

# NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT

## ORAL HISTORY 4 TRANSCRIPT

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INTERVIEWED BY JENNIFER ROSS-NAZZAL  
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ROSS-NAZZAL: Today is September 14<sup>th</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 for joining us again for your fourth interview. We appreciate it.

DUNBAR: It's my pleasure to be here.

ROSS-NAZZAL: I thought we'd start today by talking about your final mission, STS-89. You were the Payload Commander for this mission. Did anything change as a result of your previous mission, where you had served as the Payload Commander, and you had learned from your experiences? Did you change anything?

DUNBAR: I used that experience. Actually, I probably merged my experience on USML [United States Microgravity Laboratory]-1, where I was Payload Commander, my third flight, with what I'd learned supporting STS-71 in Russia, because 89 was a Russian docking flight. USML-1, as we've discussed, was a very successful flight. I was very pleased with it. It was successful because we put in a lot of up-front effort, in training, for example, so we knew the procedures with high-fidelity hardware. We optimized the time line, because we actually walked through it.

I know in later years, those types of simulation environments have kind of been eroded because people are interested in saving costs, but unfortunately, we're paying for it on orbit. We just shifted a lot of that training to on orbit for first-time training, and it's actually more costly there. I know from my experience right now, it's displacing actual operations. So I looked at USML-1 as a very good benchmark to take into my next flights.

So when we came to STS-89, what I did was sat down with the Flight Planner the first day. I said, "You and I need to be really good friends, because if these times aren't right and the crew gets behind, you never catch up, and we just start building failure on failure. I don't mean necessarily hardware failure, but not getting things done, not getting all the data for the investigator. We need to iron this out right up front. We need to have the right people doing the right things."

My commander, Terry [Terrence W.] Wilcutt, made me that point of contact for the crew, even for the pilot and commander activities. He says, "You're in charge. We've got our job up here. Wherever there's an opportunity to do research, we want to do it." Joe [F. Edwards, Jr.] and Terry were very good about that.

So what I did was sit down with the Flight Planner and then walk through all of the manifest to see what was supposed to be on the flight, what the estimated times were, what the crew interests were. I sat down with each of the rest of the crew, because we had three, well, actually four rookies on board, including a Russian cosmonaut, Salizhan [Shakirovich] Sharipov, and determined what they wanted to do, so that at least we tried to match some interests.

Then the rest of it sort of falls out. You've got a certain number of hours in a workday. You've got a certain number of days in the flight. You have some stuff you can't do at this time, you know, certain things you can't do when you're doing thruster burns and so forth. We laid it

out, and because we did that up front, even though we couldn't simulate it all--that was another thing. We were working SPACEHAB, and SPACEHAB had very few integrated simulations with real hardware.

We used past experience. If we had a piece of reflown hardware, an experiment, something like protein crystal growth, which we didn't have specifically, but something like that that had flown multiple times where you knew how much time it really took. Then you used that corporate memory to build into your flight plan.

I think that we built in a pretty high fidelity flight plan. The only time it really started to fall apart a little bit was on undocking day, and that was because there were some activities added in after the final plan, or close to it. We'd really never choreographed them before, and so it kind of slowed the crew down. We worked a little late that night, as I recall. But the rest of the flight went fairly well. So that was probably the best part we brought into the flight.

ROSS-NAZZAL: You mentioned there were four rookies on board. What sort of guidance did you give to those rookies? I mean, you, after all, had been on numerous flights before this flight.

DUNBAR: Well, first of all, you're working with four flight rookies, but you're working with very professional, experienced people in their own right. So what I tried to do was only--I didn't want to talk down to anybody. That's very discouraging to type one people. So what I tried to do was to couch everything in lessons learned and to use those lessons learned if they seemed appropriate, because circumstances can change, and I wanted them to know those lessons learned before they bumped into them themselves.

But the other thing I did was actually divide up assignments for flight preparation, not just the experiments, but, for example, I'd give one crew member all of the crew equipment. I'd give another crew member something else. The way that the Astronaut Office is organized, they work through other points of contacts in the office as well, so they're actually in a learning experience, too, and they're going to interact with other astronauts, and there's going to be corporate memory handed down. But I try to give them some up-front guidance, or maybe give them a couple options on how to do something, and have them pursue what works out best.

But at least I could give them some direction. Simple things, you know. How do you move the first flight day? How do you tell people that no matter how many times you do parabolas or go out and in the T-38 the day before flight, it may not make any difference. We can't predict who's going to be sick and who's going to be not sick, but we can give you some advice on how to start moving slowly; what kind of things may provoke you. That's, a lot of times, corporate lore. It isn't written down, as far as I know. What may have worked for me may not work for you, but here is some thoughts. Terry and I did that together. We usually did that kind of thing together.

I advised my crew to be sure they looked out the window occasionally when they had free time. I'd always had this goal for getting ninety minutes at the window, one orbit, and I never got it in five flights. That's why I'm not through flying. Someday I'm going to get another flight somehow; buy it, I guess. [Laughter] But in any case, we're there to work. It's a job, but there's also that part of being there that you want to take away with you.

ROSS-NAZZAL: Could you compare this flight to your previous Shuttle Mir flight?

DUNBAR: Different circumstances. When I came back from Russia to train for STS-71, I came back at launch minus three months and picked up on Spacelab systems and experiments. I was able to do that because it was my third Spacelab flight, and a lot of the experiments were the same ones I'd been training with for the Mir, anyway.

But it was very, very rushed, and so I wasn't integrated into the crew that well, either. They'd been training together for what, nine months, and here I kind of step in. It was professionally integrated, but there's a certain amount of bonding that occurs up front that is more informal, and so I don't think I ever got that way. I wasn't in the in-jokes, for example.

[Robert L.] "Hoot" [Gibson] was great as my commander, but there was just a part there that just seemed like it was always very rushed. You go straight from thirteen months in Russia into three months into the last three months of a Shuttle training flow, it is pretty much running the whole time. Whereas on the STS-89, we were together for nine, ten months. I was there from the beginning to the end.

ROSS-NAZZAL: Any other comparisons?

DUNBAR: Well, STS-71 was exciting. That was the first docking flight since Apollo-Soyuz [Test Project], so, yes, there was a real thrill in that. There was a thrill when we finally docked. I was actually in the right seat, the pilot's seat, monitoring the display, so I didn't get to look at the overhead windows as we closed. I saw that later on film, but when I was finally able to get out of the seat and look in the overhead windows and see a real Space Station. Not spinning like *2001*, but a real Space Station we were docked to, and I was about ready to see people I'd been training with. That was pretty exciting.

STS-89 was exciting, too. I was doing pretty much the same job again, monitoring displays, talking to the Russians. On both flights, I did the Russian communications to the Mir. But it's still exciting. In that case, we were exchanging crew members, American crew members, but we also took up two crew members--let's see, I'm trying to think. We took up--no, we had just exchanged the American crew members, Andy [Andrew S.W. Thomas] and David [A. Wolf]. I get all my flights mixed up here. But the two crew members that were on board, well, Anatoly [Y. Solovyev] was one I had trained with, so that was kind of fun to see him up there.

ROSS-NAZZAL: What are your memories of that first day in flight?

DUNBAR: From 89? Well, of course, the first day is a preparing-to-rendezvous day. It takes us two days to finally meet up with the Station. So I remember, you know, your biggest activity is post-insertion activities. You're getting your suit off. You're configuring the vehicle. You're getting ready for bed. You're cleaning up the entire middeck area. I say cleaning it--organizing it, so that when you start the next day's activities, you're not worrying about finding things. You're not getting behind the time line.

So the first day is hectic, but we had trained that several times. Everybody knew what they were supposed to do. I thought it was reasonably well organized, so that we got to bed on time, and the next day, we got up on time. I don't remember being tired. That was going to be our docking day.

Docking went extremely well. Terry's an excellent pilot; did a great job. Everything was pretty much nominal. I'll have to go back through my notes. I remember that there was

something--Mike [Michael P.] Anderson and I were working the docking module in operations, it seems to me there was something there, but I can't remember now what it was. But nothing that was critical enough to impede normal operations. Opened the hatch, did the television, and started docked operations.

ROSS-NAZZAL: Did you exchange gifts?

DUNBAR: Yes, we did. We did that all in the base block, which is their equivalent service module, at the table.

ROSS-NAZZAL: Do you remember what you exchanged?

DUNBAR: Good question. As I recall, it might have been some models or pictures we signed. That's a little fuzzy to me. See, when I talked about dividing tasks, I wasn't in charge of gifts. So I was probably worrying about something else at that time and just showed up in time for the camera and lights and this, and then the commanders exchanged the gifts. I probably didn't even see what they were. [Laughs]

ROSS-NAZZAL: So what were you in charge of?

DUNBAR: Oh, well, a lot of the choreography of what was happening during the flight. I told you I was doing the flight plan, so I was sitting there with the post-insertion check list. I had some switch operations, but I was there checking off, making sure everything got done on time

and that the right people were doing it and also monitoring the display pages. That was true with docking as well.

I was in charge of the integrated time line, making sure we did things on time. I'd say, "Here's the time. CDR [Commander] this." Now, they all had--we only had two copies of that flight plan, so there was one there you could reference on the aft flight deck that everybody could look at, and then there was one in my lap. I was the scorekeeper. If it got done, I checked it. If there was something not done on time, we might not dock.

Joe Edwards was on my left in the commander's seat, and he would initiate the burns. He'd put in the--actually, we took some turns in putting in the commands, the keystroke commands, and then we would eyeball each other and make sure we'd agree that we had the right command in, and we could do a countdown, start the countdown clocks--and this is all manual--and then initiate the burn. So he and I were doing that on the front, and then I would check, yes, that burn is complete, and we would walk down through that time line.

The same once we were docked. I had the flight plan, which included everything in the SPACEHAB, and I had experiments, myself, to operate and transfers to do as we transferred experiments and cargo back and forth. I'd put the flight plan up on a hook on one of the handrails, and I just made sure--people that did something came and checked their own activity off, and then I policed it and just made sure, "Yes, we've done everything," and then I'd let the ground know what time things were completed.

Because that's the only way you really learn how long an activity takes is if the crew tells you. No one has a camera on a crew member all the time, or even knows what they're doing all the time unless they're familiar with the activities. So if you don't tell the ground it took fifteen minutes to set that camera up, then the next crew doesn't learn how long it really took. You have

some very smart, bright, young, energetic, athletic young engineer who can do it in the simulator in five minutes, and they'll put that in the flight plan. But now you're zero-G, you're all hands and legs. It wasn't where it was supposed to have been stowed, you know. No, it took twenty minutes. So that's how long it really took, and you need that feedback, those lessons learned, so the next crew can benefit from it.

ROSS-NAZZAL: I'm sure that's an invaluable resource.

DUNBAR: Yes. Well, we hope that--I was very religious about it, because I know that we had benefited from it, from past flights.

ROSS-NAZZAL: I understand on this flight you were working on telemedicine. What is telemedicine?

DUNBAR: Yes. Well, it's what's called the Telemedicine Instrument Package, TIPS, I think it was. What it was was basically a suitcase that in that suitcase included all the equipment to do a physical exam with the data connected to the Shuttle communications system, the downlink system, so all the data went to the flight surgeons in mission control. That's sort of what telemedicine is.

Telemedicine is not a new concept. I mean, UTMB [University of Texas Medical Branch] down in Galveston [Texas] does diagnostics medicine on people all over the country, even in prison populations. What was new was doing it from the Shuttle with a multiple hops involved, satellite hops. So we could hook up an EKG [Electrocardiogram]. We could send

stethoscope sounds down to the ground. We actually had small cameras. You could do eye exams. You could do skin exams. So there were a number of things. That was a Pathfinder piece of instrumentation that we wanted to mature for both Space Station as well as for exploration.

ROSS-NAZZAL: Did every member of the crew participate?

DUNBAR: No. [Laughs] We had two crew medical officers on board, myself and Terry, so we actually set it up. We did an exam, a full exam, on each other, and then I think we might have had--maybe Mike came in. I don't recall who else got maybe partial exams.

ROSS-NAZZAL: Before the flight, did you go to some medical training or meet with some physicians?

DUNBAR: Well, we actually were trained on this very package, the training version of it, here at JSC by flight surgeons and by engineers. So, yes, we were trained by the instructors as part of our medical training.

ROSS-NAZZAL: I understand that Dan [Daniel S.] Goldin called on board this flight. Do you remember that phone call, and what occurred?

DUNBAR: I think he talked to the commander. He was probably up on the flight deck, and I was probably someplace else. [Laughter]

ROSS-NAZZAL: Making sure those boxes are checked.

DUNBAR: Maybe it's a memory thing, but I don't remember it precisely.

ROSS-NAZZAL: I also read that you paid tribute to the twenty-fifth anniversary of the Skylab Project.

DUNBAR: Oh yes.

ROSS-NAZZAL: Do you recall what you said?

DUNBAR: Well, I have it in my notebook. It was very intentional, because I felt that the world was forgetting about Skylab, and yet it was my earliest experience here at the Johnson Space Center. I came in as a Flight Controller. I started working Skylab reentry as a Guidance and Navigation Controller. Of course, it wasn't crewed at that time. We brought it back into the Earth's atmosphere in 1979.

But here we had the country's first Space Station. It set three world records, and the longest, eighty-four days. The book called *Biomedical Results of Skylab*, which really documented, for the first time, different physiological changes in the body, became a world standard. Even the Russians were using it to extend their missions on Salyut; at least, one of their flight surgeons told me that.

Yet here this great program was sort of missing from the American consciousness, as I learned going out to give speeches. I was a great admirer of all those crew members, and, of course, Joe [Joseph P.] Kerwin was still with Wyle Labs [Laboratories] at that time. So I felt it was appropriate, since we were getting ready to build a Space Station in 1998, to also give tribute to the Skylab crews and the mission.

ROSS-NAZZAL: You mentioned your notebook. Is that something that you would keep on every mission, or is this something that you've compiled since you've been an astronaut?

DUNBAR: No, we each take a notebook up with us. It's kind of personal mind-ticklers, you know, or things that we want to make sure we don't forget that aren't part of the formal Flight Data File, we call it, and notes and that type of thing. We get to keep it. It's one of those few things we get to keep. So I have, I think, the last three missions, we had those implemented, and I have all three of mine.

ROSS-NAZZAL: What a great memento.

DUNBAR: So, yes, I had all my notes, what I was going to read in that.

ROSS-NAZZAL: Do you have any other memories of the mission itself?

DUNBAR: Well, you know, it's the one flight film I now show all the time I speak, so every time I see it. Well, I think what is sometimes forgotten—we exchanged crew members, American

crew members, Andy Thomas for David Wolf, and we had, I think, somewhere over 2,000 pounds of cargo exchange. But we also had twenty-three science and technology experiments. Some of those were predecessors of what we eventually deployed on the Space Station. We actually tested the Canadian Space Vision System on that flight, which was eventually used with the robotic arm for assembling the Space Station. We tested a mass measuring device for looking at changes in crew weight, which is going to Station. So it was a Pathfinder flight.

I think it's really important to remember that on the flights we execute now, we have an opportunity to test hardware, test protocols, equipment, in the real environment before we deploy them on the next vehicle. So that's a risk mitigation strategy. That means we'll have more successes than failures if we can do that, and I think we demonstrated that on our many Shuttle flights before we flew Station.

We also had an experiment from West Germany. We had some pregnant swordtail guppies that gave birth. They were looking at the development of the vestibular system, and that was very interesting. Let's see. We had an experiment--we were talking about Station development. We had the prototype of what's called the Volatile Organics Assembly [VOA] that's now on Station, but for looking for twenty different contaminants in the air. Well, the breadboard of that, if you will, flew on STS-89. We had a failure, but we got to fix it. We understood what was happening, and that's, again, risk mitigation.

We had an experiment from Japan. That was the Real-Time Radiation Monitoring Device, RTMD; looking at the radiation flux through the South Atlantic Anomaly, so it was actually the equivalent of--almost as large as a Space Station rack, not quite, and it was sending real-time data down to a team of Japanese researchers. So we actually had international involvement in that flight that isn't always recognized.

ROSS-NAZZAL: Did you have a chance to visit these two nations before you worked on these experiments, or did they meet you at JSC?

DUNBAR: They actually did all the training in the U.S. Those two experiments were--let's see, I believe the guppy experiment was on the middeck, and the Japanese experiment was in SPACEHAB, and they came and trained us in the U.S. I've been to both those space centers, of course, the German and Japanese space centers, but I didn't train there on these experiments.

ROSS-NAZZAL: Any other memories from the flight? Anything significant or funny?

DUNBAR: Great crew, absolutely outstanding crew. I think Terry's one of the best commanders I've worked with. I've always had outstanding commanders, but I thought that he did a really good job of working with the crew and the Russians. Let's see. Everything was successful. We had a successful ten-day flight. No losses of any of the research. We did fix the VOA, and we got it up and running, got the experimental data they needed. So I was very satisfied with the flight. It went well.

ROSS-NAZZAL: I'm glad to hear that. And I'm glad to hear that you're hoping to get another flight.

DUNBAR: Not in the NASA system. [Laughs] I think I'd have to make my own vehicle to get a flight at this point, but, you know, I can stay forever optimistic.

ROSS-NAZZAL: Well, I'd like to talk about your role as Acting Deputy Director of Flight Crew Operations. How did you find out about that position, and how were you offered it?

DUNBAR: Well, I flew STS-89 in January of 1998, and I was approached a little bit later, I think by Dave [David C.] Leestma. I was looking for something to do. You know, we have jobs after flights. He asked me if I wanted to come in and be Acting Deputy Director of Flight Crew Operations. I said, "Sure, that's a good experience, and I'd like to do that."

So I went up there, I think, in either April or May of '98. Then even--well, just after the first part of the year--oh, I also had kind of another job, too, okay? Mr. [George W.S.] Abbey asked me to start working; see if I could support him on some university partnerships, as well. I'm trying to remember the order of this and don't have it completely straight, but I ended up working myself into another job.

So then in early '99, Harv [Harvey L. Hartman] who was head of HR [Human Resources], talked to me about coming up to the ninth floor and developing a full-time position as the Assistant Director for University Research and Affairs, which is what I did. So I was a Deputy Director of FCOD [Flight Crew Operations Directorate] for about six months.

ROSS-NAZZAL: What were some of your main duties?

DUNBAR: Well, sort of duties as assigned; what Dave wanted me to do, really. If it was covering a board, one of the boards where FCOD's represented, I would do that. You know, issues as they came up. It varied. We were in the middle of a lot of Space Station types of things on a lot

of issues. So it was really not a day-to-day defined activity. We also included Aircraft Operations Division out at Ellington Field [Houston, Texas].

I think the one big thing I remember, Bob [Robert J.] Naughton, who was the chief out there, was interested in getting some temporary cover for the KC-135. So I philosophically supported him on that in trying to carve out the budget money, and helped him defend that.

ROSS-NAZZAL: I have read that you found that there were some problems with the EVA [Extravehicular Activity] and crew escape suits, and that you worked some of those issues.

DUNBAR: Oh yes, I did that.

ROSS-NAZZAL: Can you talk about that?

DUNBAR: Well, actually, this gets into the new ACES [Advanced Crew Escape System] or pressure suits. I was starting to get comments from the crews that, especially the women, that the new pressure suit wasn't fitting. So I started looking into it--it was under contract to the Shuttle--and found out, as it was verbally told to me, that the old launch and entry suit, which you have to wear during ascent and entry, fit the entire range of everyone. But somehow when we signed the contract for its replacement, which was a full-pressure suit, the ACES, we ended up going back to about a 1956 Air Force database, which was primarily based on Air Force men and large women.

So we were missing about two sizes at the lower end, and I mean, really significantly bad fits. I'm considered, in height, anyway, a 75<sup>th</sup> percentile female in height and about a 90

percentile in shoulder width and that type of thing. I went over and did a suit fit. The arms were so long that when you--these gloves go on with a ring attachment--that my fingers were at the glove ring, and you could bend the hand all the way back. When you pressurized it, you had absolutely no motion, which is generally true of the suit, anyway, but I was concerned that even after depressurization, there was no way I could manipulate a harness to get out of the seat, or hook up to the escape pole for an emergency egress, or even get the rope and rappel out the outside.

I tried it. I went over and did a demonstration. I says, "Look, you know, most of the women are smaller than me, and this isn't going to work."

What was really interesting to me is, you know, I mentioned this interaction with the Russians at the beginning. I was getting a little push back. I was first told, "Well, we can't afford it."

I said, "Well, we're going to have to. This is a safety problem. This isn't a problem of looking good. This is a problem of people not being able to save themselves, and if someone's behind them, holding everyone else out in emergency egress."

So we ended up--this was through a company in Worcester, Massachusetts, David [Clark Company]. I flew up there. It was a great company. They build all the pressure suits for the Air Force, as well. Basically, we were flying an Air Force pressure suit. But they had a limited set of measurements, and it wasn't clear to them what the problem was. One of the problems was that the reason suits weren't fitting well is that they had made everything to a male hip proportion, as well. Well, women have different hip proportion, and so in order to get the hip to fit, the upper torso was so large, it wasn't even close. So once they figured that out, that was

kind of a “Eureka” moment. [Laughs] I have to tell you, I was a little surprised it was a Eureka moment, because I imagine the apparel makers have figured that out a long time ago.

We flew up--I don't know--eight, ten women; I can't remember how many flew up. They took individual measurements to come up with, I think, two additional sizes. I have to go back through my notes. But we managed to get that through.

I know I wasn't real popular with some of the people outside FCOD, but it didn't matter. The right thing to do. I mean, it would have been another EVA suit story. We wouldn't have had a suit that fit them; therefore they wouldn't have been assigned, and you've got all these people sitting in the office who walked away from other careers, and we're going to say, “No, you can't fly because I don't want to build a suit for you.” It simply wasn't correct. It would have affected Eileen [M. Collins], probably, too, because it was a significant problem.

So we got the suits in line. I think we had a glove problem. We actually still had a glove problem even--we had a glove problem on 89 for the guys. I mean, they didn't fit broad hands. I left before we, I think, fully solved that.

But I related to a situation I had on STS-89. I didn't fly the new suit on STS-89, because it didn't fit, and I flew the old suit, which was a medium, by the way. So I was flying a medium LES [Launch-Entry Suit], and the rest of the crew was in full pressure suits, launch ACES. Salizhan Sharipov showed up, and I was kind of his mentor and keeper, because I spoke Russian, and he was just learning English. So I remembered when I went over, and I had my fit check on this new ACES, and I remember I told you I was laying on the floor the first time, and I actually had suit techs [technicians], as well. “You'll have to wear this size. We can't afford to make your size.”

I said, “But I don't feel safe in this.”

He says, “Well, we don’t have enough budget to make your size.” So that’s when I went into the LES.

I took Salizhan over. Salizhan got in, and they pressurize the suit, and he’s complaining a little bit because maybe the finger is an inch too long, and the suit tech says, “Well, that’s not safe. That’s not safe.”

I just looked at him. I couldn’t believe it. [Laughs] So if it wasn’t safe for Salizhan, how could it be safe for me? I vowed that after I got off that flight, you know--then I had that opportunity to do something about it. That was simply a double standard in terms of safety. So I hadn’t forgotten that.

ROSS-NAZZAL: How long did it take to make those changes and get those suits in place?

DUNBAR: Well, that’s a really good question, because I went up on the ninth floor before it was fully implemented. I just know that eventually they stopped flying the LES and had all the ACES in place. I think it was probably by the time--you’d have to ask Nancy [J.] Currie, because she was one of the people that was affected and the one I was most worried about, because she was on the FGB [Functional Cargo Block] flight, and I think she’s one of the people that came to talk to me. She’s the Army helicopter pilot, as well. So I think by the time she flew the FGB flight for the assembly and the start of the Station, that she may have had an ACES suit, but I’d have to check.

ROSS-NAZZAL: The other item that you focused on while you were in this position was encouraging more support for individuals who were living in Russia. Can you talk about some of those items that you pursued?

DUNBAR: Well, of course, that was not just for me. It was a general--for everybody. I had done a tour in MOD [Mission Operations Directorate], as well, and when I was in MOD, before I went to train on STS-89, MOD, Mission Operations, was already putting in a support plan for their people. I concurred. I supported that, because we were trying to put in support. We put support plans in, or trying to put support plans in place for the crews themselves, but we were sending more and more people in Mission Operations over. We were starting to lose people, because they were going to be gone for a long time, and there was no support over there.

So I didn't really do anything by myself. I kind of weighed in to make sure that the people that went over had connection to home, that they didn't feel abandoned by the organization, that people talked to them. I just would remind people, the office, that they were still--part of the office was overseas. But I wasn't changing the culture at that time; I think I was helping to reinforce it. So I can't take credit for anything special there.

ROSS-NAZZAL: As you mentioned previously, you started working into a new position with Mr. Abbey as the Assistant Director for University Research. What were some of your duties in that position?

DUNBAR: Well, it was interesting. Mr. Abbey and I were having a discussion after my last flight. I was in I guess it would have been my fifth year as a member of the National Science

Foundation's [NSF] Engineering Advisory Board. The NSF is responsible for keeping all the national statistics on engineering enrollment and graduation. I was telling him about the last meeting I'd been at where since 1987, we'd been seeing a significant decline in engineering enrollment and graduation. In fact, we were only graduating about two-thirds of the freshmen in engineering, you know, that started. And that compared to countries like Japan and other Asian countries, we're well behind, and that it was going to really affect us in the future.

He was very interested in that, and he observed, from his point of view, because, you know, he started back with Dr. [Robert R.] Gilruth and Apollo, that we used to have a much more proactive relationship with the university community. Now, NASA was putting \$1.1 billion a year directly into the university community, but very little of it was coming through the Office of Space Flight [OSF]. Most of it was coming through Space Science and Earth Science.

So it was going to those departments that were creating that pipeline, but we weren't creating a pipeline in Aerospace Engineering, except if it were unmanned rockets. We needed people that knew how to build human-rated systems and knew how to build live support systems and so forth. We did not have very many university grants, if any, except for education coming out of OSF. So I started doing a little bit of homework and found out that when Max [Maxime A.] Faget was head of Engineering, that he may have had the equivalent, in today's dollars, several hundred millions of dollars that he could send to universities.

ROSS-NAZZAL: That's a lot of money.

DUNBAR: Well, I got my master's degree on NASA money, you know, for the Space Shuttle, working on thermal protection systems, so my task was to start without any money, but

reconnecting to the university, starting in the state of Texas, to let them know that human spaceflight was still here, and that we needed engineers, and that we would provide a presence on their campuses, and that I would help connect them to where there might be money. Then I also got all the earmarks, too, so when they came down, it was my job to ensure that we got a product out of them, which I tried very diligently to do.

ROSS-NAZZAL: What sort of projects would you get out of the schools?

DUNBAR: Well, the first thing I did was hold what I called the Engineering Dean's Summit. Remember when we used to have kind of a technology open house on-site, about I think it was in the year 2000. In conjunction with that, I invited all the deans of engineering and vice presidents of research, where we had contact information, to first come to a half-a-day set of presentations. They could still do all the tours, because they were all set up, but we would take all the directorates--and it was at the Gilruth [Center]--and we'd come in and show them what we do.

Actually, it ended up being a half a day on one day, half a day on another day, and then they could take tours. We put a CD [Compact Disc] together. We didn't get all 256 deans, but that's fine. We got about a hundred people there, many of whom had not been on JSC forever or for a very long time.

Then did the same thing again in the year 2000, but we didn't have that open house then, so it was kind of a one-day workshop at the Gilruth. My perception was it was a good day; they really appreciated it. But it wasn't as effective as being able to go around to the different buildings and have everything already out there for you to see and touch and do. But it was at least still an effort to have a presence at the universities.

ROSS-NAZZAL: Did you try and develop any sort of mentoring programs for students?

DUNBAR: We had programs that I actually tried to put more light onto, because I wasn't the Education Division. I supported them. I made sure people knew it was there, and then I started some programs. I started the Mars Settlement Design Competition, which brought in students from all over Houston for a weekend in Building 9, and then we exported it to White Sands [Test Facility, Las Cruces, New Mexico], and they brought in students from all over New Mexico, including the Four Corners Indian Reservation, which was a lot of fun.

Then my other charge from Mr. Abbey was to grow the KC-135 student program, so I was out growing that. I think we finally maxed out our capability there and got funding for it, for the airplane. Had a good competition for grants, and then I would go out to Ellington and welcome them when I could.

ROSS-NAZZAL: Did you work at all with the Co-op Office?

DUNBAR: I supported it, but I tell you what, the Co-op Office is so successful, they turn away candidates. So I would go to their welcome sometimes. Whenever they asked me to come down and give a speech about exploration or something about spaceflight, I always did that and would try to fulfill all the invitations from the Educational Division, where it came to talk to the young people.

ROSS-NAZZAL: I also understand that you were coordinating an effort to apply NASA expertise to solve some of Texas' water problems. Could you talk about that?

DUNBAR: Oh, how did you find that out? [Laughter]

ROSS-NAZZAL: I actually saw a nomination that you had, and that was listed, so I thought I'd ask you about that.

DUNBAR: Oh. Well, it wasn't my idea. It was Mr. Abbey's idea. He was asked to be part of the Texas Water Board, which was set up in Austin, as an effort to start looking at the state's water problems, because it hadn't been looked at from a synergistic point of view, ever.

Because it's an interesting state. The state has what called Capture Water Rights, which means if it's on your property, you get to keep it. So, fortunately, people have been very generous. They don't stop up all the rivers that are on their property and have their own lakes. They will let it run through their property.

But then you have one side of the state that gets a lot of rain, us, and you have another part of the state that's agriculturally oriented, like the Panhandle, that depends on rain, but doesn't have a lot of artificial irrigation. And you've got the Rio Grande, that you've got disputes between Texas and New Mexico, so it's a very diverse state.

Well, it was actually the governor's office that was interested in seeing whether or not NASA had any technology or insight that could come to bear on that. So Mr. Abbey brought Don Henninger, Dr. Henninger, down on one of our flights, because he was in charge of closed-loop life support and water reclamation for spaceflight. We looked at whether we could take

technologies that we had and help apply them or at least bring some more visibility to the water problems.

A couple of things we did is we had an earmark come through from Texas Tech University [Lubbock, Texas]. Now, Texas Tech called me and said, "We didn't ask for this." They were very embarrassed about getting an earmark. They wanted to earn it. "What can we do to earn this money?"

I said, "Well, you know, you're ag--." They're an agriculturally oriented university, because we'd already toured them. "We'd be interested in developing a project with you that might involve water recycling or something, or helping people understand how to manage water." So, as I recall they did a little, I think it was maybe in either civil or chemical engineering.

They wanted to do something that would recycle gray water with some of these very poor areas down at the border, and they actually did it. Gray water is not the wastewater out of the toilet, but out of the washer and dryer. They had some beds. They'd use the washer and dryer, and the water would come out into some sort of garden bed, percolate through, and eventually it would drain clean. So this house was kind of self-sufficient in that. It was kind of a demonstration. They did very well in that.

Then I'm not sure what happened to the Water Board. Of course, Mr. Abbey left in 2002. Of course, we had Mr. [Roy S.] Estess for about a year, and then General [Jefferson D.] Howell [Jr.] come in. I think when Mr. Abbey left, the involvement with the Water board probably went away.

ROSS-NAZZAL: Do you remember any other key projects you worked on in that office?

DUNBAR: Well, we took part of an earmark, again with Texas Tech, and got the--it was called the "salad machine." It was actually a plant growth unit from Ames [Research Center, Moffett Field, California] shipped to Texas Tech. They reinstrumented it, because they're very interested in--have a kind of a closed environment for growing plants in 1-G to support us in our future exploration work. So they put it right in the middle of their agricultural complex. Again, I think the liaison was with Dr. Henninger's lab, and so I haven't checked in it in quite some time, because that was three years ago.

Gosh, yes, there are some other things. Oh, University of North Dakota [Grand Forks, North Dakota], Dr. George Seielstad, who's chairman of the aerospace department there, came down to visit us. He wanted a relationship with human spaceflight. They had a lot of NASA money coming in for Earth sciences and space sciences. But, as he pointed out to us, if JSC represents the middle of the United States, we don't have any aerospace companies going from Oklahoma, I mean for space companies. He wanted a presence there.

So I visited them twice; I gave some lectures. We then linked them up with the wharf on the Space Station, and actually they got Senator [Byron L.] Dorgan excited about that, taking pictures of North Dakota, South Dakota, using some stuff that--AgCam was the project that they developed. It was based on some small-airplane work they do, as well.

Unfortunately, the wharf is under threat of being not manifested, but you have all these students that have built this sophisticated instrumentation, and I really hope they get to fly it, because they're going to get some great pictures back that's got data in it that will affect that whole Upper Midwest area.

So I have to go back to my list, but those were some of them. Oh, Rice University [Houston, Texas] and nanotubes, we did the cooperative agreement with Dr. Rick [Richard E.] Smalley on that, based on work that we did in-house here, and that we funded one of his graduate students, so we helped him grow that. There's NASA money in that Carbon Nanotube Project at Rice.

ROSS-NAZZAL: If you don't mind, I'd like to talk about the *Columbia* accident. Where were you when you heard about the accident?

DUNBAR: Interestingly enough, as I recall, that was a Saturday morning, if I'm not mistaken. I was going to come in. I was still on General Howell's staff. But he'd just taken over, and I wasn't sure whether I could still get into--I usually used my badge to get into the Director's suite there. I wasn't sure it was still good, because he was still manipulating his staff. So I decided to watch it from home, and that's where I saw it.

ROSS-NAZZAL: After you heard that they had lost communication with the Shuttle, did you come on-site?

DUNBAR: Yes, I came on-site immediately. Actually, you know, it was one of the first times I had not been in the Director's suite looking at all the displays, most of which had to do with thermal protection systems, because that's what I came from. I'd always worried that the next accident wouldn't be a launch; it would be an entry. But I also knew the tiles were pretty robust.

But I didn't know that we'd even been having a trend with this ET [External Tank] bipod, which is not factory-laid foam.

So I immediately came in. You know, a couple of weeks later, they were interested in doing tile repair, so I had worked on that back in 1978, '79. I brought in all the papers and documents I had on that and gave those to Engineering.

ROSS-NAZZAL: Did you play any role at all in the investigation or the recovery efforts?

DUNBAR: Only from a resource point of view. I knew a lot, still knew a lot, of the people in the field, so I provided some names and addresses to the CAIB [*Columbia* Accident Investigation Board] on an Excel spreadsheet.

ROSS-NAZZAL: You've changed positions quite a bit lately. In the fall of 2003, you were promoted to be the Deputy Associate Director for Biological Sciences and Applications. What did that require?

DUNBAR: Well, I went from being a staff position to a line manager. This was an opportunity for me. I felt, if I was going to continue a career with NASA, that I needed to get back into line management experience. So Space and Life Sciences took a very successful Cellular Biotechnology Program that had been flying on the Shuttle and on Mir, and decided to put it into a new division. They brought in, as the new director, Dr. Neal [R.] Pellis, who was the principal investigator on this and also had been the chief scientist for Space Station at NASA Headquarters [Washington, D.C.], and asked me to be his deputy.

ROSS-NAZZAL: What were some of your job duties?

DUNBAR: Well, my first job duty was to implement the Quality Management System [QMS]. Now you're starting to get into management, you know. [Laughter] So that meant QMS has with it certain standard requirements --developing metrics, our reporting packages, you know, safety laboratory inspections, budget, outreach, communications with Headquarters, all of the above.

ROSS-NAZZAL: Quite a change from your engineering duties early on in your career.

DUNBAR: Well, I actually used my engineering duties. It was a good marriage, because Dr. Pellis, he was the scientist. He's the cell biologist, an immunologist. But our major task was not just doing the research--we had fifty university researchers on grants--but building a new Space Station facility called the BTF, the Biotech Facility. That was a major, multimillion-dollar project with Wyle, so while that was in process, we had a lot of project management reviews, budget reviews, hardware reviews. So in terms of the QMS, those are the things that Neal would sort of push off at me. They were all engineering-type things, so I was able to use my engineering.

ROSS-NAZZAL: What were some of the other assignments that you had after working on QMS?

DUNBAR: Well, I'll tell you, that's a big one. Well, gosh, you know, kind of day-to-day--that's a big assignment. The rest is day-to-day, you know, budget, management, personnel, everything a manager works on to get a project developed.

ROSS-NAZZAL: Now, you've since moved on. You're now the Associate Director for Technology Integration and Risk Management.

DUNBAR: Yes, and that's an interesting story. As you know, we've been under quite a bit of budget restructuring in the last year to bring ourselves in line with the mission for space exploration. One of the decisions that was made--and I have to tell you, not for parochial reasons am I saying this. but I think it was a little bit shortsighted--was to eliminate the Cellular Biotechnology Division; in fact, eliminate all cell science in the agency. Because there's a belief that that's not related to human health. But we know that's not true. [Laughs] However, they needed to find money to pay for the rest of the vision.

Well, that put a lot of the cell science personnel out of work, essentially, but still within the directorate. Of course, we were understaffed, well understaffed. We had been trying to actually get people, bring them in. So we took our people and redistributed them to some of those positions. We had some good fits.

Then so Dr. [Jeffrey R.] Davis, the Director, actually had a need for someone to set up his risk management system, because we interfaced now with some very formal risk management databases and boards, one for Station, one for Shuttle, one for the Center, and one for exploration, which is being developed. So he asked me to set up the risk management system.

Then, because of my interfaces with the national academies and technology and different external boards, he asked me to look at kind of an advisory position in terms of technology integration. So where I thought there might be something on the outside, because I had all this university, all these university contacts. You know, is there something that we can--both ways, actually--export or also import?

ROSS-NAZZAL: I just had a couple of general questions for you, and then I'll ask Sandra if she has anything for you. What do you think was your most challenging milestone while working for NASA, or is?

DUNBAR: Challenging milestone; that's a really good question. You mentioned earlier about coming into NASA for the Shuttle Program, and there was really a change of thought about integrating women, and it was wonderful. You walked into a crew equipment room, and they were trying to fit you with everything. You walked out to Ellington, and they gave you your own helmet with your name on it, you know. So it was just a wonderful environment.

I think the most challenging was actually coming into senior management, if you will. I had a great mentor in Mr. Abbey and Harv Hartman in Personnel, whom I went to many times. But I think that's still going to be a little bit of the challenge for the technical women. I didn't find anything technically the biggest challenge. That doesn't mean that I knew everything, but it means what I didn't know, I knew how to go learn about, or be able to delegate, if I had to. There was always some way of tackling that problem.

But I think that NASA, as it's evolving, is going to go through that next step of bringing its senior women into either program or technical management. In other words, we still don't

have a Director of Engineering who's female, although there have been many women senior to me that I think could have been qualified. We haven't had a Program Manager, Shuttle, Station, or otherwise, that's been a woman, even though we've had some excellent potential people.

So that sort of tells me something, you know. We get HR, and we get IT [Information Technology] now, which is probably good, and get safety oversight. But it's going to be the big jobs, the more responsible jobs, that I've found a little bit still frustrating. It still didn't matter what you knew, or how you did it. There was still this structure there that was really hard to break through. Without sounding--I don't mean to sound I have a chip on my shoulder. It's just an observation. I've seen it with other women, as well.

I'd like to see another Dr. [Carolyn L.] Huntoon come through to be Center Director, and I think it would be good for the agency in a lot of ways, because the rest of the world is changing.

ROSS-NAZZAL: You mentioned Dr. Huntoon. When we interviewed Sally [K.] Ride, she mentioned that she owed a great deal to Carolyn Huntoon, that she was almost a mentor for her. Has anyone served as a mentor for you at NASA while you've been working here?

DUNBAR: Well, Dr. Huntoon, most definitely. She was even on my dissertation committee. I mean, I'd say that most of the women can owe their selection to Dr. Huntoon. I mean, she fought very hard in the early classes. And to a large extent, the men who got to do technical proficiency, maintain their medical degrees, can thank her, as well, because she--in the early years--we used to have funding for the mission specialists to maintain their technical proficiency, just like the pilots have funding to maintain their flight hours.

Pilots still get funding to maintain their flight hours, but the rest of us spend our own money, mission specialists, to maintain our technical proficiency. We lost that when she left. So I owe a great deal to Dr. Huntoon.

ROSS-NAZZAL: If you had to look back and pick one item that you think is your most significant accomplishment, what would that be?

DUNBAR: Really good question. Well, you know, it's kind of a hard question. My dream from childhood was being able to fly in space. The fact that I was able to do that--and you don't do it by yourself; a lot of people enabled that. I didn't build a spacecraft. I didn't form the agency. A lot of things conspired positively to allow that to happen, and I'm very grateful. So it's not just my achievement, but I'm very grateful for that opportunity and to have done it five times.

Maybe one of the enabling achievements to get there was just graduating in engineering, and that was all me. [Laughs] Every student for himself. So if I look back on it, sometimes I wonder. When you're young, you don't see all the stuff, you know. I had some mentors, though, and some help. I had Dr. Jim [James I.] Mueller--called him "Doc"--who was chairman of the department, that was a great supporter. Introduced me to my first NASA engineers, and allowed me to think that it was possible, and didn't call me crazy that this was what I wanted to do. So maybe that.

But, you know, I'm not through with life yet, so I don't know. I don't know if I can say what's the best and most significant yet.

ROSS-NAZZAL: Yes, I think it is a tough question. If you don't mind, I'm going to ask Sandra if she has any questions for you before we cut the tape.

JOHNSON: I just had one I thought of when you were talking about Shuttle Mir and being there two different times. In between, there were issues with Mir. I mean, there was the fire, the collision, and those kind of things.

DUNBAR: Fire and collision.

ROSS-NAZZAL: I was just wondering, your impressions of Mir from the first time to the second time you were there, and what maybe some of the differences were with the Station itself?

DUNBAR: Well, of course, there was another module on board by the time we went back, and one that was closed up. [Laughs] So it looked different from a configuration point of view, but it looked pretty familiar inside, except the U.S.-outfitted module was new. I can't say there was a big difference. It was the same vehicle. Sometimes it had the same smell. I couldn't tell, from a physical point of view, the biggest difference. Does that make sense?

JOHNSON: Yes. I was just curious.

ROSS-NAZZAL: Is there anything you think we should talk about that we haven't covered? I know we've had four sessions.

DUNBAR: Four sessions.

ROSS-NAZZAL: And they've spanned quite a length of time.

DUNBAR: I know. I'm trying to remember everything we've talked about. Well, twenty-seven years allows you to, I guess, maybe have some retrospection on the program and to look at lessons learned and maybe postulate about the future. I think we've all been waiting for the directive to go on to our next goals, and I think it's exciting to go on to the Moon and Mars.

I'm concerned about premature retirement of the Shuttle, because I think that will hinder our ability to do that; hinder our ability to do research on the Station that will enable our exploration, mitigate risks. That's because of what I know now in the directorate I'm in, and there are too many people that think that we've got everything solved, and we don't. I'm afraid that attitude is going to allow us to be too complacent, and we'll have another problem. It's hard.

If you looked at both the accidents we had, it wasn't just a failure of a system. It was a failure of policy and legislators and upper management. Both times what I saw, from my little knothole, was declining funding, eroding support, and personnel and so forth, and an attitude, even from Washington, that this was routine. So that after the accident, they all blame the Center's treating it as routine, and the poor engineers are taking it in the chins.

In fact, if you look both at *Challenger* and you looked at *Columbia*, both problems had a trend before them. Both trends sort of got put in different buckets, some of that due to management changes, and those management changes due to budget reductions. Both times there was chaos in the leadership. If you look at *Challenger*, our Administrator had just

resigned. If you look at *Columbia*, we were just going through a change, as well, including a Center leadership.

They keep forgetting that when you have flight operations, real-time flight operations, you cannot introduce a lot of changes at once, or you're going to break something. You have to always have the resources there. You can't keep cutting resources till you have the accident, and that's the way we've been treating this. Cut the resources; don't believe the engineers; save money. Then when you have an accident, regroup.

I'm concerned that we're going right down that line again. I see the vision, and I see the rhetoric, and I don't see the resources. I see the shortcuts that we're taking right now. So I'm hopeful. I'm one of maybe a small chorus, but there is a chorus out there saying, "Let's stop and take time to do this right. I know we've got a budget cap, but maybe that's not the right budget cap." Point-eight percent of the federal budget goes into space. We are spending \$100 billion a year on a war, and it may be a right war, but we should look at our future as well and spend more on that, or our young people--you know, talking about the pipeline will be moot, anyway.

So that's just some closing thoughts. You don't have to do anything with that. One of the diamonds in the nation's crown is its ability to explore the unknown, to pursue knowledge, and provide world leadership. I don't think we can afford to lose that. Many nations that have said they could are no longer on the forefront of history. So I hope there's some way I can help make sure that we stay in the forefront of history. Does that make sense?

ROSS-NAZZAL: Absolutely, yes. Well, thank you so much for sharing your perspective and thoughts with us over these past four interviews. We've really appreciated it.

DUNBAR: You're welcome.

[End of interview]