russia when you first arrived?

DUNBAR: The training was very much like a university in a way. Norm and I were separated from the cosmonauts until three months before flight. It was just Norm and I in the classroom, and we had four hours of Russian language every day. I think it was four hours. We had technical classes, systems classes. We had physical exercise and yoga. We got a schedule every day; it was almost academic. Now we actually had some of the classes deleted because we already had them.

I finally had an instructor explain to me why it was structured that way. The first head of Star City was Yuri Gagarin, and the test pilots, our equivalent of the test pilots in the MiG pilots, or the Russian Air Force, military officers don't always go to college. It's not a requirement to become an officer, and yet their cosmonaut engineers, their board engineers were very often civilian and very often employed by [S.P. Korolev Rocket and Space Corporation] Energia. They were design engineers. They had graduated in engineering, very, very good, such as Sergei [K.] Krikalev. So the way that they brought them up to the same level, whether it be orbital

mechanics, star navigation or whatever, these were the kinds of courses they taught, they put them into almost an academic environment. So they put Norm and I in that, without realizing, I think, that we'd already had a lot of this material, just training for our prior flights. We were supposed to be there eighteen months, and our training team was able to waive a lot of those academic requirements, and so we were only there a year, a little over a year.

ROSS-NAZZAL: When you were in Russia, what were some of the challenges that you encountered during training, or just life in general over there?

DUNBAR: I always find challenges fun. I like adventure. There were some things that were just interesting and fun and you liked to get through them, because you feel proud about it. Getting through water survival in Lake V\_\_\_\_, when it's freezing; but also getting out on the lake and realizing that you're in the Soyuz, and the Soyuz is rocking not because the water's rocking, but because some of the Russian kids on the bank of the lake have taken a rowboat out and climbed onboard your capsule and are rocking it back and forth. [Laughs] Or the helicopters picking you up out of the water and taking you to shore. It's really rustic, and it's not a military base, so all the village kids are under the helicopter while the helicopter is trying to land, and the Special Forces are chasing them away, and it's freezing cold, you're wet; you're in the van, and they've just asked if you'd like to get warmer, and so you think they're going to turn the heater on, but instead they bring you a large goblet full of vodka. [Laughs] So there are some differences, I think, culturally, but they're not things that deter you or depress you. It's, "This is interesting."

The only time I maybe was not as patient in terms of tolerance was trying to readdress some of the attitudes about being a woman there, because they weren't as reluctant in reminding

me that women weren't as qualified. I had that said to me several times. Even though the U.S. had sent me there, I found myself in the position of defending our presence, or my position there, to their flight doctors as well.

ROSS-NAZZAL: What was the reaction when you would tell them that you were sent here by the U.S.?

DUNBAR: To ask them questions in return and maybe to challenge the assumptions based on medical data and fact or maybe on culture, and I had a lot of support from the Russian women there who were mathematicians and engineers. You didn't always see them, they were behind the doors, but they were my best friends and they initiated it. They really wanted to, as they told me, personally see me succeed, because they had felt that they weren't always successful in succeeding. There were a lot of engineers who were women in Russia, but they don't get promoted to the top positions, and it's kind of sad. They're a big part of Star City, but they're behind the closed doors.

So it wasn't a big part of my experience there, but it was the only component, or the major component of those things that weren't quite as fun. Because at that point in your life, you know, I was in my mid-forties. I'm there to do a job, and I'm there to do it well. I'm there to represent my country. I'm not there to defend the position of women for the world, you know. You'd like to get past that. So, in part, my response was just doing the best job I could; demonstrating that I had the capability to do it and try to defuse the discussion.

ROSS-NAZZAL: Let's stop and take a break here for a second.

[Tape change]

ROSS-NAZZAL: What type of support did the Astronaut Office provide for you as you were in Russia at that point?

DUNBAR: Well, it was an interesting time. When I arrived at the airport in Moscow, Ken [Kenneth D.] Cameron was our DOR, operations rep, over there, and he came with Norm and I. I think he received a call. I don't know the exact procedure, but he received a call that said that we no longer worked for the Astronaut Office; that we reported to the Program Manager, Randy Brinkley. And we said, oh, well, that was new, that had never been briefed to us. It didn't seem to make a big difference, but when we finally got into our apartments and our shipment hadn't arrived, didn't have clothes, didn't know where to get food, except drive into the embassy, all kinds of things, and we wanted to get help, we had to go through the Program Office.

So when we got into the apartments and we didn't have, for example, a dryer, and it's the middle of winter, and we didn't know how we were going to dry our clothes. Then for the first three weeks I had no heat. I called the Astronaut Office; they weren't sure how to help us. The first response we got from the Station Program was, "Well, you have to live like the Russians. They're paying for everything; we aren't." And the Russians in our apartment all had dryers. They had very nice apartments. These were Russian cosmonauts, they all had western stuff, and people, I think, assumed that they were hand-to-mouth, and that's not true at all. It took several weeks, you know, both of us explaining that we're trying to study, we're trying to learn Russian, hanging up our clothes all over the apartment and not having them dry, and not having our

shipment with irons and ironing boards and the rest of our clothes and any personal items at all, was an overhead on our training that was starting to erode our study capabilities.

On the other hand, Ken and I and Norm, being just the three of us, were having really great parties on Saturday night. [Laughs] Ken didn't even have a washer or dryer. What he would do, see, either Norm or I would host a little party, and I think Ken figured out how to get some margarita mix someplace, and we'd watch—I think we had a TV with a video player, and we did have some movies. We'd watch a movie, cook popcorn, and have margaritas.

Then Norm's washer vibrated; it was one of these little European ones. We were watching a movie one night, and it went into the spin cycle and started walking across—it was in the bathroom; there was no separate laundry, so this washer started walking across the bathroom. We thought it was pretty funny. We were kind of watching it, and then it hit Norm's sink and dislodged the sink from the wall. Then it wasn't funny anymore. [Laughs] But that was our entertainment for several weeks.

But that was interesting, that organizational startup situation, not knowing who you worked for, but we managed. The social highlight of the week for me, actually, was going into the embassy on Saturday mornings, being able to buy a newspaper, because I had no news and no TV. Well, they did hook up a Russian TV. I think we had one channel. When you get over there, there's a big culture shock. So the phone was very difficult to hear. Couldn't get out, because you couldn't call long distance. Wasn't getting any phone calls.

They brought in a satellite computer link and it was sort of a—I don't remember what you call it. It'd dump all the e-mail, so you didn't have a live link with anybody, and then you'd go through the e-mail. My dish was the only one that had a clear view, either not being jammed or having a building obstruct it, because Ken's wasn't always working from where he was. I

don't know that Norm was using his, but I had played with mine a little bit in terms of signal strength and optimizing it in direction. My window faced the perimeter of the complex there, and I knew where the satellite was. It was, I think, over Norway, so I pointed it and got a good signal strength. So I was actually for a while doing e-mail for a lot of different folks. Even the U.S. trainers that came over, I could usually get their computer hooked up.

ROSS-NAZZAL: You mentioned the embassy a few times. What sort of services did the embassy provide you while you were over there?

DUNBAR: Well, Moscow has a U.S. Embassy complex for the people there, which means that they have a little commissary; we called it the 7/11. You could order meat, too. I ordered a turkey for Thanksgiving. You have to order it lots of weeks ahead. Then you actually had Americans there that you could visit with. So on a Saturday morning, for example, I would go in and they had a little deli there, order some food, sit down, read a U.S. newspaper, talk with people, see what was on the news, just catch up with everything, and it was kind of little touch to home, and then go back in the afternoon. Do a little shopping as well.

ROSS-NAZZAL: What did you learn from your first flight that helped you while you were in Russia?

DUNBAR: My first flight was a process of both learning the German culture and the German systems, as well as ours; it was my first training flow. So out of that, I took both those experiences with me to Russia. We have a process that works. We were trying to integrate

another country with that. You know to what extent you can compromise and actually perhaps be in a position to do that, and what places you can't. So that's experience, I guess—that's a good word for it—and a competence of knowing what you know and don't know. It was a learning process, I think, that helped in Russia.

Actually, it was kind of funny when I first got there and met my first Russian flight surgeon, and I was still learning Russian, obviously. He didn't know any English, but we both knew German, so the first walk we took, we were talking in German.

ROSS-NAZZAL: So do you still keep up both languages, German and Russian?

DUNBAR: No, because you don't have an opportunity to, but it's funny where that's stored in your brain. Every once in a while something will come up and you'll want to speak Russian and you're speaking German. It's interesting. Or all of a sudden I'll have some thoughts in Russian, or I'll see something and all the German words will come up. I'd love to have the opportunity to keep up with it, but I don't.

ROSS-NAZZAL: What was the thing that you missed most about the U.S. when you were over in Russia?

DUNBAR: Family and friends. The things that are always close to you in regard to relationships, I think, are what you miss the most. My husband, of course, was still over here as well, and the phone communication was very poor. We had no mail, so that made it difficult.

ROSS-NAZZAL: So how did you stay in contact? Just e-mails, is that how you stayed in contact?

DUNBAR: When the e-mail system got up, then that was primarily how we did it.

ROSS-NAZZAL: Were you able to see a Soyuz launch while you were over there in Russia?

DUNBAR: No. We didn't go to Baikonur [Cosmodrome] until actually we went down for what we would call our launch countdown test. We went down several weeks before launch to do the fit check in the Soyuz to see whether or not—they do custom-made seats called I\_\_\_\_. The guy who actually carved my seat was the same old gentleman that carved Yuri Gagarin's seat. You get into a shell and they pour plaster of Paris around you as you're on your back, and let it sort of harden, mostly. You're actually wearing a kind of a body suit. Get out of it, and then he carves out a tolerance level for your pressure suit, and you keep fitting it, and then that shell goes into a metal cradle well in your launch and entry suit. Well, you have to check all that out before launch; make sure you're knees clear the instrument panel in front of you. That was the first time I'd even seen a Soyuz, the first time I'd ever been down to Baikonur. So that would have been in the early part of '95.

ROSS-NAZZAL: I wanted to ask you about the book, *Dragonfly*, in '98 that book came out. What were your thoughts about that book when it first came out?

DUNBAR: I don't, quite frankly, think very much about the author. He contacted the Astronaut Office and set up an interview under a façade. He said he was interviewing for a New York

magazine, and he set it up through Lucy Lytwynsky and would I talk to him about my flights. So I showed up, and he asked one question and then he said something to the effect, he says, "Well, do you know that Dr. Norm Thagard says this and this and this about you?" All very negative.

And I said, "I'm sorry, but I'm not going to engage anything negative, and I'm certainly not going to reply to that." And he kept pressing me. He was actually very rude. I said, "You know, I signed up for an interview with *Vanity Fair* to talk about the space program and all the great things that we're doing, and it sounds like you want to do some sort of tabloid negative article, and I'm not interested." So I terminated the interview. I didn't know what he was writing about.

I then later found out he'd actually written a kind of people called a "tell all" book on Wall Street or something like that. Then he came out with this book. Then I read it and it was clearly a little bit of truth, a framework of truth, filled in with fabricated events and conversations. A couple of people I know extremely well. I know it didn't characterize me and a couple I know extremely well. I know didn't characterize them or the conversations. So it was really kind of amusing.

My family read it. I told them about the book, and my sister was so angry that she told me later that when she went through the airports and it was displayed, she'd turn it around so nobody could read the cover. I said, "I don't know if that might be illegal or something."

She said, "I don't care. I don't want anybody buying it."

ROSS-NAZZAL: Isn't that nice of her? Did other people in the Astronaut Office feel the same way?

DUNBAR: Well, yes, a lot of people. Actually, when I read it, I went to the chief of the office and I said, “Look, just so you know, these things didn’t happen. I didn’t say these things. I don’t know about all the other people, but I know that didn’t happen.” I had understood that this guy had spent a lot of time with Frank [L.] Culbertson [Jr.], and I think Frank—I’m told that he felt that he also didn’t characterize that as well.

So I think you have to be careful. It’s too bad he didn’t capture the real program. Everything in life is going to have some challenges. There’s always going to be a little negative stuff. You have to capture it so you can learn from it, but it is not the flavor of the experience, and what he was trying to do is paint a very negative experience on something that I think was very beneficial to our programs.

ROSS-NAZZAL: When you returned from Russia, what were you working on, or did you then start training for your next mission?

DUNBAR: I immediately started training for STS-71. I had three months before launch. Fortunately, we were flying a Spacelab. It was my third Spacelab flight, and so I understood the systems. The experiments were either the same as what we had on Mir, because we were putting Norm and the two cosmonauts into the Spacelab and doing medical tests on them, or they were experiments I had done before. So it was actually very easy to train for it. I felt very comfortable slipping into the crew. “Hoot” [Robert L.] Gibson was the commander. He made that very easy. It was fun to work with Greg [Gregory J.] Harbaugh, so it was a good group. And Ellen [S. Baker]. Of course, we flew my two backup crewmembers, Anatoly [Solovyev]

and Nikolai [Budarin], up with us. So it gave me the opportunity to help train them into our program, and that was a lot of fun, although I was very reluctant to leave them alone when we undocked. I would have liked to have stayed on the Mir.

ROSS-NAZZAL: I can imagine. Can you talk about that training and training those two crewmembers here in the U.S.?

DUNBAR: Of course, our trainers trained them, but one of the things I did do was to try to help translate what we had trained together in Russia and the equivalent in the U.S., because translations are never exact, especially in technical terms. So I'd be listening to our trainer and their translator, and they wouldn't always get a translator that knew the technical words, so I would then help with the Russian equivalent, and then you'd say, "Oh, yeah, okay. Now I understand." Because physics is physics, chemistry is chemistry, and the laws operate in both languages. So once you got a concept across, that made a big difference.

ROSS-NAZZAL: What was the press interest like in this mission, since it was the first mission for the program?

DUNBAR: I can't tell you, because in Russia I never saw the U.S. press, and I came back and was so busy training, I think other people on the outside are a better judge. I don't know. Did it get a lot of attention? It was the first docking mission between the two. I hope it did, but I don't know.

ROSS-NAZZAL: Give us a sense of the historic precedent of this mission, from your perspective.

DUNBAR: From my perspective, it was the first docking between Russia and the U.S. since Apollo-Soyuz [Test Project]. Apollo-Soyuz, I think we all hoped that that would have been a thawing in the Cold War. It was a great experience, but it didn't thaw, not to the extent that we would have liked. But now, this mission was called Phase 1A, which meant it was a phase leading into International Space Station, but there was a Phase 1A and then a 1B. OneA, the Russians trained us at their cost in Russia, and we trained the cosmonaut, Sergei Krikalev, at our cost in the U.S., so it was kind of a trade. And Phase 1B, then the U.S. trained to fly a number of Americans on the Mir, and built facilities, housing facilities, to provide infrastructure there at Star City.

ROSS-NAZZAL: You mentioned Apollo-Soyuz. Was that still prominent in the memories of the Russians when you went over there?

DUNBAR: Yes, because the medical facility there, or the quarantine facility, we'd actually built. The "Prophy" it was called, Prophylactoria, which is a medical isolation facility. So some of the older people there, there are actually quite a few, remember Apollo-Soyuz.

ROSS-NAZZAL: Can you talk about the launch of this flight? We talked about your first launch, but what are your memories of the launch of this flight?

DUNBAR: We all went down together in a plane out of Sh\_\_\_\_ Field, which is near the Star City complex, so Norm and I and our crews and the flight docs [doctors] and a lot of the trainers and the head of the Center, we went into quarantine facilities there. We had training for several days. They don't officially announce who's the prime crew until the day before flight, in which they have what's called the grand commisia [phonetic], a grand commission. It's a big press conference thing. I mean, we all we knew, but it's an official event. They announce the prime crew and then Nikolai and Anatoly and I were backup crew.

The morning of launch, we actually all went to the launch site, got up very early; it's dark. As the dawn's coming up, we're out in the middle of a desert there in Baikonur. You can see camels and so forth. We make a perfunctionary stop that's tradition going back to Yuri Gagarin; that's where Yuri got out and went to the bathroom, so they all get out. It's tradition.

[Laughs]

Then we get back in the van, we go to the launch site. And what's amazing to me is that this is a fully fueled rocket; the gases are coming off of it, and it's surrounded by people. Then Norm and his two crewmembers get off and there's another ceremony there beside the vehicle and then they go up the gantry, get in. Then those of us in the backup crew got back in the van and went to the waiting area. They don't have the same kind of large crews or large viewing area and so forth as we do, but they have kind of a bunker where a lot of the senior people go down in, and there's a TV and they're eating and drinking and waiting. No countdown clock then. We all watched our watches, and then about two minutes before launch, went out on the top of this bunker and watched the launch, and then they were gone. It was a very cold day, I remember that.

ROSS-NAZZAL: What were your thoughts as the rocket took off?

DUNBAR: I thought it was great. After you've trained on the Soyuz, the systems and the simulators, I would have loved to have taken a ride on it.

ROSS-NAZZAL: What about that Space Shuttle launch for STS-71?

DUNBAR: Another great launch and a mission. The rendezvous was—I was sitting on the pilot's seat, talking to the crew, and helping integrate the time line. It's sort of my function on that part of it while Hoot flew. We all had jobs to do, docking adaptor. Greg was working a laser range finder, so there were lots of things going on. It was very intense, because it was our first docking mission. It was exciting. I like watching the movie—because everybody else got to look in the overhead window. I'm sitting there watching the displays and the flight plan. I have to be in the pilot's seat because that's where we had the radio, the ham radio transmitter, because we're talking to the Mir on VHF [Very High Frequency] via that way. I'm not looking out the window. The picture of that, of the docking, with the Mir against the Earth was just really quite spectacular. So it was like watching *2001: A Space Odyssey*, except it wasn't a spinning space station.

ROSS-NAZZAL: What was the reaction when you finally docked with Mir?

DUNBAR: Well, there's no large whoop and yell on the flight deck. It's a point in the flight plan, and you go, "Okay, check, check, check," and then, "Mission control, docking complete. Next

step.” So maybe they might have been cheering with relief in mission control, but we’re just thinking we’re not done yet, you know. “Boy, the next five minutes, I’ve got to get the middeck hatch open, our airlock hatch open. I’ve got to get down the tunnel. I’ve got to get the camera deployed, because when they open the hatch on their side, I’ve got to have cameras and microphones down there. There’s going to be a big press event that happens at this time.” We’re all sitting there going, “We’ve each got our job and we’ve got to make sure we don’t miss that window.” Now we’re conscious that there’s going to be a big event. It’s going to be broadcast in both the U.S. and Russia, so we’ve got to get the cameras in place, because we’ve got ground coverage in both countries, communication coverage we have to worry about, and that’s a flight plan. PAO [Public Affairs Office] will kill you if you miss that one. [Laughs]

Plus all the other stuff; are the systems in place and so forth. Of course, they’re doing the same thing on their end. We have to equalize pressure, even though we’re nominally at 14.7 psi, or 760 millimeter, 1 atmosphere, there’s always a delta-p, a difference in pressure. So we had to open the relief valves to make sure the pressure was equalized, and then we could open the hatch. Then of course there’s a little window in the hatch so you could see the crew on the other side, and you open the hatch. We sort of went over to the Mir side, dragging our camera and mikes [microphones] with us, and the ceremony on that side and an exchange of gifts and so forth.

ROSS-NAZZAL: What sort of gifts did you exchange?

DUNBAR: I didn't bring any; it's what they packed for us. I think it was fruit and chocolates, but I don't remember. You sort of find out when you're there, because maybe Ellen was in charge of gifts. "Oh what did they pack?" "Oh, I think we're giving them chocolates and fruit."

ROSS-NAZZAL: So what was the ceremony like? Was it something that was preplanned, pre-scripted?

DUNBAR: Just the time-lining part of it and the exchange. All the crews there around the Mir dining room table, and we make sure the cameras are set up and so forth. We get the "go" from Houston that everything's enabled. Then the commanders each say something and they shake hands and we all shake hands. Then there's an end to that, and everybody's on the watch at that end, we have to do exchange, you had to get experiments back and forth, we have to get stowage, supplies back and forth, and it all has to be done before the next big milestone, which, on that flight, I think we went to bed at different times, so mealtime, so we had to get back on the flight plan, so it was very much choreographed.

ROSS-NAZZAL: What did you do after these ceremonies?

DUNBAR: Research and transfers, we call it, and handovers on the crew. Actually the old crew starts handing over to the new crew, so we actually kind of separated into different groups. You've got the Russian cosmonauts doing their handover, getting Norm off and into the Spacelab, actually, because Ellen and I started doing the medical exams on the two cosmonauts

and Norm, and that was on the flight plan, and there were other things that they had to get done, so it was a combination of a lot of different things over those dock days.

ROSS-NAZZAL: Can you talk to us a little bit about those medical exams and what sort of things that you did?

DUNBAR: We looked at exercise physiology, for one thing. We had a bicycle ergometer there and a gas-exchange system; you put a tube in your mouth. It's just like taking a treadmill test here on the ground. Then looking at the efficiency of your body. You do have degradation over time. This was a ninety-day duration that they had, so how much does their cardiovascular system degrade? And you want to get those measurements before they get down on the ground and start to reacclimate.

Dr. Mek [phonetic] had a device that went around the neck and looked at the carotid artery pressures and, again, is looking at how well your vascular system responds when it's been in weightlessness all the time. The question is, when you get into 1-G and the blood starts pooling down into your feet, does your venous and arterial system constrict down your legs and keep the blood up at the head? It turns out it kind of forgets if it doesn't do that over time; it's either use it or lose it. So we need to be able to characterize that in order to counteract it, particularly for Shuttle flights, with crew coming back sitting up after a long period of time.

We did finger sticks; did blood chemistry; lower-body negative-pressure device, looking at how efficient it was to do a slightly negative pressure pull on the body, bringing fluids back into the lower legs so you could rehydrate; doing echocardiograms, imaging the heart and looking at each of the volumes of the heart.

ROSS-NAZZAL: How much time would you say that you spent doing these medical exams on each person?

DUNBAR: Once we were docked and started it, it was full-day operations, then that's what I did most of the day. They weren't all three in there at a time because there were still handover activities going on on Mir, so we had the old crew and Norm in there most of the time.

ROSS-NAZZAL: What else did you do while you were on this mission?

DUNBAR: I think I've characterized operating the medical research. Of course, during docking and undocking, working the VHF radio, the integrated flight plan, monitoring some of the systems on the displays. I'd have to look at the flight plan to see what else I did.

ROSS-NAZZAL: What are your memories of Mir? Maybe you could describe it for us.

DUNBAR: I will never forget the first time we opened the hatch. It smelled like a well-used Russian kitchen; I could smell all the food coming in. Then I also smelled mildew, because they'd had a problem with airflow and stagnation, and in the cold parts of the station they'd had condensate develop, and it had been seeping into some of their thermal blankets, and actually they had been developing a mildew. So I was very sensitive to that smell, because I grew up in the Northwest, where I'd never smelled it. The first time I ever smelled it was coming into [William P.] Hobby Airport [Houston, Texas], and I remember saying, "What is that smell?" and

it imprinted on my brain. So when we opened the hatch to Mir, I said, “That is mildew. I know that smell.” And sure enough, where we docked, and through that module, which would have been—was maybe Kvant—I’ll have to think about which one it is—as we floated through, and we had to pull ourselves on a line they had strung, there were some damp blankets that you could feel. And there was a window there that you could actually see some of the water condensing on.

ROSS-NAZZAL: You were also up there during Fourth of July again. Do you remember celebrating the Fourth of July?

DUNBAR: No, I don’t. Maybe we didn’t make a big deal of it because we were docked with the Russians at that time. I’m sure there was something we did, but it may have just been so busy and came and went, that I don’t recall.

ROSS-NAZZAL: What are your memories of closing up that hatch and your feelings at that point?

DUNBAR: We were joking about it. I remember that the Russians were talking—I have to think real hard about this—and I took Anatoly and Nikolai over some tortillas. They liked American food, and we had a lot of food left over and we were trying to find stowage volume for foam that we were bringing back, that had been in the Spektr module, where we’d had experiments, and we couldn’t jettison it overboard. So we were trying to find places for this foam, and we had extra food; we’d left it with them. I remember finding some tortillas, which Anatoly really liked, some of the great big soft Mexican tortillas. I took it over to him, so I was on the Mir side and

we were getting close to hatch-closing. We'd already enabled the Russians, I was on the headset where I could hear both, and someone from the ground asked—I guess they saw me on camera—asked me which side of the hatch was I going to stay on, and I said, “Oh, I think I'll stay on the Mir side.” Of course, they knew I was joking. [Laughs] I said, “Unfortunately, I'm going to be going to the U.S. side.” So I shook hands with them, and we closed the hatch and started the separation operations.

ROSS-NAZZAL: Do you recall what you spent some of your free time doing with the various crews?

DUNBAR: Before flight or during flight?

ROSS-NAZZAL: Before or during flight.

DUNBAR: Mostly it's before flight. When we were back in the U.S., getting ready to launch 71, we had a number of joint dinners and barbecues and that kind of thing. We did a lot of entertaining for Anatoly and Nikolai and their families so that they would feel comfortable; Nikolai in particular. He was a flight engineer, an engineer from Energia, had trained for seven years, and his first flight is going to be in a U.S. vehicle. His first trip to America is to come to the launch site, with his family, and in Russia wives aren't allowed to go to launches, so this is a big cultural change. They consider it bad luck to have spouses at the launch site.

So there were a lot of things. We were trying to also reassure the spouses, too, about what the launch was going to be like. The spouses of the U.S. crew was trying to bond with

them; they were all going to be together. So there's a lot of training, but there's also a lot of collective social activity as you get ready to go do that. I've always looked at that as one of the best things that I got out of this experience, was five flights and five families. I have my own blood family, but you can't come home from a flight like that without having really bonded with one, two, or the whole crew. There's just some shared experiences that are really unique that no one else has, whether it's something that happened on the mission—I mean, good, you know, something you can share there, or the whole flight, or something maybe three or four of you saw from the flight deck on the Earth and you say, "Oh, look at that! A volcano going off. Isn't that fantastic," or, "Look at those coral reefs," or, "Look at the southern lights." There's just something there. You've gone through the training flow together, you have the hard times and the good times, the twenty-hour days, or it seems like it.

ROSS-NAZZAL: Did you have any PR [public relations] tours after this flight?

DUNBAR: We all do, yes, do it as a crew and you do it as an individual. We're always invited back to our home states, and I always went back to Washington state to talk about the flights.

ROSS-NAZZAL: Did you do any PR in Russia after this flight?

DUNBAR: We went back, of course, and we did some debriefing, but they don't do the kind of post-flight tours we do, or like the Germans did. We did a German post-flight tour with the whole crew that was quite remarkable, and saw a lot of Germany, but it wasn't quite the same in Russia.

ROSS-NAZZAL: I also noticed, when I was looking through some of the materials, that you took up a Houston Rockets guard uniform.

DUNBAR: Oh yes. Anatoly loved basketball. I wasn't part of this; it was arranged by some other folks on the crew, but I think they were getting ready to reveal their new uniform logo, and so they gave Anatoly the opportunity to wear the shirt.

ROSS-NAZZAL: How neat. We have about twenty more minutes left, so do you want to talk about your work with the Mission Operations Directorate [MOD] in '95, when you were working as an Assistant Director?

DUNBAR: Yes. I came off of STS-71 in '95, and then I started working on I think it was the Soyuz TM development. We flew in what was called a Soyuz T, or that's what I trained in, and the U.S. part of Phase 1 and on to Station was investing in some modifications to Soyuz, some upgrades on the displays and sizing and so forth. So because I had trained on Soyuz, I was asked to be part of that group. I was working on that into the fall, and then I received a call from Jim [D.] Shannon, who was Deputy Director of MOD. Jim had actually been one of my early bosses when I was a payload officer in MOD. He asked if I'd come over and help them, kind of help coordinate the training for ISS, "Look at what we're doing, run a board, do a gap analysis and see how we could do things better."

And I said, "Sounds like a great opportunity to me." So I became Assistant Director in MOD, and was there until early '97.

ROSS-NAZZAL: What sort of recommendations did you make?

DUNBAR: A lot of them. Up until that point, there wasn't a place where everyone working on training could come to talk about their problems and their issues and look at integrated schedules. So we set up a board and we set up presentations, and the value of these kind of initial boards—and it was a funny program, so we didn't own all the costs. We were delivering training to Station. In some cases we had almost like a reimbursable agreement where they would pay for it. In some cases we had institutional costs, but it was apparent that we didn't have everything tied together.

So this initial board, which was called the Training Readiness Review Board, the TRR, it's not a control board, although Jim told me that I could obligate cost schedule, but it was very clear in the beginning what we needed was a venue where people could actually just come in and discuss it and talk about it and identify the problems and come up with a strategy to solve them. So based on my training flows and so forth, we came up with some initial agendas. We said, okay, how are we going to train EVA [Extravehicular Activity]? Do we have the facilities? What's the schedule? What about the robotic arm? Do people have issues? Of course, by that time, all the issues were coming out of the woodwork, so it wasn't hard to come up with an agenda. What was hard was figuring out how to phase them from week to week to make sure that we could, in a timely manner, respond to the issues that needed to be worked.

So it was like risk management in a way. We were sort of a risk management board. Come in, just for people to even put the presentation together, helped to clarify the issues. They made their presentation. We would have a roomful of people and a board, and I had a kind of a

semi-co-chair, Frank [Francis E.] Hughes over in training; sat with me. He owned the budget and he was in charge of training for MOD for the crews. We would agree on the issue, and if there needed to be some implementation on Frank's part, then he would do that. That's what we did. Then I would also report back to Jim where I thought some of the activities might be directed, where shall we put our resources.

One of the things I remember about the job, feeling particularly proud about, was, when you're doing a TRR, you don't always have an end product because you don't own anything; you're a facilitator. So it was nice to have one thing I could call my own after this rotation, and that was actually the science control room over in mission control. We had two control rooms in the old mission control. We were in the process of certifying the new control center, with the fiber optics and so forth, but we had two old Apollo-era control rooms that had taken us through most of the Shuttle flights. We were going to take one of those control rooms, and that was going to be a national historical site, preserve it.

What to do with the other one? Well, we knew that there were some challenges in maintaining a control room for our Spacelab folks over in Building 36. Also, nobody knew who the researchers were. We put them in this windowless room. We did the research on the vehicle and we were getting ready to do it on the Station, and we had cameras in mission control showing all of the flight controllers, but what about all the researchers and the university students and so forth? So Jim and I talked about it and said, well, let's take that other control room and we'll make that a Science Support Center, and that's what it is now.

There's one thing that isn't there that was kind of my hope, and that was we had cameras in there. It was my hope that when in the middle of the mission, and PAO is rotating among cameras to send out to the public through NASA Select, that they'd sometimes show the

researchers and the students and the people that are excited about the work that's coming down to the ground. But unfortunately, we had some budget cuts and I think the cameras were taken out, so we lost that capability. But we still have roving cameras, so I'm hopeful when we start up again that we'll be able to show the people that are actually generating the research that we put on Station.

ROSS-NAZZAL: While you were working with Frank Hughes, what were some of the key issues that you were looking at?

DUNBAR: You're looking at content, what needs to be done, and who owns it, who does the training for what. You're looking at facilities. It was very clear that we didn't have enough funding in some of our facilities and that some of the facilities were not aligned with the operational schedules. We had to agree on where the training was going to occur. Remember, now we had this Station that was spread—components spread all over the globe, and every country wanted to do the training in their country, for good reasons. You understand. If I'm going to build a billion-dollar Japanese research module, I want all the crew in my country for a while, not only because it's cheaper for me to train there, but I need the visibility for the political buy-in and the public buy-in as well. Well, when you add it up, the time it took to go through all those countries, Canada for the arm, Europe for their space—Columbus, and Japan, and Russia, and I'm forgetting someone—

ROSS-NAZZAL: Brazil?

DUNBAR: Brazil. I was going to say Brazil for the pallet, maybe, but it's not there. The training flow was enormous, and all the researchers. So we had to really sit down and talk about what's a reasonable training length. How do we facilitate that? Can we use tools? You obviously want to do some of the training in-country, but can we use other tools, such as the laptops we eventually deployed that allowed you to do training, CBT, computer-based training, which was a new concept at that time; slip a CD [compact disc] in and train on the plane. Those were the kinds of things we talked about.

So there were all those challenges out there to make it do the right job, meet the objectives, be cost-effective, but also we were very cognizant of the fact that astronauts have families and you cannot deploy them for three continuous years. You need a psychological support group, which kind of went along—we didn't own that, but that was part of training. How did you make this a reasonable thing?

ROSS-NAZZAL: Is there anything else you would like to discuss today? We have about ten minutes, but I hate to start talking about your next mission.

DUNBAR: I think STS-71 was a wonderful demonstration, maybe like Apollo-Soyuz, about the engineering discipline that went into making that a success. Remember the Shuttle had never even made it to Mir, to test. We were able to dock the first time, and while a lot of that is due to the piloting skills of Hoot Gibson, a lot of it is due to the engineering and operational support on the ground. There's just no doubt about it. Without the discipline and the exactness and the capabilities of that team, it wouldn't happen, and it won't happen in the future unless you have that in place as well. From that point of view, it was a big event.

ROSS-NAZZAL: We thank you for taking time out of your busy schedule to meet with us today.

DUNBAR: You're welcome. Thank you.

[End of interview]