# NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
# ORAL HISTORY 2 TRANSCRIPT

BONNIE J. DUNBAR
INTERVIEWED BY JENNIFER ROSS-NAZZAL
HOUSTON, TEXAS – 20 JANUARY 2005

ROSS-NAZZAL: Today is January 20th, 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 for joining us again today. We really appreciate it.

DUNBAR: Thank you.

ROSS-NAZZAL: I'd like to begin by talking about your first mission, which we had started talking about previously. I'm wondering if you can talk to us about that launch day, if you could sort of walk us through that day from your perspective.

DUNBAR: Well, let's see. What I do remember? Of course, being in October, it was very nice at the Cape [Canaveral, Florida]. We called it "banker's hours," because we launched, I think, about twelve noon. It was two shift operations, but it was banker for me, because I was on what was called the blue shift, so I had the best day. I got up at eight, lunched at noon, worked into my evening, went to bed at a normal time, and proceeded on. Of course, the red shift had to go to bed immediately after launch, and then we went twenty-four hours.

But it was actually a picture-perfect countdown and launch, and considering that that launch date, I think, had been set about nine months before launch, was quite nice and especially good for the Germans as well, since they bought and paid for that flight.

ROSS-NAZZAL: Do you remember what was going on as you were getting ready to launch? What were you talking about in the crew cabin in those first few minutes before you got into orbit?

DUNBAR: It's pretty standard. It doesn't change. There's a timeline from the time you get up, have breakfast, to go in and check out your emergency systems. Of course, we didn't have launch and entry suits on that first flight in '85, and I was on *Challenger* then. We had blue flight suits, and we had the helmets, and we did a helmet pressure check. Then you go out to the van. You proceed to the launch site. You start ingressing the vehicle. You get hooked up to your air, the seat belts, and everything else that goes with it, the harnesses.

Then the countdown clock proceeds. There's a little bit of banter, but not deep conversation. We're listening on our headsets to the Launch Control Center first before launch. We know what's supposed to be coming. We've got the timeline in our checklist.

Of course, on that flight, we had eight up and eight down. We had five NASA crew members and three payload specialists, one from Holland and the other two from Germany. So there were actually four on the middeck, and so that made it kind of busy, but very comfortable. It wasn't that crowded at all. Then time went down to zero, and we launched.

ROSS-NAZZAL: Any special memories from that first day, given the fact that you had wanted—

DUNBAR: Well, I was on the flight deck for launch, and what I remember—Jim [James F.] Buchli was MS [Mission Specialist]-2, or the center seat engineer—is that when the main engines quit and just as we were getting ready for the external tank separation, and because he had flown before, in order to demonstrate to me that it was now zero gravity, he put a pencil in front of me, and then he let go, and, of course, it's just floating there.

Then my next step was to fold up my seat, because we had Spacelab. We had a seven-day Spacelaboratory flight, microgravity research, all from Europe pretty much. We had a couple of MIT [Massachusetts Institute of Technology, Cambridge, Massachusetts] experiments in there—covering all disciplines, human health to fluid physics, even protein crystal growth on that flight. We had a glovebox. We had frogs. We had a little centrifuge that we were looking at the development of embryonic frogs as well, so about a hundred different experiments. So we had to activate the laboratory, and I was Spacelab activator, but it was my first flight as well, so I was moving very slowly.

I thought, "If I can fold the seat up and get it down, take it down to the flight deck, do it slowly, methodically, and not provoke my vestibular system, then I'll probably be okay for the rest of the flight." So I started very slowly, and then I felt fine. I gained a little more confidence, and I said, "This is going to be great." Didn't have any symptoms. Got that stuff stowed away. We got on the checklist of the flight plan and started activating, and everything else went like clockwork the rest of the flight.

ROSS-NAZZAL: Can you tell us what it was like working those two shifts? Well, you were on one shift, but there were two shifts for the whole flight. What was that like?

DUNBAR: First of all, when you have four people spread across two shifts, it's really two and a half shifts, because Wubbo [J.] Ockels kind of had a bridge function. Since it was a German flight, they determined who they wanted to do what. But Wubbo actually, I think, started on one shift, went to another shift. But, in any case, you've got at least three people sleeping while the rest are working, and it was very roomy. Either Hank [Henry W.] Hartsfield [Jr.] or Steve [Steven R.] Nagel were on the flight deck, in general, but if only one was on the flight deck, because they were in opposite shifts, and everybody else was back in the lab [laboratory], they got a little lonely. They had a whole flight deck to themselves; their crew members were asleep down on the middeck.

So what I remember is it being very roomy, very comfortable, really very rewarding to be able to do the research on orbit and communicate with your counterparts on the ground, and in this case, we had a Mission Control Center for the payloads, called the Payload Operations Control Center, in Oberpfaffenhofen in southern [West] Germany, so that's where we talked. Back in the lab, we didn't say, "Houston, *Challenger*," we said, "Munich," or "*München*," in the German phraseology. Then we would talk to their engineers when we were operating the payloads, or we would talk to their researchers if they were enabled.

If we wanted to talk about Spacelab systems, then we'd talk back to Houston, or the Shuttle systems. So I did both. On my shift, I was responsible for Spacelab systems, and so I would talk to both Houston and to *München*.

ROSS-NAZZAL: Did you ever talk to anyone in German, or was that in English?

DUNBAR: We had a pretty strict protocol when we started out. In the interest of safety, we had a common language, and it's English. It was actually a filtering criterion on the part of the Germans and the Europeans that the crew members they sent to us spoke quite good English. English is also a kind of a scientific language as well, and they were all physicists. I think they were almost all physicists, so they spoke perfect English.

We, in our protocol, provided, though, that we could talk to the investigators if we needed to, and the protocol said that if an investigator from any one of the countries participating wanted to speak in their home language, that it had to be precoordinated on the ground, and we had to allow for translation, because we didn't want to get in a situation where there was a discussion on an experiment that interfaced with a system, and a switch was thrown that we weren't aware of. So it wasn't a control issue, it was a safety issue, to make sure everybody understood everyone else all the time.

ROSS-NAZZAL: And did that ever happen on board the Spacelab, do you recall?

DUNBAR: We did have investigators who spoke to the payload specialists in a different language, and it worked out fine. They were enabled; we had translation. For me, since I needed to be responsible for the Spacelab systems, I needed to know what was being discussed, and so although we'd studied German, I wasn't conversationally fluent in German, particularly technical German. But if it was in German with another crew member, one of the other crew members would tell me pretty much what was going on, or I could sort of follow if I had good com [communication].

There was one discussion, I think in Dutch—I'd have to look back—that Wubbo had, and of course, he translated to me, and then I got a confirmation, I think, through the ground. I have to think back on that; that was back in '85, so that's twenty years ago. But I recall from the flight that we had no adverse events from the protocol that we operated.

ROSS-NAZZAL: Since you were working on Spacelab systems, did you participate at all in working on the experiments themselves?

DUNBAR: Oh yes. Yes, it was a dual role, because once the Spacelab is up and running, it's pretty transparent, so our twelve-hour shifts were dedicated to the research. But if there were a problem, a malfunction, an in-flight maintenance procedure, then I would have conducted that on my shift, and on the other side of it, Guy [Guion S.] Bluford [Jr.], who ran the red shift. He was the mission specialist in charge of the lab on the opposite shift.

ROSS-NAZZAL: Can you talk to us about the handovers? When the other team would come in, how much time would you spend with Bluford, telling him what was going on in the lab?

DUNBAR: We had a flight plan to follow, and we had kind of the master flight plan that Guy and I would hand off that would have notes in it, plus we had our notebooks, and we kept the ground informed as well. So when we finally got to the handover, maybe it could be ten, twenty minutes. They were actually very efficient.

I'd tell him where we were on the timeline. Because another attribute of the way we trained back then is that it was an eighteen-month training flow, and several months of that we

trained in [West] Germany at Bonn-Cologne, in a simulator, parts of the timeline. So we all knew the research. We knew what the flight plan ought to look like, and with that background knowledge, you can shorten your conversation in handover. So I'd say, "Yeah, we're right on schedule. We moved nothing to your shift," in many cases. Or, "We weren't able to do this particular experiment because of something. It's been moved into your shift."

Then we also had teleprinter uplink messages from mission control in both Centers, which might summarize the changes as well. So I'd go through those notes, the teleprinter notes, the flight plan, give him a heads-up on; and he'd do the same for me.

We had pretty efficient handovers. I don't remember any of them ever going over thirty minutes. That might have been the time. I'd have to go look at the flight plan to remember, but I know that when we eventually flew STS-50 in 1992, our handover was about fifteen, twenty minutes, and they were right on time as well.

ROSS-NAZZAL: Was there any sort of competition between the two teams?

DUNBAR: No. No, we were working different things. The competition is against the clock. Time is money, and it's not in our interest that we look at the clock, it's in the interest of all the investigators on the ground.

I think we sometimes forget that we're just a research platform, and there are researchers and graduate students that have been working years on this project, and the only way they are able to finally conduct the final experiment is in the environment for which it was designed, which is microgravity, or if it's outside the pressurized hull, maybe something had to be exposed to a vacuum, or Earth observing, whatever. So their success is very much dependent upon us,

how well we're trained, how well we understand their scientific objectives, how we're able to communicate with them in the method we have, which is circling Earth at 17,500 miles per hour. So it's very important that you're well trained and understand their objectives, but we're just part of the research team.

So we look at that. Here's a complement of experiments that we have timelined. Those researchers typically are all in the control center. They're watching TV. They're listening to the downlink. They've got data coming down, digital data, sometimes CCD [Charge-Coupled Device] data, compressed video data, and those are the research results, and so we're all trying to make sure they're successful.

ROSS-NAZZAL: Did you have any free time during the mission?

DUNBAR: Yes. Well, it's scheduled free time, but I have to tell you, in the early part of the Shuttle Program, we weren't probably as disciplined about keeping that free time on those short missions. D-1 was a seven-day mission, and you can go full speed for seven days. We would typically try to catch up in presleep, and you really shouldn't be doing that, but again, we looked at time as money. I didn't personally want to come home and think, "Well, gee, I got to look out the window for an hour, but I've got to come back and tell this engineer or this scientist that I didn't have time to do something for them." So we felt a certain amount of pride in accomplishing everything we were supposed to do.

Now, on our flight, we also kept our discipline in making sure we didn't go into sleep. That was a continuing problem in the early days of the Shuttle, though; maybe the timeline was

too ambitious, and so you had crew members taking away from their sleep, and you don't want to do that.

So by the time I came around to my second Spacelab flight in '92, we thought we'd worked the timeline quite well, and as it turned out, we did. So we were rigorous about keeping presleep, postsleep; we got our half-day off. That was a thirteen-day mission, and so after ten days, you get to work a half a day off into it, so that thirteen-day mission, we did have a half a day off for everybody, and we didn't erode at all into our sleep periods. So we did have time off eventually, but not so much in the early days.

ROSS-NAZZAL: Do you remember any sort of activities that you and the crew did when you had a moment of free time?

DUNBAR: I remember on D-1 we had a lot of new people, including myself, and so there were press conferences that would be blocked out in the lab, and there would be camera setup time before that and deconfigurating that, as well, afterwards. There was sometimes a little free time in there, and I remember that some of the crew members—there's a long tunnel that connects the middeck crew compartment to the Spacelab itself, and so crew members would sort of see if they could float all the way down the tunnel without contacting the perimeter. Of course. that depends on the attitude of the Shuttle as well, and trajectories and orbital mechanics, and it was always fun to see exactly what would happen.

ROSS-NAZZAL: Hank Hartsfield recalls that he went trick-or-treating. Do you remember that?

DUNBAR: Yes, I was going to get to that part, because we were up over Halloween, and so some of the crew members took blank—and they were blank—pages off the back of the crew procedures book and cut out little Halloween masks. Apparently it did create a little bit of an adverse reaction from some people, who thought we were trivializing spaceflight, but on the other hand, it was Halloween, and it was in our free time.

We're having this transition of thinking that as you spend more time up there, we also have to take care of the social needs of people as well, if we're going to live in that environment. So we were sort of, I think, at one of those transition points. It was very minor for us. We didn't realize anybody had taken any offense to it, and maybe one or two letters to NASA, not a general offense, about, well, "They're having too much fun up there." [Laughter] I don't know if that's what he said, but that was kind of—

ROSS-NAZZAL: That was pretty much what he said. I was just curious what you remembered.

DUNBAR: I remember I didn't get to make a mask. I just remember they floated down the tunnel, and they had all these masks on.

ROSS-NAZZAL: Did you give them anything for treats?

DUNBAR: Didn't have any treats. [Laughter]

ROSS-NAZZAL: STS 61-A was the first mission that was sponsored by another country. What sort of challenges, if any, did that pose for you and the crew?

DUNBAR: Well, yes, West Germany bought and paid for the flight. I don't know, a little over sixty million dollars in those days, and also the Spacelab was built in [West] Germany as well. It was a flight that was more than just a science flight for them.

As it was explained to me by some of the mission management, is they were also trying to inspire their youth, their population, to look to the future; that there was still, they felt, a heavy burden coming out of World War II, in terms of optimism, and overcoming that. So this was also a symbolic flight, not just a science flight. So that part of it, actually, we wanted to be part of that, and there was a lot of youth interest in it. There was also a lot of *Bundestag*, which is their political Congress, basically, interested as well. We trained in Bonn-Cologne. Bonn was the capitol. It's now moved back to Berlin. So there was a lot of political interest in it as well. So we felt a certain amount of responsibility in helping them to succeed in that area.

The challenges that were there were typical of any mission in which you're dealing with different cultures and different languages. They're not insurmountable, it's just finding the bridges. Both Guy and I took Berlitz German so that we could live there, because I was, altogether, out of an eighteen-month training flow, there for seven months. So on the weekends, I was out shopping, going to the food markets, not the other markets; they had a great outdoor market in Bonn on Saturdays, and you wanted to be able to talk to the populace. You wanted to be able to read the signs, and so that was a fun challenge.

The culture was something that you work through. The Germans are a wonderful people. They're spread in different cultures within the same country, just as we in the United States are. In fact, the Germans in Munich had a kind of a bond with southern Texas, if you will. They looked at themselves as sort of almost Texan in their culture, and in northern Germany it was a

little more reserved than the Munich area, and this is, of course, what we could see and what they were telling us. And they were getting used to us. Guy and I were sort of a new set of people for them to work with.

Their first astronauts were very much equivalent to our original seven, and although I had an office there in Bonn-Cologne, I do remember the mission manager came in one day and was very unhappy with a decision that had been made at NASA Headquarters [Washington, D.C.] and wanted me to call and tell them that they were unhappy, and of course, this was my first flight. I would no more have called the NASA Administrator. But I did call my boss, Mr. [George W.S.] Abbey, who was Director of Flight Crew Operations, and said, "What do I do about this?" and so got them connected, talking directly to one another. Because they just assumed that I had the same relationship with senior management and Congress that their folks did. [Laughter]

I became very good friends with Hans Ulrich Steimler [phonetic] and Wolfgang Wyborny, who was their Ops [Operations] Manager, both really outstanding people. But I learned much about the culture from them, the decision-making processes; what was important, what wasn't important; how to negotiate. In fact, actually Hans Ulrich came in one day and told me how to negotiate with them. [Laughs] I'll never forget this discussion. He says, "What you must understand—," and so we had a very good discussion about that.

Funny language stories. I was in the middle of a meeting with their engineers, and of course, I had come originally out of Mission Operations, so I was trying to understand their approach to operations, because they're going to be operating out of Oberpfaffenhofen, and there were things—they were learning what we controlled versus what we expected them to control,

and I was using a phrase called *housekeeping data*, which is downlinked data that's about how an equipment is operating, you know, temperature, pressures.

One of the German engineers finally looked at me, and he said, "Housekeeping data. Is that because you're the woman of the lab?" [Laughs]

And I thought, "That's one of those language things they forget about." So I had to explain to him what we meant by that. So it's a lexicon of words. But, actually, English and German, of course, had the same root basis in language, and so many of our technical words are common. That's one that was not, but the technical aspects of it, generally, we didn't have much problem with.

ROSS-NAZZAL: Sounds like you learned a lot, in terms of working with internationals, especially, that you would apply later for Space Station and Shuttle-Mir.

DUNBAR: Oh, no, I had a wonderful time. I made a lot of good friends. Actually my maternal grandmother was German. Her father and mother had emigrated from Germany. I was never able to trace the family; we think they had been from East Germany originally. But I was very interested in understanding the culture; in every town I trained in, I kept looking for the name Staats, which was my grandmother's maiden name.

ROSS-NAZZAL: Let me ask you a couple more things about the mission itself. A number of crews have told us that they ate meals together. What about your crew?

DUNBAR: Oh, we did; we did. It wasn't always there, I mean, but we were a small group, and we tried to, Hank and I and Jim and—let's see. I had Reinhard Furrer on my shift. So there were just four of us. We had to be quiet, though, because the rest of the crew—sometimes we overlapped, okay? Sometimes we had dinner while they were having breakfast on the other side. If we were up, we were a little more convivial.

But typically, we'd very quietly go in, get our—or one person would do it—get everybody's meals out, rehydrate, heat up in the oven. We had meal trays, and, of course, we're color-coded, so we knew what everybody was going to eat in that meal. Put it in the trays, and then we might go up to the flight deck and eat up there. There was only four of us. We could all look out the window, and there's nothing that's more entertaining in space than looking out the window and seeing the Earth. It was really quite spectacular.

ROSS-NAZZAL: Were there any challenges that you encountered while you were on orbit?

DUNBAR: There's always challenges, but by and large, the lab operated quite well. The challenges we found were when we violated what we historically knew were lessons learned. You know, you ought to train like you fly and fly like you train, and in a couple of the experiment cases, they just simply didn't have the training hardware ready, so when we trained in the lab, we had like wooden blocks. The procedure would say, "Throw this switch," and we'd pretend throwing it.

Well, sure enough, we get into orbit, and here's a piece of hardware we've never seen before, and in one case we threw a switch, thought things were on, but turned out it was almost a two-position switch, and so there was a second detent we didn't get past, and the experiment was

never activated. But there was also no light feedback, no—that's another rule. You ought to have some kind of feedback system, let the crew know that it's on, just like when you turn the light switch on, the light comes on. Well there's power to the experiment, there ought to be a little green light out there someplace. So that was a challenge. That was a disappointment to come back and find out that was never activated.

Another one was, there was no integrated philosophy on panels and switches when we flew the flight, because they had a lot of different vendors bringing in experiment racks, and because for them it was international. I mean, they had fluid physics from Italy. They had a glovebox that came from ESTEC [European Space Technology Center] in the Netherlands. So, as a result, the rack lighting, these trouble lights and stuff, were not integrated, so when you looked down the lab, you'd see this large array of different colored lights, green ones, amber—they called them yellow—red.

But they didn't always have the same function. On one particular rack, it was one red light's okay, two is caution, and three is stop. Well, when you do what we call a cockpit scan, and you see a red light, you know, and it's down at the end, you've got to—it would be nice if everything that were working were all green, you know. Or if something was all red, then you knew it was stopped. So that was always a challenge. Especially in a zero-G environment, where you're not always up straight like this. You have to read the nomenclature on the light and the switch, make sure everything's in the appropriate position. So that added a little bit of time overhead.

These are all minor challenges, but something that we—you know, lessons learned that we keep reinventing, but hopefully as we start exploring, we'll adapt all this human factors data that we've learned over the last thirty years and put them in our new vehicles.

ROSS-NAZZAL: Are there any other anecdotes from the mission that you recall?

DUNBAR: Okay. Well, let's see. I'm thinking. Seven days.

A personal moment. When you first have an opportunity to look at Earth, there's no IMAX film that really even does it justice. There was one point where I decided to mentally snapshot a picture, and it just really was striking. We were tail down to the Earth, but our overhead windows were in the velocity vector. So you have these big, square windows that you are looking out in the direction that you are moving, so it's like being on a platform, and the Earth limbs out there. I kept thinking, this must be what Captain Kirk was thinking on the *Enterprise*, you know. [Laughter] Because you're actually laying on the ceiling, but of course it's your own vertical—feet down to the Earth, looking out.

We were at the transition of day to night towards the South Pole, and the South Pole was dark, and as a result, we could see the southern lights from above, which just looks like little fire flames. It's very dynamic, and we must have had a lot of activity, solar activity, at that time; nothing dangerous, but enough to make it pretty spectacular. So as we're just very silently drifting around the planet and going close to the South Pole, or fifty-seven degrees inclination, so we're pretty far south, more so than a lot of missions, and to see that sight was just really spectacular. I was eating at the window, and I thought, "Well, I'm just going to memorize this," and that's one of those moments that I kept with me.

The other one I can remember—actually maybe Steve Nagel talked about this—I was back in the lab. It might have been a shift handover; no, as I recall now, Steve and Hank were both up on my shift, and Jim Buchli was on the red shift. I heard something over the intercom

that's sort of "Holy heck,"—or something like that—"what's that?" So I thought, "Well, I better float on up there and see what's going on." Or maybe they called my name.

We're looking out the front windows, and it looks like little fireflies out in the distance, and we thought—at first you'd think they were stars, and then you noticed that there's some relative motion. They're actually coming towards us. And I thought, "Well, maybe it's—you know, what's reflection off of it." And then not only did it come towards us, it went by the windows, floated by the payload bay, and hit the OMS [Orbital Maneuvering System] pod and bounced off. This is real stuff, and some of it did hit the forward windows and left these whitish streaks, which may have been just scraping off some of—we had some ascent kind of fogging that would occur, maybe some paint or waterproofing that came off.

There was a lot of discussion about whether or not we discuss it with the ground and how we discuss it with the ground. Because it was obvious that it wasn't penetrating, or we certainly couldn't see, and the relative speed was very, very slow. This stuff would just float by and just hit and bounce off. I don't remember if Hank did say something to the ground. I just kind of watched it, and I said, "Well, everything okay? I'm going to go back to work."

I thought, "This is weird." I think they did talk about it, and talked about that there was some evidence of the streaking on the windows, and then we debriefed it after the flight. I've heard a lot of speculation about what it might have been. It might have been one of our prior dumps, water dumps, but it didn't look quite like that. We heard that it might have been a Russian dump. I guess, '85, it might have been Mir, or Salut, I'm not sure at that time, so I'm not quite sure, but it was interesting. It did show, though, that you can—it was in orbit, so we were actually recontacting it.

ROSS-NAZZAL: Interesting. What are your memories of landing? Were you on the middeck for landing as well?

DUNBAR: I was on the middeck for landing. What I remember is that the vehicles, of course, are just pressure vessels, and they're not perfectly cylindrical, and so when you come back into Earth's atmosphere, there's some deformations. You can hear the little creaks and groans. It's a double-hulled vehicle, though, so there's no concern about losing pressure, and, of course, we've got makeup gasses and stuff, but you—especially as you come through the Mach.

At that time we had four on the middeck, and I sat right to the right of the waste management system, right by the ladder. I could look up and see Jim Buchli, MS-2; Guy was on the other side of him. I had a camera in my lap, because I could look to the left out the hatch window, middeck hatch window, and we wanted to get some pictures of the entry plasma and the color flows, which we did, by the way. But all of a sudden there's a big bang, and what happened is that the Orbiter actually deformed a little bit, and the door to the waste management system came unlatched and flung open against my seat. And I looked at it, and I heard Hank say, "What's that?"

I looked, and I says, "That's the WCS [Waste Collection System] doors. I think everything's okay." But then I had to hold it back with one hand so I could take the pictures out the window, and I actually held it back with one hand all the way through entry. I just didn't want us to be in a position that if anything did happen, and we had to get through that hatch, that the door was going to be open. So it was kind of like that, and so finally we landed, and they came and got us, and we were able to latch it again after we got out of our seat.

ROSS-NAZZAL: Was your family there when you landed the first time?

DUNBAR: Oh yes. Yes.

ROSS-NAZZAL: What are your memories of that?

DUNBAR: Well, it's great. I remember getting out of the vehicle. In those days, I think I went seven days without washing my hair, because I hadn't thought about a technique for it, and I was pretty grungy. [Laughs] So I remember walking out of the vehicle thinking, "I really need a shower." Took a shower, did some medical tests, and then went out and saw my family and my future brother-in-law. My sister was dating this young Navy pilot, so I was giving him the third degree, but it was very fun seeing that. That was all out at Edwards [Air Force Base, California].

ROSS-NAZZAL: Now, as I understand it, you and the other mission and payload specialists actually went back to Kennedy Space Center [Florida], where you participated in a two-week study of the human body.

DUNBAR: Yes, and it had to do with the fact that it's part of baseline data collection. If you're going to study the human body, you have to have something to compare the spaceflight data to. You have to understand the changes before flight, if there are any variations, versus going to flight, and then readaptation after the flight. So we actually had crew members who were participating in that, and I did. I actually gave my blood at Edwards, but the vestibular sled stuff and some of the other types of things we did were all back at Kennedy, and the reason for that is

that the Germans had flown that all in, I think via C-5A, and they'd flown it into Kennedy so that we could—they had the medical lab set up there. They really weren't equipped out at Edwards to be able to do that.

Also, we had all the investigators there at Kennedy for some of the biological stuff, because in the case of the Biorack, which had a number of biological investigations, I don't activate some of those until we're actually on orbit, and so they run the ground truth. Let's say you're hatching frog eggs, which is one of the things we did, is they have different ages of frog eggs, but they don't start the experiment till we're actually in orbit so they have something in parallel, and then they can look at—when we did a procedure, they did it on the ground, so that things happened in the same sequence as well. It reduces the number of research variables that you're dealing with. So, yes, we went back and participated in that.

ROSS-NAZZAL: Can you tell us about your PR [Public Relations] trips that you took?

DUNBAR: We did our PR, our postflight for that, in January of '8[6] just before the *Challenger* accident, if I recall correctly. It was a great trip. I remember that we spoke to a lot of universities. We met with a large number of the German *Bundestag*. We went to MBB-ERNO [Messerschmitt-Bölkow-Blohm-Entwicklungts Ring Nord Organization, Spacelab contractors]. We rode on one of the inaugural rides of one of the bullet trains that they had put—I think it was even a Lufthansa train, if I'm not mistaken. And it was a great trip.

One of the things I do remember, we were at Lake Constance at a hotel there, and typical of a lot of the hotels, it was an old castle. It had a little restaurant and a pub there, and we were eating and just visiting, and the crew members had their spouses there, and there was another

group of older men sitting at another table. Finally one of them walked up to us, and he had seen a picture of the crew in the paper, and he asked if that's who we were.

He introduced himself, and he said that he had been a World War II German pilot, and he and Hank started talking, and Steve, because flight is a commonality, you know. The war was a long time ago, and Hank was, I think, very interested in what he'd flown and where, and it turned out that towards the end of the war, they were recruiting very young boys to fly, and he was very young, maybe sixteen, seventeen, trained and sent to North Africa. I think he was shot down, and then the war ended shortly after. We had a really interesting discussion.

Then he went home, and he brought back a scrapbook and a few other little things, and they started looking at the scrapbook of things that he had flown and so forth. Then he gave us each a little memento, and he gave me a little paperweight, which I still have, which has a little gold eagle on it. So that was very special.

ROSS-NAZZAL: Any other special memories from that trip?

DUNBAR: Oh, there's always special memories. I'd have to go back to my pictures. I still have that eagle, so I think about that every once in a while. Let's see. It was a very hectic trip, as our postflights are. We had postflights set up for our hometowns later in February. We cancelled all those shortly after the *Challenger* accident, so that really was the only postflight trip we had.

ROSS-NAZZAL: Let's talk about the *Challenger* accident. Where were you when the accident occurred?

DUNBAR: I came back from this mission and was assigned to be a CapCom [Capsule Communicator], so I was actually OJT [On-the-Job Training] for the planning shift. So for the mission, I had been on console, I think, from maybe ten the night before to I don't know what time. It might have been four, five, six a.m.; I don't remember exactly. Then I went home, and I got up to watch the launch, which was in the morning. So I'd only had a couple hours' sleep, maybe less, and I'd thought about going back and watching it in mission control, but I was pretty tired. I thought, "Well, I'll watch it on TV." So I saw it at home; it didn't take very much thought to know something was wrong, so as soon as I heard the air-to-ground discussion, I finished getting dressed and went in to work.

ROSS-NAZZAL: What did you do after the accident?

DUNBAR: I walked into Building 4, and the first person I saw was Dr. Carolyn [L.] Huntoon, and she was on her way to the Astronaut Office as well, and I went up. People were starting to congregate. The chief of the office was John [W.] Young. We were in the process of doing a postaccident assignment of support, and so I went to my office and waited to be told what I should do.

ROSS-NAZZAL: What tasks were you given by John Young?

DUNBAR: I didn't have an immediate one. I didn't deploy out to the launch site. I was eventually sent to Headquarters to be part of the—it was called the Action Center that Admiral [Richard H.] Truly set up to track the accident and all the material that would go back and forth

to the Rogers Commission. The room itself had actually been set up by Bryan [D.] O'Connor. He was the point person there. It was everything from maps on the wall, where the debris was being found, to logs of all the requests from the Rogers Commission. Of course, it took a little while to get that in place. And then there were three of us assigned to rotate up there and support that room. Sid [Sidney M.] Gutierrez and Frank [L.] Culbertson [Jr.] and I were the three that rotated after Bryan set up the Action Center.

ROSS-NAZZAL: How long was the Action Center in place?

DUNBAR: Gosh, it had to be there at least—well, it was there until just after the Rogers Commission finished their work, so it seems to me it was there most of the rest of the year. I think I sort of phased out of it; I'm thinking September, but I'd have to look at my notes. Maybe a little earlier than that.

ROSS-NAZZAL: Now, no Shuttle missions flew again until '88, when STS-26 flew. But in the meantime you served as the Chairman of the NASA Microgravity Materials Science Assessment Task Force. Can you tell me about that group?

DUNBAR: Well, yes. I came back from this really outstanding flight, that D-1 Spacelab flight. Talked to a lot of researchers in Europe and the U.K. [United Kingdom], which was part of this flight as well, the MIT folks, and at the time, in '84 we had announced an international cooperation for the Space Station Freedom. So I'm a materials engineer, and one of the things I found fascinating on the D-1 flight was all this materials research that they were doing,

microgravity materials research. MAN Technologies, which is a well-known—mostly metals, but a materials company in Germany, had sponsored some experiments. I think it was directional solidification or binary alloys that you could not produce in 1-G, due to convective flow.

Some of it was very fundamental research that would allow them insights into their, like for instance, turbine blade processes; you know, that you weren't actually going to produce something in space, but gravity really obstructs our ability to understand some processes, because it produces convection and turbulent flow. So I got very interested in the theory behind it, and I started asking some questions. One of those question is, "Well, what are we building for this Space Station Freedom in the way of furnaces or materials research capabilities?"

The answer I got back was, is that, well, we had two lab flights planned on the Shuttle to do life sciences, SLS [Spacelab Life Sciences]-1 and SLS-2, and we were participating in IML-1, which is International Microgravity Lab [Laboratory] flight, but that we really weren't building any facilities for Station. All we had were middeck-level small things, and so I said, "Well, that won't allow us to really utilize Station or to do this leading research."

One of the reasons I questioned that is because we really helped forge that area back in Skylab. We did metals directional solidification. We were looking at eutectic points, all the stuff where we were showing that microgravity, or the lack of the acceleration due to gravity, does have an effect on how materials perform and react, heat transfer, the whole bit. It seemed that it was a real loss of our investment and scientific discoveries of the future if we didn't build facilities for Station.

So after I got back from the accident, I was in a couple of meetings, and one of them was a safety meeting for payloads for Space Station Freedom that was conducted at Marshall [Space

Flight Center, Huntsville, Alabama], and just various things I was sent to, and we started having a discussion about this. At the same time Dr. Sally [K.] Ride was asked to lead an Exploration Strategic Plan for the Administrator of NASA, and we were talking, and I talked specifically about what I thought was a gap in our ability to utilize the Station we were going to build.

And she said, "Well, why don't you lead a task force reporting back up to me on this very subject," because we both saw a link between our ability to build facilities operated in microgravity and exploration onto the Moon and Mars, which are in fractional gravity, and as a materials person, it was pretty evident to me, if you don't understand what's happening at zero—let's say you're going to do in situ resource utilization, even—if you don't understand what's happening at zero, how are you going to extrapolate to one-third and one-sixth? I can't just put a mining operation up on the Moon and expect I would get the same chemical reactions, heat transfers, times; it's just not going to work that way.

So she tasked me via memo, which either was signed by Dr. [James C.] Fletcher or it was initialed off by him, to proceed with this task force. It was a Microgravity—I don't even remember the full name—Research Task Force, and we had representation from all the Centers. We had representation from the commercial sector. We met at—I think most of the Centers. We held panel meetings over the course of a year, and we came up with a set of recommendations.

Among those recommendations, besides the facilities, was to fly Spacelab flights; to design them, test them, and mature them before they went up to Space Station permanently, because once you've got them on Station, you couldn't tweak them as readily. We've already seen that. The Spacelab flights are wonderful as a test bed. You can take them up for a week, two weeks; find out what needs to be corrected, if you have to; whether they'll function properly; and then bring them back to get the hardware back.

Out of that, within five years—we published that report in ’87. We flew USML-1, United States Microgravity Lab-1 flight in 1992 with all new facilities that were destined for the International Space Station, including a new set of furnaces. What was thrilling for me was to be asked to be Payload Commander of that flight, and so in five years I had an opportunity to see it go from a concept in a report to an actual flight of brand-new equipment and hardware; a thirteen-day flight, and everything worked perfectly. It was just wonderful.

ROSS-NAZZAL: Before we talk about this flight, I wanted to talk to you about the Astronaut Science Support Group that you also became a member of.

DUNBAR: Yes. Actually, there was several of us that started it through a discussion, George [D.] “Pinky” Nelson, Franklin [R.] Chang[-Diaz], myself, [Margaret] Rhea Seddon, and I think we had a couple of others on it. But we were sort of the core that said, “Okay, now we’ve seen what works on the middeck and what doesn’t, and what works in the lab and not. We have this corporate knowledge of microgravity that’s not in a textbook anywhere.”

Now, there’s an engineering side to that. You know, how does heat transfer work when you don’t have natural convection and so forth, and how do you provide for EMI [Electromagnetic Interference] and so forth. But there’s an operational side to that as well. What should you automate and what shouldn’t you automate? What information should you give the crew if you want to optimize your scientific output? There was no place an investigator or a hardware designer could go for that. So we thought, “What we’ll do, is rather than wait till they’ve designed the hardware and it’s too late to change it—,” which is what was happening.

The crew would see the hardware in training, and by that time, you say, "Oh, that's not going to work," and they didn't have the funds to change it.

So we started the Science Support Group, and we asked to be able to talk to the investigator and the hardware designers as soon as they put what was called, I think, a 1628, request for launch, or phase zero safety paper in, and we would give them the benefit of our operational experience, research experience. We started doing that, and it worked out very well. We'd get an investigator in, building a piece of hardware, and they would present to us, and we'd ask questions. We'd explain what our experience base had been like on similar hardware; what things they could do that they maybe didn't think about. They didn't realize, for example, maybe they could get TV down; that it didn't just belong to the Orbiter. That we could put downlink; they could actually see something. That they could depend upon us to help optimize their research results.

Many of them had been told that the crew didn't want to do research, that the crew didn't have enough time to do research, and that was kind of the word they were getting. That's not the word we wanted out there, because the experiments that came in with no crew input usually failed, and you couldn't fix them when they did. So there was no opportunity to do in-flight maintenance. So what we set down was mission-success-oriented corporate knowledge for them, and that was the Science Support Group.

ROSS-NAZZAL: Do you recall any of the companies that you worked with or any of the projects that you worked on?

DUNBAR: Oh, I was chief of that for a while. I had file cabinets. I mean, I think I had one whole file cabinet—it's probably archived someplace—of folders of the people either had sent information to us and I'd sent back some written stuff, or meetings we'd participate in, small working groups we'd put together, or even whole office seminars. We set up a seminar series. In fact, I can tell you some of our early seminar presenters were [Ching-Wu] Paul Chu, who eventually got the Nobel Prize in superconductivity; Alex Ignatiev with the Wake Shield Facility; 3M Corporation was doing vapor deposition; Larry [Lawrence J.] DeLucas, protein crystal growth, and Charlie [Charles E.] Bugg, who was actually his predecessor in that whole project, were all presenters at our seminar series.

ROSS-NAZZAL: Why don't we go ahead and take a break here for a second.

[Tape change]

ROSS-NAZZAL: Let's talk about STS-32. Can you talk about the training that you underwent for this mission?

DUNBAR: Yes. This mission was a training flow of about a year. It's the Long Duration Exposure Facility [LDEF] retrieval mission, plus we launched a SYNCOM-IV. LDEF had been launched about five years prior to this mission in 1990. Originally we were supposed to launch in December of '89 and be up over Christmas. We even had Christmas photos made, but then we slipped over into January. LDEF was launched as a passive satellite to test the effects of Low Earth Orbit, LEO, on different materials in particular, and so it had a constant attitude around the

Earth. It had witness plates that were looking for distribution of orbital debris, among other things, but it also had wiring harnesses of different cladding material; look at how ultraviolet light affected it as well. Those were just a few of the experiments.

The accident occurred, and we didn't get it, and its orbit was decaying. It did not have an active attitude control system. It had sort of a damping system that allowed it to stay in one attitude, but it couldn't de-orbit itself, so we couldn't actually put it down someplace. And we needed the data. It was meant to be brought back on the Shuttle. We didn't have anything equivalent in terms of looking at orbital debris or those environments. So the flight was put together, and there were five of us on it. I got to operate the robotic arm. That was a fun training flow, because we did a lot of development in it, in terms of models on the simulator and attitudes that we'd use the Shuttle for.

In fact, we did something unique on this flight. Because we were also looking at atomic oxygen, which is in the ram direction of flow, we were concerned, the investigators were concerned, that as we came down to pick up LDEF, and we did what was called an R-bar approach, which is we came down from the top, which was the first time we'd done an over-the-head R-bar approach, is that as I grappled it and then moved it around to put in the payload bay, they were afraid that they would expose different surfaces to the ram direction that hadn't been exposed before.

So what we did, and Jim [James D.] Wetherbee and Dan [Daniel C.] Brandenstein were doing the flying, is that we actually used the Shuttle as a shield. So we put it in the ram direction and used it like a Wake Shield and therefore deflected the atomic oxygen flow away from LDEF while we then took pictures of all the surfaces and then put it in the payload bay.

The reason that we took pictures of all the surfaces was—how much did it weigh—it's almost—well, a little more than half a payload bay long, and I think around 23,000 pounds. The payload bay is fifteen feet in diameter. I think this is fourteen feet in diameter. It had four latch points and a keel, and there was concern that maybe we wouldn't be able to get it latched down, and we'd have to maybe take it up to a higher orbit and leave it. So we wanted to at least get the pictorial data.

So we had different positions to put it in so we could take the seventy-millimeter photos out of the aft windows, and Marsha [S.] Ivins was in charge of that and did a really great job capturing each one of these panels. We also put video down to the ground. That took several hours, but we were able to do that and then got it latched and brought it back. It was a ten-day mission.

It was also the first mission we called Extended Duration Orbiter, which we had a large number of medical tests that had been put into place to determine really how long that we could keep pilots in orbit without having any adverse effects on landing. Because they came down sitting up, so we were concerned about fainting or an orthostatic intolerance. We flew the Lower Body Negative Pressure Device, which had not been flown since Skylab, but was also a technique that the Russians routinely used as well.

When you draw a slight vacuum on the lower body, about sixty millimeters of mercury pressure, it causes the fluids to go back into the legs, and you drink a lot of liquids, and this rehydrates you, because you have the opposite effect after launch. After about two or three days, you've lost a liter of fluid, and you've lost the mass in your legs, so as gravity starts to pull back on your fluid system, your heart has to start beating faster and harder to keep blood in your brain. So we're trying to find ways to really rehydrate and bring the human system back up to an Earth

level. So the Lower Body Negative Pressure Device was something we tested on this flight, a new design. Actually, it's been around about a hundred years, I found out later.

ROSS-NAZZAL: Oh, has it?

DUNBAR: It's been used, yes, for a lot of cardiac studies for over a hundred years. So I was one of the subjects for that. I had an echocardiograph for imaging the heart. Oh, what else did we have? We had a lot of other middeck experiments as well, and then the Navy SYNCOM-IV satellite.

ROSS-NAZZAL: Can you talk about actually using that Lower Body Negative Pressure unit, being that subject?

DUNBAR: Yes, well, [G.] David Low and I were the two subjects. So when one of us was a subject, the other was the operator. It was basically a big can that sealed around the waist, and it hooked into the vacuum system. Of course, it had a controller on it so you didn't get too much vacuum. There was a sequence of steps down to the lowest vacuum level, and then you would dwell at that length of time—let's say four hours—and you drink thirty-two ounces of water, and you really could tell that your system was reabsorbing that liquid, and you're getting your skin color back in your legs, so it was bringing fluids back into the system. I felt, since I used it on two flights, that it really did give me some protection from entry.

We also had some exercise protocols. We had a treadmill on board, and Jim Wetherbee and David Low were those two subjects as well. I remember both of them, I think, ran around

the world; they ran on it for ninety minutes. And it was a lab, so just in the crew compartment, five of us. We were single-shift, but that didn't seem that crowded. We ate together, and, of course, you'd usually have a couple of people or maybe most people up on the flight deck. A lot of middeck experiments, so we kept very busy.

The most exciting thing that happened in that flight is that we had a fairly young mission controller. I think he was an INCO, must have been an INCO, Integrated Communications Officer, who sent up a completed command that put us into a spin during our sleep shift, and the ground called us. Dan woke up, and he said the Moon was rapidly moving through the window or something to that effect, so he disengaged the autopilot, basically, and gained attitude control. [Laughter]

ROSS-NAZZAL: When you launched for this mission, were you on the middeck or were you on the flight deck?

DUNBAR: I have to think about where I was for this mission. Let's see. You get a choice if you're going to be—I was MS-1, and because it was my second flight, I let G. David launch on the flight deck. I always liked entry better. For me, entry was not any longer, but because I'd worked on the Shuttle tiles, it was always interesting for me to see the plasma environment, and so I didn't mind sitting on the middeck for launch. It's over in eight minutes.

ROSS-NAZZAL: Can you tell us about the deployment of the SYNCOM satellite?

DUNBAR: It happened on day one, and G. David Low was in charge of that, and I was his counterpart on some of the switches and the backup, and that went very well. It spins frisbee-style out of the payload bay, and then we back away from it, and it does a spin out. We watch it while it does its full spin up and then deploys its antennas. Then we back away from it, because it has an upper stage that it fires. But it went well.

ROSS-NAZZAL: You've given us a sense of some of the differences between your first mission and this mission, but what were some of the other differences that you noticed?

DUNBAR: Well, let's see. Besides the fact that it was single shift versus dual shift, it was a rendezvous and proximity ops and grapple with the RMS [Remote Manipulator System], which we didn't have on the first flight. There were a lot of commonalities in some of the research areas, although this was an EDO flight, so it was dedicated towards Extended Duration Orbiter medical. And some of that was preflight and postflight as well, not all of it on orbit. I think we had a little more time looking out the window. We did a DTO [Detailed Test Objective] with the RMS, and we practiced inspecting the Orbiter with different positions. Of course, you can't get all the way around to the belly, but we looked, verified the fields of views, and the lighting conditions that you could see with different positions, and then we did that over a couple of days so all three of the mission specialists will get experience in that area. I don't remember all of it.

One of the things I do remember that was really pretty interesting is that because there was so much running on the treadmill, it was almost always in use during the day. I looked out the aft flight deck windows one day, and I realized that the running tempo, which was about one RPM [Rate Per Minute], was almost the resonant frequency of the vehicle, because the EVA

[Extravehicular Activity] guy wires, there along the payload bay, were oscillating in tempo with the treadmill. Then I looked at LDEF, and you remember, LDEF is massive, and it's held down with latches, but there were little foils. Part of the atomic oxygen effect had been to delaminate some spoils, and they're sitting there bouncing like they're flapping in the wind. So the whole vehicle is responding to this treadmill on the middeck. It was very interesting.

ROSS-NAZZAL: Any other anecdotes or stories about the crew or the flight?

DUNBAR: Well, I was the principal investigator on a small experiment called the Fluid Experiment Apparatus [FEA], which was meant to show that crew exercise could, in fact, affect some crystal research. So we had an Indium alloy, directionally solidified, that we intentionally—it's a low temperature melting thing, so we had a glass interface to it, and we had a camera over it—and so we had intentionally operated it while the crew was on the treadmill, and then we had some accelerometers in it so we could measure the disturbances. Now, we matched those with the accelerometers back in the payload bay in what was called the Orbiter Experiments Package, OEX, part of the ASIP [phonetic] package, and we published several papers on that. Don [Donald A.] Thomas, who's now an astronaut, was an engineer then, and he was the co-investigator on that. Then Rockwell [International Corporation] built the actual FEA, it was called, the device.

It was pretty dramatic. You could watch this molten part of the field sit there and bounce as well, and so I think we made our point, because there was some discussion as to whether or not crew exercise might even affect some of the research.

ROSS-NAZZAL: Once you actually landed, you helped to down-process the LDEF?

DUNBAR: Well, I didn't help down-process it. I went back to Langley [Research Center, Hampton, Virginia] and had a chance to look at it. They asked me about certain things. They had the pictures, but they were also interested in knowing whether I thought certain panels looked the same as I remembered seeing them in orbit, and I didn't see any changes. I actually had a chance to learn a whole lot more about what we found on LDEF. I think it was really interesting.

It was five years in orbit, and they'd put these bicycle reflectors on it to help with retrieval, and I had trained that way. I said, "You know, it's not a generating light, but there were supposed to have been these reflectors that helped me get an orientation, and I couldn't see them." And remember, in those days we didn't have GPS [Global Positioning System]; we didn't have laser range finders. We were doing triangulation with cameras, and the cameras, if they got very much sunlight in them, also bloomed, which would completely occlude your view. So I was trying to look out the window for these reflectors, and I couldn't see them. Well, the atomic oxygen had pretty much eroded every one of them on the ram end, and even some of the other ones. So it was very interesting.

The orbital debris environment, in those five years there was nothing catastrophic that went through the structure, but we took a snapshot, basically at, you know, eighty-five to ninety, and that snapshot has changed, I'm sure, in the last fifteen years. We really ought to be putting more of these vehicles in orbit and bringing them back, just to see how that orbital debris environment matches our models.

ROSS-NAZZAL: Did you have any other involvement with the LDEF once you left Langley?

DUNBAR: No. They very graciously sent me CDs of the data and the proceedings. I believe it was Boeing [Airplane Company] that pulled all that data together in a database so that we could access it for future vehicle design.

ROSS-NAZZAL: Did you have any PR trips following this trip?

DUNBAR: Oh yes. You're going to ask me to remember what they are, aren't you? Let's see. That was January of 1990. I'm sure I must have done a couple of hometowners; that's pretty standard. But I don't remember—and Langley; we went to visit the people in Langley. Nothing international. I think that was kind of a limited postflight on that flight.

ROSS-NAZZAL: You mentioned that you had done a couple of hometown PR trips. Can you tell us about those?

DUNBAR: Well, usually it's kind of home state, some things in Washington. But in my early flights, hometown meant going back to Sunnyside, Washington, which was actually the nearest town to where I grew up. I grew up on a ranch in Outlook, but that post office is about five miles away, and it's just a post office and the church. They used to have a fire station, but they don't have it anymore. But I went to high school in Sunnyside. So after my first couple of flights, they had some very nice receptions there, and once they had a parade. So I got to ride in the hometown parade.

ROSS-NAZZAL: What other things did you do across the state of Washington?

DUNBAR: I talked to a lot of schools and civic groups and professional groups and the universities. I still do that. We maintain an affiliation with our home states not just as kind of an informal, nice to do, but that's kept in a database in the Astronaut Appearances Office, and so when requests come in from those states, then very often if it's from Washington state, they'll contact me and say, "We have a request," because there's a link there.

ROSS-NAZZAL: Sure. Well, I think we can stop for today, unless there's something else that you'd like to talk about.

DUNBAR: No. I'll go back and look at my pictures from STS-32. Oh, there are a couple of things I remember now we'll talk about.

ROSS-NAZZAL: Okay. Well, we have a few minutes, if you'd like.

DUNBAR: Okay. Just a couple more things. We did some unusual in-flight maintenance procedures on STS-32. We had a leak in the humidity separator under the floor, and we verified that by putting the burrow scope camera down in a little crack on the middeck floor and saw this big water bubble around part of the pump sep [separator]. I guess the ground had figured they weren't seeing all the water they needed to see in one of the tanks. So we had to go clean it up with towels, and the only way you could get down there was to pull out what was called the big

LiOH [Lithium Hydroxide] canister in the floor. It was a storage area, but it was also a can. So every day we had to pull this out, move it across the floor, go down and clean up the water so we could stay the full mission, and then put the LiOH big box back in.

I do remember one thing that was very interesting to me. We had set up cameras so the ground could see this procedure as well, and so they could check what we were doing against what they had sent to us, but also just to see what it entailed. It was interesting. I remember doing that procedure, and I thought, "Boy, we're really moving fast. We're getting this all down. It's very efficient." Then I saw the video after the flight, and it looked like we were moving in slow motion, and I remember thinking, "Now, why was my perception of time so different than what I'm seeing on the screen?"

I think that has something to do with everything we do in zero gravity, and that is that on the Earth, you're not always thinking about holding on to something so you don't float away, or where you put your feet. You know, it's automatic. But in orbit, that's all part of the process. "Well, I can't do this unless I make sure I'm anchored somehow." And we start integrating all that information, and our sense of time is a little different. It's the opposite—well, it's probably a time compression, in a way. So it goes by very fast, but it's because there's just so much there. So I always, from that flight on, sort of tried to accommodate that in everything else we timelined in the future, remembering that when I do something in 1-G, it's going to take longer in zero-G.

ROSS-NAZZAL: Any other stories or memories?

DUNBAR: Not right now. I'm fine. My mouth's getting dry.

ROSS-NAZZAL: Okay. Let's go ahead and stop for today.

DUNBAR: Thanks.

ROSS-NAZZAL: Thanks for coming.

[End of interview]