NASA ORAL HISTORY TRANSCRIPT

BONNIE P. DALTON
INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is April 23, 2002. This interview with Bonnie Dalton is being conducted for the NASA Headquarters History Office for the Herstory Oral History Project. Ms. Dalton is currently the Acting Chief of the Life Sciences Division at the NASA Ames Research Center in Mountain View, California. The interviewer is Rebecca Wright, assisted by Carol Butler.

Thank you again for finding time to visit with us today. We would like to start where you would like to start, maybe at the beginning of your time here.

DALTON: Well, actually, I'd like to go back a little further. As I commented when you came in—the step that led to my eventually being here, was going on for my master's degree, and in obtaining that master's degree. I was one of the first people at [the University of Montana Missoula, Montana] who had a fellowship in their doctorate program in microbiology. Of course, I didn't go on and get the doctorate, and that was always something to do in the future, I got done with my paper, my research, and my orals, which is different from [programs] today. I think, in many cases, San Jose [State] University [San Jose, California, as an example, one does] either a paper and library research, or laboratory research. We had to do the same program practically that you have to do for a Ph.D., and of course, I was very nervous [after the orals].

My advisor took me down for a cocktail afterwards, and we were chatting, and he said, "Well, now you've gone through this. Where do you think you'd like to work?"

And I said, "Well, I'd like to work for the government eventually."

And he looked at me, and he said, "For the government?"

And I said, "Well, I've had this Public Health Fellowship, so to me that says there are probably some really good programs in the government," and of course, at that time, I wasn't thinking NASA at all. This [was in] 1960.

"Well," he said, "I don't think you really want to do that, because you'll probably not go any further than a GS-11 working for the government," and he was somewhat familiar [with government employment and programs] because he had grants from the U. S. Army.

So I said, "Well, okay." So my first job was for a commercial company, a drug company in upstate New York. [After 3 years there], I applied to NASA by responding to an ad in *Science* magazine in September of 1962.

I did not hear a single thing until January [1963], when I [received a] form letter that I almost threw in the wastebasket that said, "Please fill this out for your rating." So I filled out the letter, and sent it back. I didn't hear another thing until July of '63, at which time—and remember, we didn't have e-mail, we didn't have all those things—I got a telegram—big deal—from NASA at Ames [Research Center], Moffett Field [California, which read], "Respond in ten days or forget it." [Laughs]

Being in the government now, I recognize [the delays], because [of] what you have to do when you have hiring openings or you have freezes, and they were doing it even in that day. They [set up] a pool of names, and as soon as they have a window [for hiring] they go out right away. But you, [the inquirer], don't hear anything in between. I was almost devastated, thinking, "Oh, I'm never going to hear from them."

So I came to Ames in October 1963, started the first pay week in October. Another interesting part about it was that my brother was out here at the time, working for Lockheed

[Missiles and Space Systems], and I couldn't figure out where Moffett Field was. You can't find that on the map and of course, Lockheed [is] right across the street, so [the move] actually worked out very well.

Another thing that has happened during my career is that before he came up to Lockheed, Sunnyvale, he was at Edwards [Air Force Base, California], next to Dryden [Flight Research Center], so the first time I ever went down there, that was sort of a nice link in the family. …

[In 1963, when I came to Ames], 16 percent of the work force was female. That included administrative, researchers, and everything. Now we're up to around 40-some percent, which is a big change. [In the] technical [area we still represent] only 16 percent of that workforce, but it has been a big change [from] where women were [20 years ago]. You would think [that] a research center, there wouldn't be anything different about where women were; [all] was viewed very differently than now.

I worked in research as a technician with a Ph.D., and again what happens in salaries, and what happens today [is different]. I came from a pharmaceutical company, having worked for them for three years with a master's—and now don't get shocked, because remember this is '63, so I was going into a salary of $8,000. When I came to Ames, they offered me $7,000 and that was it. What they do now, if someone comes in with a bachelor's, [they are offered] a GS-7, [and they have] a period of six months, to work on a special program in which [they] can then go to a GS-9. With a master's in technical, you would be hired in automatically at a GS-9, you wouldn't be at a GS-7.

I have a feeling that the biology degree and [being a] female had a part in [the salary]. No one would ever admit that, but I have a feeling that was probably true, because at that time,

biologists were at a lower rating than engineers, and of course, this is supposed to be an engineering center. NASA is an engineering organization.

My research was in working with extreme halophiles. My research as an undergraduate had been in immunology and had been in infectious diseases, primarily working on salmonella, which is an issue of diarrhea in a lot of the military camps.

So when I came here, I was working on an organism in the [local] environment, and working on an extreme organism [e.g. salt lover]. This organism is not infectious for people. In fact, when you flew in, you may have seen the red ponds out there. This organism lives in those ponds. It survives at 20 percent sodium chloride. If you took your blood and put it in sodium chloride at that level, you'd have these little coagulated blobs, and if you take this organism down to what people tolerate [(~1%) the organism] just lyses and bursts. We were studying that organism, because [as] an extreme [loving micro-organism], and [it would be] typical of something [one] might find in an environment like Mars. The studies in that period of time, here at Ames, in the Exobiology Division were geared toward looking at what we would do if we found extreme organisms on Mars and what would we provide as a medium in which to keep them growing.

Rather interestingly, the clock always goes around, and comes back, [to its beginnings. So] as you know, astrobiology [was] started [several years ago], and there's a lot of interest in the extremophiles again. [All of this again because of potential journeys to Mars.]

All [the early work] was geared toward the Viking mission, which launched in 1975. The Director of the Life Sciences Directorate … was Harold [P.] Klein. Dr. Klein was a biochemist, microbiologist by background, and he was the science lead for the Viking biology mission. I'll give you a couple of other numbers that are rather amazing. God forbid that they thought they

were going to build that biology package for $5 million. They overran the budget, and they took it up to $40 million. Can you imagine? [Laughs] Forty million. [Compare that to today's missions.]

So when [the budget escalated there was insufficient] time for the researchers who had the experiments on Viking to really play with the engineering equipment that was being developed at TRW [Inc.]. Because [of the lack of testing] Dr. Klein wanted to bring the units back [to] Ames. He wanted to have a home for them here, and he wanted to allow time for the researchers to do some ground studies. So I applied for, and was selected as the lead for that program, because of the microbiology background, etc.

I set up a laboratory with the three units here at Ames, and thanks to the expertise of a lot of our in-house engineers, our mechanics, and our electricians, we got those units to operate better than TRW had them operating. You hear [that] so much at many of the NASA Centers, [that] have shops (and I think this was even truer in [the] period from the sixties and up until more recently), they really had skilled artisans in those shops. [We] had craftsmen. Many of them were people who really liked to work with their hands, and they would work very hard at making something work. Some of them didn't have college degrees but they were truly craftsmen. [Some support] people I [had] did have degrees, but the electrician that worked with me and the mechanical engineer that worked with me had those units operating [splendidly]; the researchers were very, very happy that they were able to do those ground experiments.

Because some of them were using radioactives, they wanted to see, 1. whether they could detect carbon sources from organisms that they were using as models, 2. they wanted to be able to study the rate of decay of the radioactive materials they had in [the system], so they would really understand what their experiments were doing if they got data back. Unfortunately, they

didn't get anything that indicated that there was life on Mars, but for me, it was a very good experience [and started a career in operations].

Immediately following that, we were starting to work on Spacelab activities, and several things happened. [Planning] was starting up that we had to have a life sciences facility at Kennedy Space Center [Florida]. Kennedy Space Center, at that time, had no one who had ever worked with microorganisms or who had ever worked with rats. Now, when I came [to Ames], I [did] not work with rats. When I was at the pharmaceutical company, all my work was with rats and with mice.

So [since] one of the biggest users of Hangar L at Kennedy Space Center was going to be Ames, [management] said, "Okay, Dalton, go down there." So I sat in on the design reviews and actually designed the laboratories for Hangar L and developed the whole list, casework and equipment that had to go into that facility.

I have to relate another incident that several of the [KSC (Kennedy Space Center)] design engineers got very angry [about]. We came out of one of the design reviews, and the lead of [the KSC] science group who was focused on the crew health, [rather] than on what we might be doing in the life sciences, came out of the review and said, "Oh, we're just building Bonnie's dollhouse."

A couple of the engineers came and apologized to me and said, "He had no business saying that." [Times have changed.]

So, you know, it [was] '78. [There] was still sort of the attitude, "What are women doing here in our territory?"

So we got Hangar L [activities going in] 1978, [but] we were still uncertain in the agency on how we were going to do this operation of Shuttle and Spacelab; what would be the

progression of activities? Would we send [all our hardware] through Johnson Space Center [Houston, Texas] and marry it there, or would everybody send their [hardware and biologicals directly] down to KSC?

Marshall [Space Flight Center, Huntsville, Alabama] people [who do] microgravity [payloads], [sent] their stuff directly to KSC. The life sciences [groups at Ames and Johnson] were under the same umbrella, even though [they] had the human side and [we had] the non-human side, so in '78 [jointly conducted] Spacelab Mission Development Test 3 (SMD-3). Johnson had done a couple of these before but alone. We [assembled hardware and biologicals and] we timed ourselves on the time it would take us. We had a crew, and the crew was composed of a researcher from our life sciences group here [at Ames], a researcher from the life sciences group down at JSC [Johnson Space Center], and a crew person, Bill [William E.] Thornton. Bill Thornton, as you may or may not know, was one of the [astronauts] on Spacelab 3.

[SMD-3] was a good experience; we unanimously agreed, both JSC and Ames, that we should probably send our stuff down [to KSC directly]. It really didn't make sense to now have another encumbrance on JSC, particularly since they didn't do anything with animals, and when we even did this test, we had to set up temporary facilities for our animals and go through all sorts of activities doing that.

Researchers around the country responded to [the] first NRA [NASA Research Announcement]. You may remember, we were supposed to be flying Spacelab Life Sciences 1 [(SLS-1)] in 1982, which at that time was called Spacelab 4. We were getting our hardware together. Spacelab 1 occurred, I believe, in 1983. In 1983, we were down at KSC doing the integration for Spacelab 3, which was a Marshall-managed mission. We had not been originally

slated to go on that mission, but they had some space open up, and we felt it would provide a good opportunity to exercise our system and go through all the paces of what it meant to take animals down to KSC, and to integrate them into the Spacelab.

I forgot to mention, when we did the Spacelab Mission Development test, I was the operations manager for that. So I coordinated all the stowage and everything for our PIs [Principal Investigators] and [lined up the vans for transport to JSC. Then I lined up] a commercial C-130, and got the stuff down to [KSC for Spacelab-3]. It was a big experience [and] little bit different than doing research.

[Interesting things happened when] we got into Spacelab 3; that was a very, very valuable experience. [In] everything we do, the agency revolves around engineering, and when [Ames] came and said, "But we cannot put monkeys into the facilities and leave them locked up in a Spacelab in their cages for thirty days, on the pad, without power," it was like, "You what? Why didn't anybody tell us this?" [Nowadays, I believe the expression is, "Duh!"]

We said, "We've been telling you all along that we have to have late access," so that was when the whole late access activity began, and they had to develop this boatswain's chair. They were suspended down through the top of the hatch, and from the mid-deck down into the Spacelab, because, of course, it's sitting [vertically with nose toward heaven]. You had to drop all this [gear], and the guy had to carry the cages, one by one, down into the Spacelab.

We went down to KSC, [9] months before flight, getting ready to fly. One of the things that you have to do [is] go through IACUC at [Ames], an Institutional Animal Caring Use Committee, to make sure that you're treating the animals correctly. At JSC, you have to go through the Human Resources Board to make sure that you're not doing anything that will impact the crew health-wise or physically or emotionally.

Well, about this time, there was an outbreak of an infection, and I don't remember where it was, whether it was in one of the primate colonies in Georgia or whatever, but this strange organism appeared. Everybody started saying, "Oh my gosh, what if we have one of those in your squirrel monkeys?"

So, six months before flight, we had people going all over the world trying to find healthy squirrel monkeys, and they had to test them, etc. We finally got a pool of three squirrel monkeys, and they had to be shipped directly to KSC, and go into quarantine. While we were there at KSC, away from home, I had to arrange for rides on the [lear jet] that they have at Glenn [Research Center at Lewis Field, Cleveland, Ohio] at that time. They had a small parabolic unit, so we could get [the monkey] accustomed to [the reduced G]. So these are all the kinds of things that were happening in those days.

We also had to do something changed the whole lab animal supplier industry. We had to have our animals specific-pathogen-free. This didn't mean that they were completely pathogen-free, because if you had a completely pathogen-free animal, that animal would not have a good immune system. But there are certain organisms that [the monkeys and rats] may take with them, [e.g.] salmonellas, some pneumococci that people could get.

And remember that when we have animals or when we have plants in the Spacelab or in Shuttle, they share the air with the people in the vehicle. The air goes back and forth. Now, we have filters in there that filter anything out that the animal might send out, and there's filters also that filter the air [from] anything that the crew might [bring] in. [People are] more concerned about the animals [transmitting to the crew]. …

Unfortunately, in working with the contractor who built the research animal holding facility for the monkeys and the rats, we thought we had planned completely on the [behavior of

particulates] in zero-G. We had an air curtain like you have when you use a hood in a laboratory [laminar flow], but it was not a heavy enough air curtain. You're probably all too young to remember this. When they opened up the cages to do the food bar change-outs and the waste tray change-outs, guess what came out? Crumbs came out, feces came out, hair came out. So we were told, "You either change this, or you'll never fly again."

We actually took the units back to Lockheed, the original designer, and the decision was made that we would not fly monkeys again, because there was always the potential that there would be a primate organism that could be a problem when you were in the midst of human primates, the decision was that we would only fly rats.

We had some very, very good engineers who were watching this at the time. I was still in operations and had to work to arrange all the testing that went on, which meant getting the rats on board and the series of multiple tests, because Lockheed doesn't have an animal facility and couldn't do them there; we had to do those over at Ames.

What happens in this kind of situation, when you're doing all this testing, and when we were doing these things [together as] in the early days [are] where we would all be sitting around with the types of screwdrivers we needed, and everybody would be joining, taking the cages apart, cleaning them. Now we have set procedures and we have the techs [technicians], but this was really a very good learning experience, because it made those of us who might not be doing this later really appreciate the complexity and what had to go into the design of a cage. You start thinking about what you would be doing for a future cage in microgravity environment, [e.g.] you can't be working with something where there are little parts that could be lost. [Other things you deal with are] the food bar--there could be warpage. You've got a food tray; if you think about a stapler that has staples going through it, now think of a great big stapler that [has] this

long food bar, and this is the shape of them. [Dalton displays example.] This one is about fifteen years old now, and it's hard, but this is the shape, and they're very soft and malleable, and they have about 25 percent water.

I redesigned the food bar, because the first one that the contractors had made for Spacelab 3 crumbed a great deal, and that added to our problems. So interestingly enough, when I started looking at it and talking to the people at Teklad, and trying to figure out what we would do, the first thought that came to me, came from farm experiences. What happens when you chew wheat? You chew wheat and it gets like bubble gum. It has a great deal of gluten in it, and gluten is a binding agent, so I said to Teklad, "Well, could we put some gluten in there as a substitute?"

And they said, "Yes, that would be a wonderful thing to put into the diet," so that's how we got our [current] food bar.

Now, talking about the experiences you have in dealing with the cages and working with them, there were some [MIT, Cambridge, Massachusetts] student groups [at Ames] this past six months who were working with the Australians, and you may have seen this. They're trying to get a flight going, an independent commercial flight, and they're trying to design an animal-holding unit, and get it up, and they wanted the formula for the diet. The young man who was working on the mechanism for the food bar wanted to make a mechanism, and he wanted to make a nice thin food bar, and I said, "Don't go there."

He said, "No, it'll work."

I said, "Don't go there."

The engineers said, "Don't go there. She knows." They would have gone down that path, because even if you get it harder, you still have to have a certain amount of moisture, and

those things are just going to warp. When you get into a microgravity environment, whether you have it manned or unmanned in the Spacelab [or STS], the humidity was down to around 30 percent.

Now, when you have an unmanned [vehicle], you're going to have it even more dry, and you want to keep it dry, because you don't want to have humidity build up and then louse up your electronics in the system. You can take electronics and you can put them through ethylene oxide sterilization, which is a dry gas, but you can't put them through humidity or moisture.

… We have another type of animal habitat that we've worked with for years. It started in the student program, which started out at JSC, [and is] called the Animal Enclosure Module (AEM). [It houses] six animals in a cage; [here] we just glue the food bars on the side. Now, the person on the outside would look at that, and they'd say, "Wait a minute. Aren't those animals going to urinate and defecate? And what is that going to do?"

Yes, they do, but in a normal laboratory environment, the rodent consumes a certain portion of their feces just in their normal metabolism, so it doesn't bother them at all. In fact, I think sometimes [the reason] we probably don't have as much issue with PETA [People for the Ethical Treatment of Animals], and so forth, about rats, [is that] when you think about rats, you think [of them as] a dirty animal. When the rats come back from flight, those animals have cleaned themselves, or cleaned each other so well. In a cage with six animals, they've cleaned each other. In the research animal holding facility, which had single housed [animals, the rats] had just one little yellow streak down their back, but in the time (three hours until we were able to access them), they had cleaned themselves thoroughly. So rats are really very immaculate. That's a side story. [Laughs]

In Spacelab 3, I participated in training the [ground] crew in the operation of those cages, procedures that we had never thought about, because this was the first time we had done the modular vertical access. KSC said, "Well, we don't have any procedures for that. We know how we get on our boatswain's chair, but we're going to have to have some procedures for how we hand over the cage and what we do."

Remember that this is not the day of computers and so forth. It's the day, still, of typing a lot of things out, and you can't access your files. So we sat down at Hangar L at KSC and typed out the procedures for modular vertical access [a few hours before their use].

When we were ready to launch, I was not able to see the launch because I had to keep in touch with the veterinarian. If they had an [abort launch and had] to come back quickly, the veterinarian had to stage herself out someplace. So [here again] was [a] really, really unique experience that I never experienced on later flights, because [the support group was expanded and because] I was sitting in the control rooms [for launch]. But it was a lot of fun.

One of the other experiences that I always like to think about [relates to technology]. I don't know if you read [Alvin] Toffler's book [*Future Shock*] back in the sixties, when he likened technology to the fact that [technology is] like a pyramid; the closer you get to the top, the more rapidly you can go because the peak is getting [narrower and narrower], and you have so many tools behind you.

When we did Spacelab 3, I remember trying to communicate with [management] back home, and I would send faxes, and people would say, "You're sending a fax? That costs dollars, and that costs money on the telephone line. Be careful how many you send." That's [was] 1983 [to 1985].

In 1992, when we were at KSC for Spacelab Life Sciences 1, we were just beginning e-mail. We didn't have e-mail then, [but faxes were cheap]. A year and a half later, when they did Spacelab Life Sciences 2 [(SLS-2)], they had e-mail. I mean, look at the changes. And the fax? Who would waste their time on faxes? That was a waste of time, really. So, a lot of changes in that short time.

So, *Challenger* happened. We flew Spacelab 3 in 1985. *Challenger* happened in [January] 1986. … We were scheduled to have flown Spacelab Life Sciences 1 the following December-January, which would have been December '86 or January '87. [*Challenger*] delayed all of our plans. So we continued working on the research animal holding facility, and doing even more changes to it.

… The engineers actually put a vacuum cleaner [suction into the design]. We called it the single pass auxiliary fan, the SPAF, which we called our vacuum cleaner, so that when the crew opened up the door to go to the cages and change the waste trays of the feeders, this big "Pfooop" came on, and swooshed everything down to the back of the units, so there was no possibility of anything coming out the front. So we not only had the laminar curtain, but we also had this big blast of vacuum coming down to take things away from the Spacelab and keep things within the cages.

So that settled all that problem, and allowed us then, without any hesitation, to fly the research animal holding facility, which housed the animals individually on Spacelab Life Sciences 1, on Spacelab Life Sciences 2, and on Neurolab.

I was the payload manager for the Ames portion of the Spacelab Life Sciences 1, and that was going to be our "make-or-break." If we had any failures with that research animal holding facility, it meant we probably wouldn't be able to fly animals in Spacelab or Shuttle anymore.

So as we went through the planning, and fortunately, we did have [the] time, [due to] *Challenger* and as the crew worked with us on the training, and they saw how well this SPAF was performing and how well the unit was performing, they said, "We want to put animals in there. We don't want to just put crumbs and beans that look like feces. We want to [fly] animals [in the unit]." … So we flew animals.

[Flying animals] was a very valuable experience, because we were able to get baseline data for all the following flights that we wouldn't have had otherwise. Secondly, it gave the crew an opportunity to do some things that they weren't scheduled to do. They weren't scheduled to take the animals to the general purpose working station, and they did. And they took pictures of the reaction of the animals in microgravity, of course. At first, the animals they're sort of fighting and then they just give in to the gravity, and they float around.

[As a sidenote, Frederick D.] Gregory, who's [now Deputy Administrator, NASA] when he was out [at Ames recalled,] "Oh yes, I remember. I was on one of those early flights, flying the student Animal Enclosure Module." And he said, "I got really scared, because it was my turn to go see how the rats were doing, and I looked down and they were just floating around." And then he said, "I went to the commander and said, 'Can we get a closed line? We're going to have to tell them they're dead.'" And so he said, "We sort of whispered to the doctor, the flight doctor, 'We're not quite sure.'"

And he said, "Well, tap on the unit." He said they were alive, but he said they were just so comfortable and at ease and just floating around there. He said, "It almost made me feel like I wish I could be that much at ease." And they do that. They readily adapt. Now, when you take them out of the cage and take them to the general purpose work station, which we also flew on Spacelab Life Sciences 1, [and] which the crew did, they're now in this big case that's about so

big [Dalton gestures] with—oh, it's about so wide by so big. We made these little things, in fact, for flights as mementos [Dalton displays model], after Spacelab Life Sciences 1, because we had all the little particulates and the fluid, and so forth, floating around to test the thing out. The animals grabbed onto them [the crew's hand], so that was a predictor of what was going to happen in Spacelab Life Sciences 1 when they were going to do any dissections and any injections. They would have to be cautious of this, and advise the crew of how to handle the animals, because the first thing would be some fear, because they're not in their little cage, which is about this long by so and about so big [Dalton gestures], and they're not floating around in their own little environment.

But they also tried something. They squirted water at them to see what they would do, and the rats reached out with their little paws and brought the droplets of water to their mouth. So they're extremely adaptable.

The only thing that I think will not happen [is flying neonates], unless we do some different kind of caging, (on Neurolab, we tried to fly very young animals). We did a flight before [Neurolab] in the mid-deck when we flew two-day and four-day, [and] I think it was fifteen-day-old rats. Two-day didn't survive. Four-day, we had a 20 percent death rate, which isn't bad, but when we went to a different cage configuration in the research animal holding facility, it did not work as well. The mother was able to [retrieve] the animals in the earlier cage. If the animal can't get to the mother and there can't be suckling, then they're going to die.

So if we ever do generational studies or want to do transgenic studies, that's something we're going to have to be thinking of in the future. And right now we are thinking of the future; an animal habitat was in the fundamental space biology program in the suite of equipment. Unfortunately, with all the station overruns, the science programs were hit. Our program was cut

back by 65 percent, both in the utilization and the hardware, and so our animal habitat had to be delayed, and so our POP [Program Operating Plan] now has us doing a buyback [of funds] in ’07 and ’08. So instead of [an animal habitat] going up [to Space Station] in ’05 and ’06, it’ll be more like the ’08 timeframe.

… In between Spacelab Life Sciences 1 and *Challenger*, we had [a needed] interval of time. We were starting work on Space Station, and having worked through Spacelab 3, having worked with the animals in various activities, I was named as Ames representative to the Space Station task force, one of the early task forces that we had in the agency. And people like Carolyn [S.] Griner [from Marshall] were on that. I don’t know if you ever knew Bob [Robert S.] Clark at JSC.

We all fought very hard [to have the racks (flight)] under the control of the developers, and not at some central location at KSC. That was one of the things that led to the EXPRESS racks we have now, and to the individual racks that JSC has for their hardware, and also the individual racks that we at Ames have for our hardware. [This] was [the outcome of] the activities that happened on that task force.

I’m still recalling back [in time], and so I’ll [go further back]. In the year before Spacelab 3, I went to Simmons College [Boston, Massachusetts]. I would say that probably getting out of the research lab and getting out of the class system that is in the research environment, ([e.g.] unless you are a Ph.D., normally you don’t have a program of your own), [led to a major career change]. When I went out of that class structure and came over to the operations, that was when I was able to be more independent and [move forward]. I was the first Ames woman at Simmons College in Boston, [which] was a good experience. At the same time,

(1982), I had begun working on my MBA [Master's in Business Administration], so that sort of came hand in hand.

Also, in '78, I [earned] my pilot's license, [which I retained] five years, [also] a good experience. Unfortunately, work made me give it up, because being on travel, you can't be flying readily every two weeks and [keep] up your skills.

… But [now let's] go back to Spacelab Life Sciences 1. In the period from 1991 to 1993, we flew [multiple] Spacelab Life Sciences 1 in [June 1991]; then the following January, we flew IML-1 [International Microgravity Laboratory-1]. Then the following spring, we flew Spacelab J, and then the following November, we flew SLS-2, so we had four major payloads in a very, very short time. A lot of sleepless days, a lot of sleepless nights.

I think one of the most grueling, but one of the most memorable experiences in NASA, was being the payload manager for Spacelab Life Sciences 1. [Simultaneously,] I was Branch Chief for the Science Payloads Operations. When you get to flight—and this is true for [everyone], and probably even more so for the payload manager because of the responsibilities—you have shortened days, or lengthened days, shortened days in terms of any sleep.

Because we were loading our animals at thirty [plus] hours before launch, we did that during the night. We would go out to the firing room at nine [p.m.] to go on shift until ten in the morning. Normally what I would do is go on shift and then stop by Hangar L just to make sure that everything was all right with the researchers and do those little interactions and those [needed] walk-arounds [with] the researchers, [to reassure them and respond to] problems, [and complaints], etc. [I'd] get back to the condo at about [noon], try to get a nap and someone [would] call [from the pad] and say, "Oh, we're just loading [cages], and we heard something

[happening] with one of the water units. What shall we do?" So they're interrupting and you say, "Fine. Do this, [do that]."

So you end up probably getting four hours of sleep and then you have to go back out [on console at the firing room]. You start out at eight, to get out there, to be on console at nine and do the shift change-over, and so forth, and you do that the next day. There were seventy-two hours of this until flight.

So when it comes time for flight, you went on console at nine [P.M.], launch [at 10 A.M.], then catch a flight to Marshall. [With commercial flight schedules, etc.], you walk into Marshall at eight o'clock in the evening, and you're on console until eleven. You go home, you go to bed, and you get up the next morning, so you're back on console at six, and you stay until eight o'clock the next evening. You go home. You get up the next morning, you go to the bathroom, and everything's gone. "Am I supposed to go out to Hangar [L] today? Do I go out [to the firing room]? Where am I?" [Laughs] [That] was a frightening, really a frightening experience, and it took me a while [to adjust]. In fact, I kept thinking, "How do I find my way to the bathroom? I don't know where I am," finally the adrenalin [of pre-launch] has [receded], I think, and your brain has to rewire in there someplace.

But every payload manager has said they've had almost the same experience, because you're just going, going, going, until you get that thing launched and get it into the air.

Anyway, as I said, we went on to fly all those missions in that [short] period of time. [In 1996, we had IML-2 and several middecks in between and] then we had Neurolab in '98. In 1994, it was decided that we would marry [the Flight Projects Office and the Life Sciences into] the Life Sciences Division.

We were integrating those people, off and on, in various [tasks] whether it was the Shuttle missions or whether it was the Biocosmos missions with the Russians. And that [Life Sciences] Division, (as a division), was not equal to a division anymore [in terms of people size]. It was more like a branch.

The other thing that was happening [was the existing life sciences group lacked] funding support. [NASA] Headquarters [Washington, DC] had put out the decree, in '92, that the life sciences organization—and they were still separate—could not do RTOPs [Research and Technology Operating Plan] anymore. They had to compete for grants, on par with the university groups.

So if you think about that, and think about the fact that when the [Headquarters] Life Sciences Group was [issuing] their NRAs, [and] awarding grants, [to only] 12 percent of [the approved and], if you have an organization that has five submittals, you may get [only] one researcher that has a winning grant. … [Thus, no funding base for a total of 15 people.]

So we married—Ken [Kenneth] Sousa had been the lead for the Flight Projects Office. In fact, historically, Bill [William E.] Berry, who is now the Center Deputy, had been the lead before Ken, and when Bill went off to a Sloan, then Ken came over from the life sciences, and he became lead. Actually, that was in '91.

Headquarters then wanted to set up a Level Two [Office] at the Center. They didn't have the program offices coming out yet, so Ken filled in that function, was in Building 200 [from] '94 [to] '96. So we had an acting division chief for '94 and '95. … In '96, Ken came back, because the program office came out [to Ames], and that was the time when he asked that I come up from being the branch chief, ([a position I'd held] for ten years), and [became] his deputy in the division.

Two years ago, Dr. [David] Morrison asked that he [Ken] come up to [building] 200 and be his deputy. [As a result], I've been the acting division chief ever since that time.

I had applied in '92 for an SES PDP [Senior Executive Service]. At that same time, Ken had applied, and he was awarded the [IDP (Individual Development Plan)] program, Career Development Program. So I applied again a couple of years later and didn't get it then. I said something to [Ken] about, "Well, I'd like to apply, but where I am in age, is it worth it?"

He said, "No, go ahead." So I applied and I went into the SES program two years ago, and all the material was sent [to Headquarters] February [02]. Supposedly, I'm supposed to go up to 200, but we'll see what happens with OPM [Office of Personnel Management], and how long that takes. Because [the division] has a research element in it, the Center wants to have a Ph.D. in the position [of division chief].

Actually, when Ken left, he said that the Center Director wanted to have a Ph.D., because the divisions that have research have Ph.Ds, and I said, "Oh, so that means if we [have] an IPA [Intergovernmental Personnel Act] coming in here, (which means someone from the outside), that means that I'm going to have to stay here and run the division."

And he said, "Yes, because if someone comes in from the outside, they don't know all the government functions."

When I went through my SES, I went ahead and I still filled everything out as if I were going to be the division chief, because I didn't know what was happening. [I also told the assistant chief] that if I were division chief, I would [diminish the infrastructure.] That it would be a division chief [and] a deputy. The assistant is nice, but he and I have managed the whole division and [a third person is a] kind of frill.

Well, now if an IPA comes in, I've told him, "No, you need to have an assistant because you'll be in the same position that I am." There'll be two people that know all the government rules, and it's just very, very hard to have one person doing all of the activities. The Centers—(and I think it's not just Ames, I believe it has happened at all Centers)—[have] become extremely institutionalized. The government has, (with ISO [International Organization for Standardization], with VPP [Voluntary Protection Program and with full cost accounting), become heavily administrative]. These things are fine, but you have to also at some time look at the tradeoffs of what are you doing in terms of your productivity.

I have three branches [in the division]. One is research and that's a group of eighteen Ph.D.'s and two people with just bachelor's; [a] Flight Ops Branch and [an] Engineering Branch. [The] engineering is [wholly] engineers with master's and one has a Ph.D. The Flights Ops has scientists and Ops [people] and some engineers. It's a mixture of Ph.D.'s, master's and bachelor's.

If we look at what has to be done in terms of training between all the organizations, whether it's in our Ops group or whether it's [among] our researchers, those people end up spending [approximately one month's time in training]. Between what they have to do for safety, what they have to do for IT [Information Technology] security, what they have to do for ethics, what they have to do for ISO, [and] everything [else] that is required of a Center [~one month is used up].

Now, in that one month, a researcher could write a couple of good papers compared to an engineer [in other organizations] who figures that they have nine-tenths of a percent of their time. So [the research and engineering requirements are] very different. This is about 17 percent of the time for the researchers versus what an engineer spends. There is a big variability, and, of

course, the researchers are hollering. They recognize there is [necessary] training. We have talked to Center management about this, it's the balance of what you have as a training group who come in, who don't sometimes have the knowledge that the researchers have. Some of this could perhaps be done on videos that they, [the researchers], could do [in] their own time [versus a required time which interrupts experiments].

I do serve on committees [such as] Respectful Resistance Action Team. We called ourselves the RAT Patrol. [Laughs] We did surveys of people, and [the feedback on training was actual]. … The attitudes toward safety [among researchers] and, the personnel organization [are very different]. The science [people] recognize [training is] there, but they have to take so many things that it's just eating them alive in time. The personnel group takes one class: office safety. That's very, very different [in terms of time commitments].

Other things that have happened [over the years]—oh, I have to tell you something clear back. Back in the seventies when I was still in the research lab, there was a bond drive, and with thirty other people at the Center, I signed a petition warning people not to submit to the bond drive because of the impact on the Vietnam activities. The last time I had my secret clearance, the guy came around, looked at that, and he said, "I can't believe this is still in there." [Laughs] He said, "This is ridiculous."

I said, "[Yes], I thought so. And I think you probably found the letter from Hans Mark that said I should spend my time in more worthwhile activities." [Laughs] Little incidents happen when you're in government service. They also had a speeding ticket from KSC for going 55 in a 50-mile-an-hour zone [in 1983]. [Laughs] I don't know what other things [may have been in there], but those are the things that he [shared with] me which are kind of crazy.

Other experiences? There are a lot of experiences talking to the public. You have different kinds of public. You have a public who isn't aware of NASA. Generally, though, when you're asked to speak to groups they're fascinated with what happens in NASA and, I think, whether you're at Ames [or] whether you're at JSC [or another Center], there are some things that we do every day that we lose sight of. It's really a unique environment.

The Center and Dr. [Henry] McDonald, in '95, instituted a peer review for each of the research divisions. Now, he knows that the people are working on peer review grants, or they are working on RTOPs, but he wanted to ensure that we are doing things [in alignment with] the Center's mission [also], not just the alignment to the strategic plans [of separate divisions NASA] Headquarters. So [Life Science] was first on the docket. [For our review team], I got Barbara Horwitz from U.C. Davis [University of California-Davis], who [was] actually president of FASEB [Federation of American Societies for Experimental Biology] and she's [also] one of the deans [at Davis along with Stuart Kim] from Stanford [University, Palo Alto, California], a leader in genetics and has done a lot of work in *C. elegans*; Gerry [Gerald] Sonnenfeld from Morehouse [School of Medicine, Atlanta, Georgia], who's known in immunology and been outstanding there; and Bernd Fritzsch from Creighton [University, Omaha, Nebraska]; and then Ken [Kenneth M.] Baldwin, who's on the NASA BPRAC [Biological and Physical Research Advisory Committee].

Ken has flown before; so has Gerry Sonnenfeld [as] researchers. The other, Bernd Fritzsch, flew one time with us on *Mir*, but Bernd has [also] come to use our facilities at Ames, [along with] Ken Baldwin. Barbara, who had not used our acceleration facilities, [and Stuart Kim] both remarked, "This is fantastic. Could everybody have this opportunity to work in an environment like this, where all these things [acceleration facilities] are available?" [This is]

what our researchers revolve their research around [the effects of variable gravity on physiological systems]. And it's been a very phenomenal study, I think.

People still question sometime, "Well what do you do in NASA, and why do you do it, and why are we having these flights?" I often sit and think, would we have spurred the interest that there is now in osteoporosis had it not been for microgravity? Here we have an aging population, and it's becoming more apparent how real this is, but would there have been the research going on, had it not been for what we found in microgravity, what we saw with the crews, what we're now seeing with cell cultures, that we have to have this force, that we're really kind of like granite has been for history. There has to be a certain force on the thing to make everything align and make molecules align and make the growth take place.

I still think there is so much that we haven't tapped completely. We know there are problems with the immune system, and I think there's a lot we have to find out, but when we start finding more out about that, or even in genomics, it leads to some of these questions that we [may] have about hepatitis C, this new thing on the horizon that's just causing so much trouble and what can we really get to take care of it if interferon is not doing the task.

I think I've almost said it all. [Laughs]

WRIGHT: You gave a presentation not too long ago, about women and space. Could you share with us what—

DALTON: Sure. In that presentation, I told a little bit of background about [M.] Rhea Seddon. Rhea, of course, had been working with us—oh gosh, she came on board [since] about 1985, after we did Spacelab 3. She worked with us a great deal and was around us when we were

working on the RAHF [Research Animal Holding Facility] and trying to take care of our problems there. And of course, because she is a medical doctor herself, she was a prime candidate to be one of the first mission specialists on Spacelab Life Sciences 1 where we had life sciences activities [both] human [and] non-human. She actually continued working with us into Neurolab [even though she had] retired from the corps in '97. She was with us in Neurolab and did the consulting there.

When I gave that presentation, it was also interesting to talk about Shannon [W.] Lucid, who worked with us on *Mir*. Well, Shannon had been with us on Spacelab Life Sciences 2, and Shannon is a physicist by background, but a wonderfully versatile individual. … You can get some people, who it doesn't make any difference what tools you give them, they just can't do it right. …

But Shannon was the kind of person, you just gave her a little inkling of training and she could do it. And this is what happened on *Mir*. We had a male doing the primary experiments, and he botched them up. He botched them up completely, and Shannon hadn't had any training on them, and the samples that came back from when she handled them were just beautiful. … I think the wonderful story about Shannon was that when she learned she was going to fly on *Mir*, she took her teenage son out and said, "Come on, son, we're going to take your car apart and we're going to put it back together again, because this is the kind of a level of what I'm going to be facing when I go over to Russia," and she did it.

Several of our people, our crew trainers, became real familiar with her, and they said she is just such a down-to-earth person, but she will make something work. I'm really so happy that she is the Chief Scientist [of NASA] now, because she has that sort of common-sense approach to everything, in addition to being a wonderful person, I think.

And Rhea is that way, too. Rhea has a very common sense—Shannon, I think, is probably a little more in the rough, and Rhea is a little more reserved. That's just her southern lady style, but both of them are just fantastic.

Those were the primary ones [I spoke about in the astronaut corps]. I also related the fact that if you look at what happens in our population here at Ames today, and look at women in the work situation, one of our women in SLO, who has been leading the science efforts in all of our payloads, did that while raising two young sons. Her husband is a researcher here, but she was still the keeper of the home, and her sons are in their teens now. But she continued to do all the work and did excellent work.

[Another] of our other ladies, (actually she's a contractor, but I brought her in as a NRC candidate) [has an interesting story]. This lady went back to school and got her Ph.D. at the same ceremony her son got his bachelor's. So she's been out in the field working. She graduated from the University of Kansas [Lawrence, Kansas].

I think women are really very adaptable, and where they see an opportunity or a situation, they seize on it and they keep going.

Other researchers, Muriel [D.] Ross. I don't know if you know Muriel's name. Muriel retired from the University of Michigan [Ann Arbor, Michigan], and she retired to Ames. So she was at Ames in civil service for ten years. For [a] part of that time, she was a branch chief. Muriel [finally] retired when she was seventy-two years old. She retired two years ago. She's now down in Albuquerque [New Mexico], where she and her husband moved. She thought it would be better for his health. [Also] one of her daughters was living down there. But she's very active, still doing telemedicine activities with the Navajo Tribe and with the University of Arizona [Tucson, Arizona], and connecting up with Cleveland Clinic [Ohio], and making sure

that there are clinics that [the Navajos are] able to connect with so that they can do medical diagnosis clear out in the field.

Emily [M.] Holton. Emily stepped down as Branch Chief for our Science Branch in the division. Emily is a year older than I am. [Last] fall, Emily and one of the other researchers submitted an article to the *Journal of Physiology*, which was on the whole technology of the Hind-limb suspension model. Emily first [developed] that [technique] about twenty, twenty-five years ago. … Ruth [K.] Globus, [with whom] she wrote this article [collaborated] on that. [Importantly], there have been over 800 citations on the Hind-limb suspension model [paper]. That is a fabulous number of citations.

Emily is still working in the lab. She said, "I'm having an awful time trying to figure out all this molecular biology."

Ruth said, "Look, you can do these studies with the rats." So there is still a place, regardless of where the research is. In fact, that's one of the things that we have been trying to work with, within this division and in the research organization, is [to support these] people who are in their [sixties and] seventies and who are still here and are very active [as researchers]. …

What is happening right now, and where the Center wants to go, is [toward] biotechnology, nanotechnology, [and] information technology. When you start talking bio and nano, you start talking molecular biology, more than you do the whole animal, and this is something that came out when we were doing our peer review, too.

[The Kims] and Horwitzes and Fritzsches, all recognized the upcoming work that our young people are doing in molecular biology proteomics and genomics, but they commented—and this is a message that we wanted to get to the Center—is that you still have to have the integrated physiologists. One of their comments was, "We see a lot of people who may be

nearing the age of retirement, but hopefully you won't forget to bring in the whole organism, the physiologist that can look at the whole organism and how we bring this [story together]." And this is the mix that we're trying to attain in our research right now. For some of our older researchers, that's a whole new language when you start talking genomics and proteomics.

In fact, in the SES [training] program, as you may know, you have to spend 120 days away from the Center, and half of that must be at [NASA] Headquarters. I spent the other sixty days at Affymetrix [Inc.], which is a DNA-array analysis [company]. I did that, because I was sitting here, not having actively done any research or done any microbiology since 1978, and here we've got a bunch of new researchers who are sending in these proposals, and I'm supposed to look at them with a somewhat sane eye and understand what they're talking about.

[Being at Affymetrix] offered me the opportunity to do a lot of reading and talk to the people down there, and really find out more about [their] tools, and compare the tools from company to company. You have the kind of array analysis tools that Affymetrix has versus the kind that Agilant [Technologies] has, and there's really quite a variety, depending upon what you want to do that's available out there, so it was a lot of fun [and informative]. I did that last September, October.

Also along the way, in 2000, I [was] nominated by my mentor in college, [as] Outstanding Alumni, and I was awarded that from the University of Montana [in Missoula].

What other things? Well, it's a good [NASA] group. I always get feedback from my husband [who] says, "Oh, why are you doing this?" We were separated for fifteen years, which was kind of a natural clash of my wanting to go forward [in my career] versus—though he would not admit it—what should be the traditional role of a wife. I put him through college and then when he was finally settled in teaching for five years, I started expanding out of research. And I

wasn't spending [just] eight hours a day [at work]. When you go into program management, you do not have an eight-hour day. You just have to accept that.

Right now, I'm in the office between 6:00 and 6:15, and when I don't go walking, I leave at 7:00. If I go walking, I leave at [6:00], and that's it. You talk to any manager, [it's] true around the country, those are just hours [required]. I think that's why Bill Berry announced he was going to retire, because he figured he was only making six dollars an hour. [Laughs] But it's hard for a family to understand that, and I wouldn't do it if I didn't care for it.

My husband [was] a high school teacher. He has been retired for two years, and he keeps wanting me to retire, but I said it's not a fear of losing anything, it's simply that I enjoy it. I'm not ready to go into that retirement community and do those kind of things, just like Muriel wasn't at seventy-two. She was still very strong, and she's still very strong, keeping the kind of associates even that she had at work.

We, [my husband and I], got back together ten years ago, by the way. Actually, I think [when we had separated] that was probably one of the reasons I took flying, [it] was to gain back my own self-confidence. I went through high school, organizing clubs and doing things all the time, and I went through college as a sorority president. I finished college in three years and a quarter, and went on for my master's and I worked while I was in college, and then I got married [and everything stopped]!

I think if I look around, it's very, very hard for men who are over fifty to accept that there is not this role that women traditionally must be at. It's a different world. And I think that's probably one of the biggest things I faced, even in work, is making men understand that I don't want to be intimidating. I want to work with you, but my skills are the same as your skills. Just because I wear a skirt or wear high heels doesn't make any difference.

Up until the last, what, five years ago, I wore high heels all the time. I have had five hip replacements in the last fifteen years, so I don't do [that] now. But I found a very, very different attitude when I was working actively with the engineers and Shuttle management and payload management, when I went in my high heels and I was looking at them nose to nose, versus when I wore flats. That shouldn't be, but I've had several women comment to me that they've felt a very, very different perception when you're on the same eye level, and I think that's true even if you're talking to people. If people can look you in the face, there's a different perception than looking up or looking down. And if you look around, and you think of some of the people, Shannon Lucid, very strong person, very self-confident person. Clark, who was at Headquarters, who was at Space Station, Catherine Clark, strong person, tall person, no problems, and I think it is a very real perception. Even Kathy Olson was fairly tall, some gentility there but—anyway, questions from you. Other questions?

WRIGHT: Well, I'm watching your clock, and I know that you have to go into a meeting at two. It's almost two, so we'll stop for now and we'll see where we're going to go from here.

DALTON: Okay. [Tape recorder turned off.]

WRIGHT: Before you start again, so is that someplace where you want to start?

DALTON: Sure. I can start [with early Shuttle flights]. I can't tell you a great deal. When we did that activity, the Plant Growth Unit [PGU] was constructed under our Flight Projects Office. It was under a contract with Lockheed Martin [Corporation], and there wasn't a great deal of

effort, as there would be with animals, because you don't have all the restrictions in terms of animal care and use committees, and you grow plants, and they either grow or they don't.

So at that time, we had a [researcher, who] retired in the late eighties, and went to farm mushrooms, but he was the science person for that plant growth unit. I'm trying to think, I believe we grew wheat in that [first flight]. We also [set] up some flights in which we flew carrots in these pods that looked like milkshake shakers? They were a big heavy aluminum [can] with a lid that capped on. We just had these carrot stems on an auger base, in auger dishes, and they were stacked in these units. And the investigator was looking at them. Fortunately or unfortunately—but this is science—what he was trying to verify, [during his] three or four flights, did not pan out, but that's research. You know, you fly it and you invest X amount of dollars, and yet it's not always going to pan out.

I might [add on] the same [note], we had [an] experiment in Neurolab and had a great deal of difficulty with this experiment. The experimenter came in, [Bruce L.] McNaughton, and he was on the cover of *Science* before Neurolab, very, very bright investigator, and working in neurology. He had a sensory [unit] implanted into the brain of the rat. Whenever you do any kind of activity, you turn your head or you respond, [and the brain cells/neurons start] firing. These neuron firings through the brain [are an] this impulse, just almost like an electrical impulse.

So he said, "Well, I've got this room full of equipment. I've got this wonderful engineer. This won't take much to do it all." So then he said, "All I need is some guidance in safety." And we got to the end of the first year, and he said, "No, I think I need a little bit more help." And this is over a five-year period.

By the time we got to the end, we had made a new cap for him that was half the size of the one he had, because the one he had would have interfered with the animal cage, and the thing would have gotten hooked [in the wire mesh]. We [took] his [four] racks of equipment, and condensed [them] down to about two lockers' worth of equipment.

… The experiment cost us about $15 million to get on board [Spacelab], but it really was an activity in miniaturization. The animal walked around this sloped piece of equipment in the work station and it got different sensations because [of the angular slope], so that it looked like you were going on the inside out, like a ribbon. You know how in candy ribbon how it sort of looks. That's the feeling you had around the corners.

[When] he got the data back [he] said, "I can't believe it. My theory is incorrect." But that's research. You know, and you say, "Oh my gosh, we invested that much money." But you don't know until you go through all those processes.

I'm sorry to have strayed, but when you [mentioned] STS-3, I think that may have been the carrot [experiment], because I think the PGU may have been closer to STS-7. We flew the PGU, I think we flew that two or three times, and then when we finished with it, because we were going to go into the Spacelab activities, we sent it down to KSC, and Kennedy Space Center has flown several plant researchers with that [equipment].

Now, you [may] say, "Well, why did you do that?" When they proposed to do Spacelab 4, they had so many experiments on [the mission]. I believe they had they had around twenty [non-human] experiments. We had all these grandiose ideas, and people really didn't realize how much equipment would be needed. As they started narrowing things down, they divided it into the green and the non-green things. So what that meant is, there was a plant experiment,

that went to IML-1, and that was flown in the gravitational plant facility, which was a full top-to-bottom rack.

That was one of the reasons we weren't interested in doing the PGU anymore, because we were helping this experimenter on IML-1 getting that experiment on board. We said "green" things, but we sort of thought of everything that was sort of plant-related. There was a yeast experiment that went on that for flight, too. And so we did that at the time.

[The] other green things were the frogs, and the frogs went to Spacelab J, so that was how we got activities on Spacelab J. It wasn't planned. It just sort of filtered out, and again Spacelab J wasn't completely filled, and, of course, the Japanese were flying the fish and the aquatics, and they were very, very interested in an experiment at this time, because they also supported the experiments, I believe it was in IML-2.

They supported a new experiment for Dr. [Michael L.] Wiederhold, and that was one experiment that we were involved in, too. Whenever there [was] anything involving aquatics, it [was] always in conjunction with the Japanese. We also worked with them on Neurolab, and the toadfish. … And then STS-95, which was also the [Senator John H.] Glenn [Jr.] flight, we were involved in that because we re-flew the toadfish experiment.

Now, some of the side benefits to an organization [as a result of flights] is Dr. Richard [D.] Boyle, who was one of the co-investigators on that toadfish experiment is now here at Ames, and he's a part of our division. When Dr. Ross left, we wanted to rebuild our capability in neurology, and have someone who was interested in biovisualization and he [Dr. Boyle] is in that area, so he took over Muriel's place.

So when you do a flight, you also look at ways [of] encouraging researchers to come into your organization. And this is the same way, I'm sure they're often looking at, you know,

"Could I join NASA, too," and sometimes they just say, "No, I don't want anything to do with this." [Laughs]

After we did the early plant flight we got started in [the Animal Enclosure Module that was the result of] that student program that was in force, and actually JSC, with McDonnell Douglas [Corporation], built the first Animal Enclosure Module.

And again, because JSC didn't have any researchers who were known for working with rodents, they asked Ames to help, and so Emily Holton became an advisor on the first student experiments. Now, the first Animal Enclosure Modules had no watering unit in them, so what they did is [send] potatoes up for water for the rats, and it was a short flight. Unfortunately, they thought, "All we need to [do is] radiate those potatoes so they won't get moldy." [This] was probably the worst thing to do. The mold wouldn't have hurt the animal, and [the potatoes] got all soft and mushy, so they really didn't serve the purpose.

After those first flights, actually, Ames went ahead and built the watering units, and after *Challenger* we were looking at what could we do until that time period in which we might be able to fly the Spacelab. So we started out with our first thought, well, maybe we can fly some of these Animal Enclosure Modules on some interim flights, because we weren't really sure when we were going to get that Spacelab.

As it turned out, Spacelab Life Sciences 1 was the first Spacelab for return to orbit. We did invest a lot of time, and we did have an experiment or two in [the AEMs] before the Spacelab, and we just totally revamped that Animal Enclosure Module.

We [added] the food bars; I think they just had pellets pasted on the sides [before]. We glued them on the side walls. We built a watering unit, which was a very simple idea, great big spring with water in a blood bag, and as the water goes out of the bag, the spring is pushing to

push more and more water out, and the crew can look through the window and see how far the spring is forward, to tell how much the animals have been drinking the water. So, a very, very simple idea.

We had even worked in Neurolab where we were able to access that unit in flight, because we had Dr. McNaughton's animals in that Animal Enclosure Module. We had two animals in there. We had a dividing wall. And because they had this little antenna on their head, we couldn't keep them in the regular research animal holding facility. With all this paraphernalia on their heads, their little "Carmen Miranda" hats, they wouldn't have worked very well [in the RAHF cage]. We had an animal access unit that we used on Neurolab so that we could actually bring the animal into a sort of a big glove, and then take them over to the [big] glove box, where we worked with them.

So when you look back at flights and you look at activities, [in which one] thing [develops] from another. When we went into *Mir*, it was supposed to be a prelude to what we would be doing on Space Station. I think that it was a very good idea, but what we have found is that the Russian [operations are very different from us].

Plus, we started Space Station with all of these operations, and because we had people still tied up in Spacelab and we had people doing *Mir*, we had a whole group of new troops who had never flown. So they were trying to set down the ground rules of how we would work Space Station. In some of the first missions [because of the new people, new roles], there has been some disappointment by researchers, saying, "Well, they put this on me, and I had to plan so far ahead."

In fact, there was a very caustic talk given at the Space Station meeting in Cape Canaveral last fall. As you may know, the NGO [non-governmental organizations] concept sort

of arose out of this disappointment of the research community saying, "We think we could do it much cheaper and much easier, and so forth, and you need to commercialize Space Station." Well the schedules have fallen behind. We had this mandate to do this, and we're now starting to do this, where we're starting to get up to speed with our increments, but there is still a lot of things to be put on. For instance, the whole suite of research equipment is not up there, for all research organizations. But the people who were back here, this young group who have gone forward and now has been infiltrated by people who were in Spacelab had looked at what are the things that we can do easier.

For instance, they've got an agreement that we will get at least twenty hours a week from the crew, which is something everyone was very fearful of. They have gone from the thirty-six months that they originally said they would have to start having procedures for the crew down to twenty-four months, to now eighteen months, which is a significant change. And they're still looking at how can we change things and make them easier for the developers, and who are then supporting the researchers who want to take experiments on board.

I think one of the biggest things, if you talk about changes over the years, [is] the AEMs and how that started from a student experiment, and what we added to it. We have actually flown over twenty-five flights with that Animal Enclosure Module. Now, if you think of twenty-five flights, and the fact that that represents at least one experiment and, in some cases, it represented sixteen experiments, there have been probably close to seventy PIs who have gotten data from those twenty-five flights. So that's fairly significant for a simple little mid-deck piece of equipment that could fly that many times.

We could still be flying it, but we can't do that and try to build Space Station and everything that has to go up there. And we won't be having any animal habitats until '07, '08,

'09, so our real quandary is, as we're looking at the research community, how do we satisfy that research community? How do we keep things going?

Another item in line with all of this [was the plan to go forward] to Space Station—where were we? We did Neurolab. We had really gotten pretty good at this. What we did with KSC, what KSC was doing with the developers, how long it was taking us, was cut by about half from when we did Spacelab 3. It had become a very simple straightforward process, and what did we do? We decided to quit the whole thing because we wanted to do something else.

Interestingly enough, when you look at the proposals that are submitted to the NRAs—(and I'm just familiar with those that are submitted for JSC for the human, and those that are submitted for our [non-human biology), many of the things] that are requested are things that they could be getting data in twenty-day missions. [But of course funding cannot simultaneously support Spacelab and building ISS.]

And building on that, you may be aware that Yvonne [D.] Cagle has been working with the crew very hard, and they're trying to push an extended duration orbiter mission so that you would take the Shuttle and park it up there, and you could do a bunch of these mid-deck experiments.

Yvonne is coming to Ames in June, and she's going to be with us through September, [supporting] us in some experiments we're doing here, and also learn more about the hardware that we're building for flights. We're looking forward to that. She's going to use her medical talents, in fact, to monitor some centrifuge studies that we're doing with humans.

I'm going to go away from that a little bit and also tell you about some of the other facilities we have, because this lines up with Flight 2, and it's something I would not have realized had I not gone from the exobiology and gone to operations, which is now joined with all

of life sciences. Within this division, we have what we call a twenty-four-foot centrifuge in which we can put about cages on arms and we can spin rats up to as much as five Gs. Normally the highest we take them is two and a half to three. We have a twenty-foot centrifuge [also]. Did you see *Space Cowboys*?

WRIGHT: Yes.

DALTON: Remember the red centrifuge? That's not at [JSC]; it's here. It's over in Building 221. And that's what was going around, and that's the centrifuge, by the way, that we're going to do the studies in this summer, in which we're taking individuals from one G up to two G, by quarter-G increments, and they will be at each increment for twenty-two hours. That takes close medical monitoring. You don't frequently see too much [change] at 1.25. You may start seeing something at 1.5. You definitely start seeing some real reactions at 1.75. You have to be very careful at 2. All of this is looking at body adaptation and how well we can adapt.

We also have a human [powered] centrifuge. We have several multi-access centrifuges. We have a thirty-foot linear sled. … One might say, "Why are you doing [all these acceleration studies]?" And we have an eight-foot, and we have the short arm. A lot of our cell culture studies are done on the short arm, because you don't need a big [centrifuge] if you're just doing cell cultures. The eight-foot is to mimic the centrifuge that's going to go into Station, ultimately. So it will be used for ground tests [as a control].

Why our researchers use these centrifuges is because there are many, many responses in microgravity that you can elicit when you go to hypergravity. In the same sense, some of the

things that you see happening in microgravity, you can use hypergravity as a countermeasure, which is kind of interesting, particularly at the cellular level. …

We have about fifteen extramural investigators coming through Ames yearly, who are using those centrifuges, and these are people who have grants, either with the BR&C [Biomedical Research and Countermeasures Program] program or with the Fundamental Space Biology Program.

WRIGHT: Let's talk some about the investigators and your involvement with them, how they're chosen for their experiments or the whole process and how you have been involved in that through these years.

DALTON: The normal process for selection of a researcher against a grant now is the NRA. Many, many years ago, they used an RTOP process, and Flight Projects wasn't united with the Life Sciences Division as such then, but when I looked through those RTOPs, they were like a grant but it was almost automatic that Headquarters would say, "This is a good program. We want you to work on it." And they would have a small group review, and the investigator was funded.

In the early nineties, Joan Vernikos went up to Headquarters as the head of Code U of [Office of] Life [and Microgravity] Sciences at [NASA] Headquarters, and as I indicated earlier, she said she wanted everyone to go through the NRA process. She was stopping the RTOP.

Code S [Office of Space Science] out of Headquarters still uses the RTOP process. Code U, OBPR [Office of Biological and Physical Research], does not use that RTOP process. An NRA goes out. A NASA research announcement goes out. Our investigators respond, just like

investigators from JSC or investigators from the academic community. There is a different NRA that goes out for ground activities versus flight activities. They're very separate. Headquarters has a contractor who contacts researchers in the field who may not have submitted, but who are very experienced in the field, and they review those proposals for content.

When our researchers submit a proposal … there's an understanding that all these [proposals] have to be approved at the division level. [This is because we] need to know [how] does that [proposal] impact the division. Does this mean that [we're] going to have to have more people over in the facilities group because this researcher wants to use the centrifuge every day? And as a researcher here at Ames, he doesn't pay for it. We charge the people from the outside, but we don't charge our people within our own organization. So does that mean [we're] going to have to somehow get more funding to take care of that?

So our researchers give a five- to fifteen-minute [presentation] at our Project Control Board, which is at the division level. I chair that, and each of the branch chiefs is in attendance at that. Though they're not a voting member, we [also] ask the program office to sit in on [the PCB], so they're aware of everything that's going on and what might be [going] up. The proposals all go back to Headquarters, even though they [Fundamental Biology] may be the funding agency ultimately.

So our researchers will submit a proposal. We work with them on the funding levels that they may need for contractors, because they don't know what the current rates may be, or what the rates may be if they're getting people through the educational associates program at Santa Cruz, and the proposal is submitted. This year, Headquarters [now] has this all electronically so that the researchers submit their program electronically. What I didn't know until the researchers came and had their proposals on the last day [was that they are approved

electronically]. They said, "Oh, you need to get online. You need to get online, because you have to approve it online."

I said, "What?"

They said, "Yes, you've got ten minutes." But, you know, you deal with that.

WRIGHT: And what a change from the earlier days—

DALTON: Right. … They just started that this year, where previously it was all handwritten [approvals]. Now, they still have to send up copies because when the peer review group gets up there, they want to have the hard copies that they look at. We're still living in a society where sometimes it's hard to go through a bunch of [numbered pages on the computer] here, and then want to read. I like to have a hard copy out so I can hold the page and then come back this way [to review].

So a proposal is passed on by the peer review. They have to have a score of seventy-two or higher for acceptance.

Then if it is a ground proposal, it will go to the program manager and Headquarters to decide what they want to fund, because they won't fund everything at that level, they just don't have the funding. In fact, right now, overall, the funding is only 12 percent of those that are accepted.

If it's a flight proposal, the next step it that it goes to something called the integrated technical review. Ames has headed that integrated technical review, and, in fact, we hosted that integrated technical review for the last three years, and then this year we worked with the Japanese to set it up over there.

The NRA for flight is now issued as an international document, so there is an International Space Life Sciences Working Group, called the ISLSWG. Headquarters has a representative member, and then the associated members have an individual, [e.g.] ESA [European Space Agency] has a representative, CNES [Centre National d'Etudes Spatiales (French Space Agency)] has a representative, the German DLR [Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V.] has a representative, I believe the Italians now [belong and] the Canadians [and Japanese (NASDA)] have a representative.

So they also send their people to the international technical review. The technical review [is] not at a program management [level], although the program managers often come, but it will be [have] division chiefs. We start [the ITR planning] process almost simultaneously with the peer review. … The peer review might take a week. As soon as they're done with their proposals, then they send them to us, and we distribute them electronically to all the other members of the ISLSWG, to their representative members, for this technical review. There [are] between four to five categories. [Last] year, there were 300 proposals.

What had to be reviewed, that was in that 72 to 100 [range], was 120 proposals. The proposals are rated on their feasibility, on their costs, and on their manageability. For instance, you might get someone on [the] human side [who] may want to have thirty different runs of crews. Thirty different runs right now means ten flights, which means that could impact the ability for anyone else to do an experiment, so if they were demanding that many, we might say, "This isn't feasible or fair to the others." If it's something very simplistic that wasn't really time-consuming, like maybe just swabbing the tongue, then you might say, "[Yes], that doesn't take a lot of time." But if it was going to be an experiment that took two hours a day, and they

wanted thirty crew members, which is ten flights now, that would be totally unfair. We might say four flights maybe or two flights; there would be that [limiting] parameter.

Now, most of the people who look at [the humans] are the Houston people. What the Ames people look at is [non-human things]: microbiology, rodents, *Drosophila*, *C. elegans*, [or molds and plant experiments]. If we got an experimenter, [in which the] individual wanted to look at flying bees—we would review that and say, "Okay. What piece of equipment do we have that we could fly bees in?"

The Canadians had an insect habitat. No, it wasn't an insect habitat. It was a small aquatic, but it could be used for insects. Now, they [have] decommissioned that, but, potentially, we could put the bees in there. … [It would have to be negotiated]. Again, if the experimenter said, "Oh, I have to do ten different operations in a day," which might be three hours a day, for four weeks, [and], if the crew only has twenty hours on Space Station to spend on science operations and you have an experimenter that says, "I want to spend three hours a day for four weeks," that's already blasted any other research. That's already taking up a third of the science time, whether it's for human experiments, non-human experiments, microgravity, or for the commercial world.

So we would probably say, "Well, if they could live with *x* amount and part of that is based on people who have worked with insects in the organization and know something about it and sometimes that talent is in our NASA group, sometimes it's in our contractor group. We do have our contractors working with those [proposals] and evaluating them, and in that kind of process, there are a lot of things that are coming up now with *Drosophila*, because that could be flown early. It doesn't take a lot of space. [In fact], one of the things I'm looking at in terms of increasing the complement in the division [and], when the [hiring] freeze is over, [is] trying to

pick up a gal who was recently graduated from Stanford [with] a background in *Drosophila*. She helped on STS-95 with [Haig Keshishian] from Yale [University, New Haven, Connecticut]. … She couldn't help us with this proposal [round], because she had submitted a proposal herself with a [lady] by the name of [Kathleen M.] Beckingham, from Rice University [Houston, Texas]. …

In the ground [proposal], there isn't [an ITR], because there is nothing to impact it, [the procedures]. … There may be some researchers who want to use our acceleration facilities, and so they will get in touch with the [lady] who is the manager of our research facilities. She will get one of our researchers [assigned to the facility], and [work with them to] determine the [support] cost would be for [conducting] their experiment.

For instance, if someone comes in who wants to put cell cultures on the short arm centrifuge, then Dr. Ruth Globus, who is our cell culture [person] and the science person for that facility, will work with the facilities manager and they'll go over, "Well, would this be a good way for her to run this? Can we run this? How can we support it?"…

[During] that initial [stage], we generally get about twenty inquiries, and there may be between ten to fifteen that finally come to fruition, and that ranges from things like *Drosophila* to rats.

One of the other things that happens when a [ground] proposal comes in [is that] we have to take it [to] the Institutional Animal Care and Use Committee, [for a] preliminary guesstimate on [feasibility]. Will it not hurt the animals? Is everything being treated [appropriately]?

The same thing is true for any flight activities. Any flight activities we do, if we send a piece of equipment out to a PI's lab, say they're going to fly with us on Space Station, but they want to test a piece of equipment, a cage in their lab, and they're going to do ground test, that has

to go to the Institutional Animal Care and Use Committee because anything that has a label of NASA, NASA is ultimately responsible for.

In line with that, I had told you earlier that we didn't fly monkeys anymore after we did Spacelab 3. That was squirrel monkeys. Well, we did fly rhesus monkeys with the Russians on the Cosmos flights, and I think it was three different flights [in which] we had rhesus monkeys. The last flight, which occurred in '98, there was an event which stopped us from going forward and doing any more Russian flights, but it was a truly significant event. As you may have remembered—remember Bonnie [J.] Dunbar had an incident where she responded [negatively] to a drug or something?

WRIGHT: Yes.

DALTON: Well, this is the same thing that happened to the monkey. When the monkeys came back, you determine the dose of sedative you're going to give them, based on their weight, just like you do in humans, and they were going to be taking biopsy samples. They gave the sedative to the animal, and the animal died. The animal responded differently, and what they believe is it was a response to microgravity and what the system could tolerate, but, of course, that disturbed PETA totally.

I wasn't involved in it. Ken was in the Level Two, so he worked with one of our [people] in PAO [Public Affairs Office]. But that was a very, very, very trying time. They spent about a year answering requests for information on the use of animals. I think it's justified. I think PETA has done a lot to maintain good practices in the laboratory, but NASA has always been

very careful [to abide by the rules of ethical conduct and humane treatment], and I think where we all get very concerned is that there is a lot that could be distorted.

About that same time, we were in the process of [of preparing for] Spacelab Life Sciences 3, which never happened. That was going to be the flight of a rhesus monkey, and it was an activity that we were doing in conjunction with CNES. And what we actually did is we had trained the rhesus monkeys to respond to computer games, and there were two elements of that. It was for food response and, secondly, they had learned about eighteen different types of games, which kept them entertained. During this process, we went ahead and installed computers in the animal care facility for the animals to play with, because that's something that has come out in the years, that you shouldn't let these animals with that much intelligence just be bored.

Well, all of [the Cosmos findings] came up a year before [the proposed SLS-3] flight. It was decided we would not fly the flight, and it was primarily because of the concerns with PETA, but the good thing that came out of this is that one of the researchers, and, in fact, he was featured in *Newsweek* about four years ago. … He lives in Georgia, and he actually started the Sonny Carter Center down there, [and] has been working with autistic children, and has used a lot of the methods that they used in teaching the monkeys, and has had a marvelous result with these autistic children. So even here, look at the benefits of a program like that. And here there was nothing done to the animals. There were no biopsies, nothing of that sort. They did have to have a penis sheath [for urine collection]. [Laughs] But none of the other activities. It was just all in training them. So here [were] some real worthwhile activities, and we had to cancel [them].

What other things have come out of the flight program?

WRIGHT: Tell us some more about the Cosmos program that we were involved in, and how you were involved with that.

DALTON: I wasn't involved with that, because Cosmos started [with] Ames' involvement in 1978, [under Kenneth A. Souza, as Ames' representative]. I told you that in 1975, I started working on the Viking Program. Actually when we started doing that, [it was] the nucleus for starting up a small division called the Biosystems Division, and it was out of the Biosystems Division that the Flight Projects grew, and then the Flight Projects became the Life Sciences Division. … We started the Biosystems Division to set up the [Viking ground] lab.

We also had control of the Animal Care Facility [ACF], [Dr.] Richard Johnson was the head of that division. Richard was a biochemist, he retired probably about eight or ten years ago. Anyway, the veterinarian for the ACF was a military [person], that was his tour of duty. … One of the next members that joined was Bill Berry. He became part of that group [along with] John Tremor who worked with the carrot experiments on some of those early flights, and who was also a co-investigator with Ken, in the frog experiment on Spacelab J.

Jan Kennard was another person [in our group, who] was our resources person. She had started at Ames about the same time I [had], and she was in Life Sciences, working with monkeys. She left Ames in about [1981], went back to work for Bionetics. [She is now] their vice-president for personnel. We had started doing all our work on our MBA together.

Ken [Souza] was at Headquarters, and in '78 he came back to Ames. Dr. Klein [Director of Life Sciences Directorate] had started discussions with the Russians about [the] Bio-Cosmos program. So Ken headed that up, and we had some of the early flights, [which] were just rodent

flights. They were flights with academic investigators and with NASA Ames investigators; there were as many as sixteen investigators [along with cadres of] co-Is [co-investigators].

How they managed these [was] that the hardware in the vehicle was all built by the Russians. The U.S. actually paid dollars to the Russians to go on their [flight vehicle]. I don't know what those early flights cost, but the later flights, like the flights that flew in '98, [were approximately] ten million [per] flight, which is really cheap if you think about it, and we had a monkey. We [did build the] equipment for the monkeys on [the later flights] but what the U.S. paid the Russians was [inexpensive].

Our investigators went over to Russia. They went to the landing site, and they had a temporary setup at the landing site, where they were processing these animals, somewhere out in Siberia. When they were through processing, [they] took [their samples] to IMBP [Institute of Medical and Biological Problems], which is the Russian Institute in Moscow, and from there sent their samples back home where they processed them more. …

… [The missions] were on two- to three-year centers, and then [the last three were] with monkeys in them. The last one was the flight in '98. …

What you will see happen over time is [that] you begin recognizing the names of some of researchers because [they have been on the list a long time]. … If you look at, for instance, the people who were selected initially to go on Spacelab 4, they were selected in 1978, and they were supposed to have flown in 1982. They did not fly until '91, and their actual mission when they got their specimens and got their dissections in flight was not until '93. They were distributed between IML-1, Spacelab J and Spacelab Life Sciences 2, so that was a long time.

Now, Dr. Halloran and those other people who were supposed to have been on R-2, were selected five years ago, and it may be another five years [before they fly]. The first mission right

now is being planned for ’05, so, eight years. That’s a long time. That’s too long to have a postdoc working. [Laughs] It’s a problem.

… Now interestingly, a couple of the PIs that worked with the monkeys on Bio-Cosmos are not the same PIs that were going to be on Spacelab Life Sciences 3. One of them was the same, all the others were different PIs. They were looking at different things, like this learning capability. I think part of that stems from the fact that, in the nineties, and what was happening in the nineties; it was called the Decade of the Brain. That was why we had Neurolab. … [Even Nurolab] researchers were chosen in ’93, so it was a five-year ordeal until they got to flight.

I know there is a lot of conversation, even today, about how long it’s going to take to get to Station. Once you decide you’re going to fly an experiment, now, I think it really doesn’t take much longer than it did on Spacelab. The real zinger in all of this is the changing schedules. We went from six missions a year down to four, and to three crew persons. When these things drag out, it’s really, really just a series of events. It’s not the time it takes to develop the experiments; it’s the series of events that go with flight. Every researcher has to realize what they’re signing up to when they put in a proposal. But sometimes [microgravity is] the only way they can get the research [answer] they want.

WRIGHT: During Shuttle-Mir, the development time was somewhat shorter.

DALTON: It was much shorter, yes. We were doing this in about eighteen months. … It was a system in which they said, “Okay. We’re going to propose we’re going to work with quail. Anyone who wants to sign up experiment, here’s the door. And so that’s what they did.

And actually the fundamental biology program is looking at perhaps using that as a method in some of the early flights to get the most science. … [They may say], "We're going to fly rodents. We're going to bring them back. We're going to have a team dissecting them. What do you want the parts for?" We call that a bio-specimen sharing plan.

We have always tried to have a bio-specimen sharing plan, even when we had researchers lined up. In fact, SLS-1 had one afterwards, because we didn't have any experiments in flight but we had the parts available for the researchers who were ultimately going to be on SLS-2 afterwards.

[In] SLS-2, they had a really big team. We had the researchers that were the original researchers from Spacelab 4 for the rodent experiments (fourteen researchers) and we had a team of, five Russians who came over and about ten Japanese and a couple of Canadians. So there was a big group that were [in] line end of the queue. …

With all the new tools that have come around [for] genetic analysis [e.g.] DNA array analysis, one of our researchers, Cathy [Catherine A.] Conley, [was given] some of the testes from 10 year frozen SLS-1 rats. The program manager, in talking to her, said, "Well, could you go look at these things," and he gave her some money and said, "Look at them and see what happened." … She [showed] by her gene analysis that there had been an effect of microgravity on the testes of these rats.

Between [Cassie's] data, which had indicated there was lessened production of testosterone, [and the research of] April [E.] Ronca, who looks at what happens in terms of stress factors prior to birth.

There is interesting data, which [coupled] with the concerns they have now about radiation for females, [one is tempted to say], "You know, if you want to be an astronaut, you'd

better think a couple of times before you go ahead and do that. You want to have your family afterwards? Maybe you want to have your family before." [The data is] interesting [from that aspect] but it also leads to looking at other things that we may not be aware of.

I mentioned [Dr.] April [Ronea] who is actually a behavioralist and psychologist and has worked with the rat [hind limb suspension] model, and [is also] a rat physiologist. She is a researcher here now, and we first ran into her on a flight. She was one of sixteen researchers, and she was at Indiana University [Bloomington, Indiana] at that time.

She was looking at what happens in flight, and she has found some very acute things happening when the animals are put under any kind of stress, pre-birth, in terms of the responses of the animals postpartum: weight changes, how readily they adapt to suckling behavior and even interacting with the mothers in the group. So it's [quite] interesting data. …

By the way, we can use that suspension model as a real model for hypergravity. I haven't heard of people doing it on higher animals, because you'd have problems probably with them trying to get away, but it works very well [for the small rodents]. This is the one that I told you Emily Holton developed, and then Ruth Globus working with her, and they had over 800 citations.

WRIGHT: The years that you describe, and all of the components that have major life in this life sciences field, sound to be so challenging and so interesting. As we're coming close to the time that we need to finish today, is there an aspect of your job that you've enjoyed more than the other?

DALTON: I think what I've enjoyed more than anything else is being told, "No, you can't do that," and then proving that we could do it. One of the really fun things is when you get an experiment and you say, "How are you going to do that?" It's one of the things I kind of miss right now, being in management, because I really loved working on Spacelab Life Sciences 1 and being Branch Chief in the Operations Branch. You sit around the table and you talk about an experiment. Just like this, "Why couldn't you take that stuff?" It was like [wheat] bubble gum [story for food bars]. And you just start thinking about, what is there that we could do that might make that work. That's the fun of it, of having something that hasn't been done in microgravity, and you know there's not a piece of equipment. How do you adapt that piece of equipment or how do you make the experiment work? What do you do? And sometimes it's very, very simple little things, putting a piece of [velcro in a corner in] a simple way.

What I find interesting [is the natural operations inclinator]. Probably a lot of women in technology and in the professional world will say, "Why did you have to bring that in?" I think there's a lot of things that come from our home life that you get out of being a housewife and the manager of a household, and particularly if you find yourself doing the plumbing things at home, or trying to do them, that you see as simplistic ways to try and get some of these things done in flight, because the best thing you can do is to make it very simple and make it very inexpensive.

You don't want to burden a crew person who is trying to fight nausea, trying to keep all these experiment procedures in mind. You want to keep things very simple, plus you want to keep them at a point that if it breaks down, they can look at it. I always have to think back to—what was *The Right Stuff* [and then the Apollo 13] movie when they had the explosion. Remember, on the ground, they were thrown this big heap of stuff, which was the underwear and the socks, and [asked] now what can you do with this. That's really, really very applicable,

whether you're starting from the beginning or starting from the end. You really have to think, what's the simplest component.

Unfortunately, I think that sometimes our young people [don't] think that way, because they've been exposed to the high tech, but that's the fun part for me, those times when we used to sit down and say, "How can we do this? What can we do? What can we make it simple?" Or even making it simpler for the experimenter when they come in, because, interestingly enough, you get into a field station situation many times, when you can't have all the sophisticated equipment they have in the lab. In fact, you don't want to do that, because you don't want to ruin their [lab] equipment.

You can't afford to buy a $50,000 piece of equipment every time, for every different thing a researcher may do, so you talk with them. "Now what do you really need?" And that's hard to drive out sometimes, because the first thing, and understandably, the researcher will come to you and say, "Well, I need this, this, and this."

And you say, "Well, what happens if we don't have this?"

"Well, yeah, we could do this." And it's that bargaining back and forth that is kind of fun. You never try to undercut what they need, but you really look at the reasonable approach and what can be done.

WRIGHT: In all that you've done and all that you've accomplished, is there one accomplishment or a time that you feel like, of all the things that you've gone through, all the long hours that you've put in, all the sacrifices you made, it was worth it just so that you could be one part of this whole program?

DALTON: Well, I think [of] one of the things—I'm going to go several steps back. I think something that happens with everyone, that I don't wish on anyone, is that it's hard to keep that balance between family and work, and I think that's one of the things I regret. It didn't help my marriage, and I feel sometimes I could have spent more time with my daughter. She was very understanding and wonderful, but she didn't want to go into the space business, I think, because of that. I have a very dear friend at Marshall, whose daughter went into engineering but wanted nothing to do with NASA, and I think that's partially because, [like my daughter, she sees] how much time [her] parent [was] spending in all [the SLS-1 crew training].

If I look back at training—and I think things have changed drastically for a lot of young women—I wish that I had had more math in school. I remember when I had algebra, geometry, trig, I wasn't going to take calculus. I took calculus when I did my MBA, and it was a snap. It wasn't a problem, but I think it was the way it was viewed when I was in high school, like, "You're a woman. You ever going to use that? What are you doing in this class?" In fact, I was the only girl in [high school] physics class, and I got the highest grades, and the guys were mad at me. So you have to apologize for that. [Laughs]

I'm glad to see that those ideas have changed. I think that's important. I don't think there's anything I would want to do over or that I would regret having done. I've always told the people, when I was in the branch, when I was in the payload, along the way, that the sin is not in making a mistake, and I think that's something our educational system doesn't look at correctly. [Yes], the sin is not in making a mistake; the sin is not using that mistake as a learning tool and admitting you made the mistake. And sometimes that's hard to acknowledge. You want to impress everybody. But at the same time, you should just say, "Look, I'm stupid about the thing. What do we do?" And let's go from there.

I had to use that approach when I went into SLS-1, because I was coming [in] as a microbiologist when I entered the operations world, and I didn't bring engineering [education]. I knew everything about laboratories, but I'd look at this piece of equipment and say, "Okay. How am I going to operate that? What am I going to do?"

And most of the time, the engineers would say, "You know, that wasn't a dumb question. We didn't think about that part." I think that's kind of the test point that you have to have in any system, is to set a naïve person in there to ask the stupid questions. And that's also something you have to remember about flight hardware, too, because again, you've got a [big] cross-population who's going to be running that experiment, like Shannon Lucid, who is extremely bright. Here's a physicist doing a life sciences experiment, and doing it well, who really learned everything and what to be careful for in dissecting animals and looking at all parameters of the experiment.

So I think admitting where you made errors or not being afraid to ask questions, those are some of the biggest things. Even in management now, I know there have been situations [of doubt]—I faced a situation several weeks ago where I deliberated and said, "Okay. Am I going to look like a fool or what?" We were supposed to do this countermeasures and evaluation program with JSC, and we've been involved in this for three years. We did the integrated test regime last summer, and we were working towards doing the big bed rest study that was supposed to begin in December, January.

We got a notice from Headquarters in December. Everything seemed to be moving kind of slow, but we got this notice from Headquarters in December and they said, "Stand down. … We'll let you know in sixty days." Well, they didn't let us know, they didn't let us know, they didn't let us know.

So three weeks ago, I was at Headquarters. I went in to the person at Headquarters and said, "You don't have any money to do this now, too, do you?"

And he said [whispers], "No, we don't"

And I said, "You don't know if you even have money in '03, do you?"

And he said [whispers], "No." And he said, "But I want to keep those facilities open."

I said, "I don't have any income to pay for 5,000 square feet of facilities for the next five years." I said, "We can't do it."

So we got the person from JSC on the line and he said, "I only have funding to pay those contractors to the end of April, and that's it."

I said, "Plus, you guys haven't made up your mind now, whether you want to do them at Galveston [Texas] or you want to do it at Ames."

He said, "You're right. Even if we have money, now we don't know where we want to do them, and we've got all things settling out."

So when I met with Dr. McDonald, I really hesitated. "Should I say something? Am I killing the program?" I said, "I think we need to address this, but I'd like your input, because you made the original agreement that we would be working with JSC to do more activities immediately."

[Dr. McDonald said], "Cut it."

The next day we had a fireside chat with Dr. McDonald. This is after these retreats that our managements had been having together. The first thing he said at that fireside chat is that the agenda for [NASA Administrator Sean] O'Keefe is to get Space Station on line. [I believe] HEDS [Human Exploration and Development of Space] is out of pocket for twenty years. There

is not going to be any talk about going to Mars, [sending] a human to Mars. He said, "Plus, the military is building so many robotics."

That made perfect sense. It made perfect sense and why he said yes right away, but I was scared to say something because I thought, "Do I want to be the one that someone says, 'Oh, she killed the facility'?" But it may not be used. And those are the kind of decisions that are hard to come up with. But if you don't do them, you're not much value as far as a manager for the group either. And you just have to look at all the inputs that are there.

Probably other things that I find difficult in management, is working with your people, and I have found it more difficult in the research group than I have in the flight group. [That] is working with your researchers and your research managers to ensure that everyone is very fair to everyone. I think because each researcher has their own research grant, or whatever they're working at, and they're competing against each other, there is a tendency in the research field to be very, very competitive and to be pushing all the time. If you have someone who is managing [a] research organization whose interests are primarily [in one area], for instance, [e.g.], if you have someone who [is] managing who's a physiologist, that person's going to be more attentive to the physiologists than to the molecular biologists. So to try and bring that around so that you don't have that, and so everybody feels on equal ground, I think is [extremely] hard [at times].

The third thing is to be looking at the organization and what's going around that organization, and to protect the people, [to] keep them productive. When we got this big cut on Space Station, the first thing my people in the projects [were] saying [was], "My gosh, 65 percent has been cut out of our budget? What are we going to do for the next couple of years?" And so we had brainstorming sessions last summer. "What can we do? Let's not wait for fundamental biology. What are the things that could really be done?"

A month ago [I] sponsored a Space Station workshop here at Ames to look at what could we do in the near-term science. What I've found, and this is where I find that I'm deficient, is that I have been away from research so I have to be constantly reading, myself, and it was one of the reasons I went to Affymetrix. What is happening out there? How do we balance this? [Unfortunately], you can't have a total researcher in here, because they've tried that, too, and they didn't have the business management skills.

[There is] a fine balance, I think, in all of our NASA organizations, and I think when you talk to a lot of the people at the JSC, you find the same thing. It's a hard balance, trying to manage the research, manage within the confines of what budgets are, what NASA expects, and to encourage the people that if they're not in this area, that they redirect themselves to go in this area, because those are the pathways of the agency, the biotechnology, the nanotechnology, the information technology. Those are the three cornerstones at Ames right now. If you look at what's happening out in the world there, that's what's happening in the world.

So anyway, those are the challenges. But I love it.

WRIGHT: Well, it's been most satisfying for you to keep enjoying challenges, because there seems to be so many keep getting thrown away.

DALTON: I think that's true for managers at all the Centers. … I spent three years in industry, but, of course, I was just at a technician level at that time, and I often wonder, "Oh, wow, are they having this much [difficulty with budgets, directions]?" And I'm sure with all the dot-come failures that they are, although I read an article that said that actually the economy problems of a couple of years ago, and that are still continuing, were good. It's like you have to have the forest

fires every once in a while to weed out [the under brush], so I keep thinking about that in terms of our research.

The meeting [I] went to today on the taxation structure at Ames right now is of concern primarily because we're concerned about our researchers. The statement was made by Nancy Bingham, who is associate for Dr. McDonald, that we have hired more researchers and we have decreased our administrative NASA staff, so [that] means that we now have to spend contract dollars for them. Can we maintain the flavor of Ames, that is, a research community, if they're being undercut by all these expenses to be maintained at the Center? So [we have] a real challenge. …

WRIGHT: It sounds like you have another large challenge in front of you, and we wish you the best of luck. We thank you for taking so much time out of your schedule to visit with us.

DALTON: I'm sorry your time was cut short. I thought we would be able to have more.

WRIGHT: We're used to forest fires, too. We're very flexible, and we try to take the best that we can. We will be looking forward to sending this to you, and then maybe when you have a chance to look at it, we'll see if there's some more things that we need to visit about it. And now that you're coming to Houston on occasion, if we need to fill in some other spots, we can do that. We'll talk to you then.

DALTON: Sure. And you know, we could do telecom if you ever wanted to. I don't know how effective that is. We could try that sometime, too.

WRIGHT: We'll see how this works out and then we'll go from there. So, thank you again.

DALTON: The Flight Programs [has] a really dedicated group of people, and in our research group [we have talented and good], a very good group of people. In the publications that we've been getting out in our research group, we've been averaging about four publications per person per year. That means some are doing more than others, but still that's a pretty good average. So, we're glad to do that.

WRIGHT: Well, congratulations. That's great.

DALTON: And it's in peer review journals, and that's pretty darn good.

WRIGHT: And that means, of course, that's your enthusiasm across the division is still there, so that's terrific.

DALTON: … We also had a really nice report from the peer review. One person had been on the previous panel in '95, and we did that purposely so that we'd have that continuity, and they said [that our group was] much improved over '95.

WRIGHT: Well, now you continue on this path. And good luck with that area as well.

DALTON: Thank you.

[End of Interview]