ORAL HISTORY TRANSCRIPT

DANIEL C. BRANDENSTEIN
INTERVIEWED BY CAROL BUTLER
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BUTLER: Today is January 19, 1999. This is an oral history with Dan Brandenstein for the Johnson Space Center Oral History Project. The interview is being conducted in the Kistler Aerospace Corporation offices in Kirkland, Washington. Carol Butler is the interviewer, assisted by Summer Chick Bergen.

Thank you for joining us today and taking time to talk with us.

BRANDENSTEIN: It's my pleasure.

BUTLER: To begin with, what made you interested in becoming an astronaut? Was there something when you were younger, interest in flight, science fiction, anything?

BRANDENSTEIN: Well, the history of how I got involved and interested, growing up in high school and the like, there was no space program, so aviation was probably my interest. Although I never did any flying, I was always interested in airplanes. I built model airplanes and the like. And basically it kind of narrowed down to my freshman year in college, kind of had to chart a course through life. Up until that point, it had been a little of this, a little of that. I guess, fortunately for me, it was during the Mercury Program, so now a space program had evolved that I was aware of. Since my interest in aviation was quite strong, it looked like the space program was the ultimate form of aviation.

So at that point I thought, well, you know, you might as well shoot for the top of the heap, and I decided I'd consider, would like to be an astronaut. I wasn't sure what it all entailed and what I thought the requirements were. As I said, fortunately there were only

seven astronauts at that time. I basically got the biographies of the original seven and just kind of took the common thread of those seven individuals. Basically, they were all military pilots, they were all test pilots, and they all had a degree in science or engineering or something like that.

So I was going to school at University of Wisconsin at River Falls, and they didn't have an engineering program, but I pursued a double major in math and physics, which was about as close to engineering as you could get there, and it was things I was really interested in. Through high school and throughout, math and physics were always my favorite courses. I was most interested in those. It also happened to be the path of least resistance through college for me. If I had had a major in history or English, I'd have been dead. So that kind of came together.

Then my senior year in college, I started looking at the various military aviation programs. The Air Force sent their recruiters to the campus, and they were good recruiters, but they weren't aviators. They were enlisted professional-type recruiters. Whereas the Navy team that came were actual pilots, and they sat down and they told you flying stories and laid out what it was all about. They impressed upon you that the Air Force lands on three miles of runway and the Navy lands on 750 feet of pitching steel.

So, once again, looking at what looked to be most interesting and most challenging, the naval aspect of aviation caught my fancy, and I went and took the tests and the physicals, and got selected, and right of out college then, went through aviation officer candidate training down in Pensacola [Florida], and got my wings through the Navy flight training program.

So I basically had one of my Xs in a box as I perceived it. Then my Navy career took me into the A-6 community. I flew about two hundred missions in Vietnam, made two cruises over there off of two different aircraft carriers. The Navy requirement to get into test pilot school was a minimum number of flight hours, so after my second cruise, I had accrued

enough hours for that, so I applied for the Navy test pilot school, seeing to get the second X in the box.

The first selection I was selected as an alternate, so I was halfway there, I guess. But part of the way the program worked, if you were selected as an alternate, the next time they had a selection, you automatically were reevaluated and then put back in the selection process. And that time I got selected, so then I went to the test pilot school, then continued on for about three and a half years of flight test work. That wrapped up in the middle part of the seventies, and the space program was more or less slowing down. Apollo had been stopped. The Skylab was in progress, but that had a questionable future, from what you read in the media.

At that point in time, we historically know now that the Shuttle Program was being developed, but it wasn't obvious to me at that point, as I recall. So I kind of thought, well, heck, my chances of being an astronaut are probably kind of slim, because it looks like the program's kind of winding down. So I went back to the fleet and continued my naval career, which I enjoyed very much. It was something that I enjoyed doing and felt a great deal of professional satisfaction doing it.

But then in '77, the call went out for selection for astronauts for the Shuttle Program, so I quick did a little research and said, "Wow! There is a chance." So the process worked that military folks had to apply through their parent service, so I filled out all the paperwork and sent it in to the Navy, and I passed their screening, and then those names got passed on to NASA.

Then in—I think it was August of '77, I went to Houston, in the heat, and went through the week of interviews and the like, and then in January of '78, the word came from Mr. [George W. S.] Abbey, the phone call. Actually, I was stationed right up here on Whidbey Island [Washington]. In fact, it was early in the morning. It was one of those things you kind of don't forget. I was in the shower and the phone rang. My wife answered

and got me, dripping wet, out of the shower. George, in his typical fashion, started asking about the weather and everything else, you know. I wanted an answer; I don't want to talk about the weather. So ultimately he got around and wanted to know if I was still interested in coming to Houston and being an astronaut. The answer to that was pretty obvious. So then that was the last X in the box, pretty much, at least to be an astronaut. I still hadn't flown.

So then in the summer of '78, we moved down to Houston and started our astronaut candidate training. Keep going?

BUTLER: To jump back just briefly, you mentioned the early program and the Mercury astronauts. Now we're coming up on the anniversary of the Apollo 11 moon landing. Just out of curiosity, do you remember where you were when they landed on the moon?

BRANDENSTEIN: Sure. I was between my cruises, and I was home visiting my folks. I stayed up, I think, all night or most of the night on the living room floor while everybody else was in bed, watching it on TV. I guess this is maybe a vain attitude, but my initial impression, when Neil [A. Armstrong] stepped on the moon, was that I was hacked off because I wanted to be the first one on the moon. [Laughter] I got over it; it wasn't a big deal. But that was kind of my initial impression. But it was a tremendous achievement and it just reaffirmed my desire to get involved in the space program.

BUTLER: Great. You mentioned coming down to Houston to join JSC with the first group of astronauts elected in what had been almost ten years. What was it like at that time? What was the atmosphere around NASA and of your group?

BRANDENSTEIN: Well, obviously our group was all very excited. It was kind of interesting. See, we were the first group that had mission specialists in addition to pilots. Earlier I kind

of went through my long-range planning because I'd been interested in it and looked at it since early on, and kind of laid all these milestones that I figured I had to accomplish to get there. But a number of the mission specialists, they weren't pilots and they never had been pilots. I think Sally Ride is one that comes to mind. I mean, she was saying how she was just walking through the Student Union one day and saw a flyer that said NASA was looking for astronauts, and that's really the first time she'd ever thought about it. A number of the mission specialists, that was their attitude, because they weren't military pilots. Like I say, up until that point to the Shuttle Program, that was kind of the Xs you needed in the boxes to be considered.

So the wide diversity of backgrounds that we had in that class was unique to NASA, and I personally loved it, because I've always been interested in a lot of things. I mean, I'm fascinated going into a factory where they make bubble gum or you name it, just to see how different machines and different things work. In my lifetime, I took up skiing and I didn't take lessons; I learned to do it through the school of hard knocks. I bought a sailboat and I made some sails because I thought it would be kind of fun to make a sail. So I was always interested in not just what I did, but kind of a wide variety of things.

So being now in a group with people that were doctors and scientists and all this was really fascinating to me. There were a lot of neat people there with very interesting backgrounds, that knew a lot about things I didn't have a clue about, so you could learn a lot more. And that was kind of the flavor of the training. The first year of training, they try and give everybody some base line of knowledge that they needed to operate in that office, so we had aerodynamics courses which, for somebody who had been through a test pilot school, was kind of a "ho-hum, been there, done that," but for a medical doctor, I mean, that was something totally new and different. But then the astronomy courses and the geology courses and the medical-type courses we got, all that was focused on stuff we'd have to know to operate in the office and at least understand and be reasonably cognizant of some of the

importance of the various experiments that we would be doing on the various missions and stuff. So I found that real fascinating.

He's passed away now, but the astronomy course was Professor Smith out of University of Texas, and he was kind of your almost stereotypical crazy professor. I mean, he was just a cloud of chalk dust back and forth across the blackboard as he went on, and we had twelve hours of astronomy. He claimed that he gave us four years of undergraduate and two years of graduate astronomy in twelve hours. And it gave you a good appreciation of what it was all about. It didn't, by any stretch of the imagination, make me an astronomer, but the intent of it was, like I say, to give you an appreciation and give you an understanding, and then also because of the very special instructors they brought in, it gave you a point of contact. So if somewhere later in your career you had a mission that needed that expertise, you had somebody to go up to and get the level of detailed information you needed.

The other good thing about the classes, there weren't any written tests. You absorbed as much as you could. There were people in the class that were kind of the interim step. One of the guys I met there in my class turned out to be a good friend to this day, is Steve [Steven A.] Hawley. He was an astronomer. I flew A-6s in the Navy, which was an attack airplane, so I don't know how it got around, but we ended up calling him "the Attack Astronomer," because he'd never flown. The mission specialists flew in the back seat of the T-38s. He really took to flying and really enjoyed it, so somehow during the evolution he got the nickname "the Attack Astronomer—A-squared." So, you know, he learned about flying and that type of operation, and I learned a little more about astronomy and the like.

There were a lot of those interchanges because you had such a diverse group of people. We always joked—and it was that way. I mean, like I explained how they taught you the astronomy, well, everything was pretty much that way. It was just dump data on you faster than you could imagine. A common joke was that training as an astronaut candidate was kind of like drinking water out of a fire hose; it just kept coming and kept coming and

kept coming. Like I say, probably the good point of it was you weren't given written tests, so they could just heap as much on you, and you captured what you could. What rolled off your back, you knew where to go recover it.

That was—I can't remember, I think it was almost eighteen months that we were in that. I think the first AsCan [astronaut candidate] class lasted that long. Ultimately it got streamlined and reduced [to one year]. We had a lot of field trips. We went to all the NASA centers. Basically, being an astronaut, it's not real narrow, highly specialized; it's very diverse. Your missions carry a variety of experiments. So as I came to find out later in my time at NASA, you really look for people that are adaptable and have a more diverse background, almost the better off you are, because the way you operate in the office, you have assigned tasks for six months, nine months, a year, and these are technical tasks that you do when you're not training or flying a mission, and, you know, you get switched to another one, and you try and develop a corps of astronauts that really have a very broad base of experience and knowledge that covers the wide spectrum of the space program.

That was part of the reason of going to all the centers, because you got to learn what they did at all the other centers, so you got a better understanding. You went to the contractors, where they were building the Shuttle, and go to understand that a little bit more and all that. So it gave you a really good, broad experience base. That's, I think, from my perspective, what I liked about the job. You weren't stuck in a small, narrow area. It kind of goes back to my nature. The Navy is kind of that way, too. They move you around in jobs every nine months or so, and that's what I always liked. I liked new experiences and learning more, and having a more diverse-type job as opposed to a very narrow focused-type job.

BUTLER: Great. Talking about the training, and you talked about how the Shuttle was still being built, basically, when you were starting, and you mentioned all the various course work

you went through, did you do any training while you were an AsCan, specifically on the Shuttle itself? Did you go in any simulators?

BRANDENSTEIN: Yes. You got a full set of briefs on each system on the Shuttle so you knew how the electrical system worked and how the hydraulic system worked and how the computer, and you got some time in simulators. You didn't get time in the upscale simulators, the moving base or the fixed base. They had what they called single-systems trainers where you kind of go in and you just learn one system at a time. The cockpit didn't move, but it had the basic displays and things. A lot of the switches, in a single-system trainer, a lot of the switches that weren't used in the level of classes you were getting were just pictures of the switches that you needed to operate, to learn the system you were working with, you actually operated.

So, yes, you got quite a bit of time doing that. Once again, it was the first time through, and you got a pretty good understanding of it, but it isn't until you really got further down the line in the real mission training that you really get to understand a lot of the subtleties of the Shuttle.

BUTLER: Were there differences between the training that you went through as a pilot compared to the one that the scientists went through?

BRANDENSTEIN: No, not really. The class—it was a big class, thirty-five, so we were split up into two sections. We had the Red Team and the Blue Team, and had our appropriately colored t-shirts and the like. Generally you went to classroom half a day and then you did flying, got checked out in the T-38 and did some of these other things on the other half, you know, the morning class. One half of the class was doing something in the morning and the

other was doing it afternoon, and then they switched, so made best use of the assets and the like.

So the pilots got checked out to fly the T-38, and the mission specialists, a lot of them had no flying experience, so to be a crew person, that's the reason they flew, was to learn to operate as a crew. So they had to be trained on not being a pilot necessarily, but being a crew person, what procedures you had to use to fly in the air ways around and, once again, to learn the systems of the T-38 and the various skills and functions of a crew person. And the T-38 had a stick in the back so they obviously got to fly some. They weren't allowed to land because they didn't get trained for that, and didn't want to break the airplanes, but we could take it off and up and away and swap back and forth who was flying.

A lot of the flying was kind of travel, business-type travel, but also there was an area just outside of Houston over the Gulf of Mexico, we could kind of go out and do what we called "turn and burn," which is do aerobatics and just do loops and rolls and chase around clouds and stuff like that. But all the time that's a way of maintaining your piloting skills. Obviously for people who had never flown before, that was—well, it's a kick for people that flew thousands of hours, but for somebody who never had flown before or had very little experience or just a little experience in a small light airplane, it was a real kick, because you could go supersonic with those. You'd pull 7 Gs and it all happened. It was all kind of new and different to them. And they flew with guys like myself.

As I said, all the pilots had been test pilots before, so we'd go out and kind of run them through the wringer, showing them the various things you'd do if you're testing a new airplane. Most of us were military pilots. I think most of us were, yes. All of us had been, at least somewhere in our career. We'd go out and do simulated combat and show them what it's like to have a dog fight and all those sorts of things. So that was fascinating to them, as me sitting down with an astronomer or a doctor and finding out about the types of things they did.

BUTLER: And all that helped with the team experience, too.

BRANDENSTEIN: Right. Exactly. Yes.

BUTLER: That's great. As you were training and going through and they were completing the Shuttle, the first Shuttle mission, STS-1, launched in 1981, so this is right as you were coming out of your training.

BRANDENSTEIN: Yes. We'd completed our astronaut candidate training, and once you complete your candidate training, then you basically get assigned technical assignments. My first technical assignment was on the support crew for STS-1. They don't even have those anymore. We had support crews up through about the fourth or fifth mission, I think. Basically, they also had prime and backup crews for the first couple of missions.

The crews were spending so much time training that what the support crew did—and I think there were about four people on the support crew, if I remember correctly—maybe five or six. I don't even remember for sure. And basically our job, we were just kind of right-hand people for the crew. Part of it was we got to be Capcom. For STS-1, I started out as the backup capcom for ascent, and Rick [Frederick H.] Hauck was backup capcom for entry. I think Sally [Ride] and Jim [James F.] Buchli were backup capcoms for the on-orbit phase, as I recall. I know Rick and I for sure. I'm not sure about the other two. I think that's where they fit in.

In addition to that, all the procedures to fly the mission and stuff were just being developed, so the crew would be over training and we'd be helping with the engineers and whatnot, developing the procedures that they would actually use to fly various parts of the mission. Once again, the support crew job was very diverse. We were capcoms. We were

developing procedures. Early on, the Shuttle had a certain number of significant technical challenges. The main engines were—they'd blown up a number of those.

BUTLER: Oops.

BRANDENSTEIN: So one of the guys in the office was basically the office representative, that he ought to be the smartest person in the office about the engines and follow every event and detail that was happening with the engines. The thermal protection system, the TPS, was another one; they were having a lot of trouble with that. So I was assigned to be the TPS expert in the office, so I spent a lot of time going around and talking to the real experts, the engineers and stuff that were doing it, and attending meetings as they were making decisions as to how to proceed with the tile. The tests—they were breaking off. They worked on how they were going to solve the problems so they wouldn't come off. And all those sorts of things, because that was something that was obvious on the Shuttle new and different.

I always told people that the Shuttle was really, other than a couple of areas, was pretty basic design. I mean, the structure was basic airplane structure, just like a 727 or something like that. But the big three things were the computer system and the whole data management system that was a step forward in the state of the art. The other were the main engines, and the other was the thermal protection system. So those were the things that, as you would expect, when you're taking the biggest leap, you run into the most problems. So we had people focusing on that. So I did a lot of traveling, a lot of work following what was happening in the TPS world, and got to be reasonably knowledgeable about that. As it turned out, the system is a pretty robust system, although at that point in time people were worried a lot about it.

So those are all the types of things. In addition to that, they were looking at in-flight maintenance, what could be repaired, so I worked with some of the engineers and flight

controllers, and we developed a whole set of in-flight maintenance procedures: if this box failed, how you could change it out with another box so you could have yourself covered. So we were building a tool kit and a whole set of procedures to do in-flight maintenance. So once again, it was a lot of diverse-type work which I found to be really interesting.

BUTLER: You mentioned the thermal protection system. When the Shuttle—once they got on orbit and opened the payload bay doors, they noticed that some of the tiles had come off. What kind of discussions surrounded that on the ground?

BRANDENSTEIN: Well, the discussions were, well, they could see one off, were there any others, you know. So there were a lot of questions as to, well, were there any other tiles missing, and if so, where were they? They did a lot of soul-searching as to which ones were missing, which weren't. The ones that were missing, you know, you knew where they were, so obviously you went back in and the thermal experts did some analysis and determined that—well, first you tried to evaluate and they didn't really totally come off. They kind of sheared, as I recall. So you had some protection there. And they were in an area that wasn't critical. So the ones you could see, you obviously analyzed, to be comfortable that it wasn't going to be a problem, but the biggest concern was, well, what is there that we can't see? Namely, we can't see the bottom of the vehicle, and that's the most critical area. So there was some serious tile missing there. It could be a bad day. We had ways of finding out that there weren't any missing.

BUTLER: Good. Good. And they did come back safe and sound.

BRANDENSTEIN: Yes.

BUTLER: Looking at the tiles, and you mentioned the engines and just a lot of changes in the way the American program was approaching space flight, the Space Shuttle was the first manned craft to fly with man in it the first time. Are you aware of any of the discussions surrounding that, and what was the motivating factor in that?

BRANDENSTEIN: Well, I think it was basically the nature of the vehicle. By the time we were on board, that decision had already been made. And I don't ever recall it coming up for discussion. Well, no, I don't think—there was very little discussion. There may have been one or two trial balloons floated to talk about flying it unmanned, but that took a lot of modification and that wasn't in the cards.

There was also some talk about not flying a full mission, flying an RTLS [return to launch site]; in other words, just going up, turning around, and coming back. Once again, that balloon was floated and it got kicked around a while, but the general consensus was—and the reason for that was they thought you'd have somewhat less stressful environment on the tile if you flew that. I don't know if you're familiar with the RTLS maneuver, but overall that's a lot more stressful maneuver. So I think after a bit of discussion, leveler heads prevailed and that was not the option. I don't think anybody in the Astronaut Office was very enamored with that idea.

But, you know, that's the way things worked at NASA. You throw everything on the table and you don't have it out and discuss it and try and—the recommendation to do it was very good, because people were concerned about the tile. It, in certain areas, provided a more benign environment for the tiles. It was a very legitimate type of suggestion, but really when you shook the whole thing out, it solved a couple of problems, but it created more worse ones, at least in some of our minds.

So after a fair amount of discussion, it was decided that wasn't the way to do it, and I think—I don't know, I thought as we approached the first flight, everybody had worked real

hard on doing all the verification and checking everything out, and I think most of us felt quite confident that it would work fine. I guess my biggest worry was, I looked at the pad and I saw the tight clearances there. The first 100 feet is probably what worried me the most. I figured we could pass the first 100 feet and we'd be all right.

I hadn't been associated with any other program, but I guess some of the old hands that had been associated with the Apollo Program and whatnot, they weren't concerned about it, but it just seemed to me like it was an area that I worried about the most. So a couple of seconds into the flight, I felt a lot better.

I was actually probably most excited being the Capcom—well, what had happened is, in the process of getting ready for STS-1, Ed [Edward G.] Gibson, who was the primary capcom for ascent, retired, so then all the powers-that-be, I guess, put their heads together and decided whether a new guy could be a Capcom on the first mission. Neal Hutchinson was the flight director for the first mission, and I think he had a lot of confidence in me and probably had a strong vote.

So anyhow, when Ed Gibson retired, as opposed to pulling another experienced astronaut in to be the ascent capcom, I inherited that position, and Terry [J.] Hart moved up to be my backup. So that was kind of a thrill for me. To this day I think I was more excited being Capcom on the first mission than I was actually flying my own mission. I still look back and think about it, listen to the tapes. I mean, I settled down, but you make calls back and forth just to kind of check to make sure everything was working all right, and the first couple, it's real obvious that my calls, I was pretty excited. [Laughter]

BUTLER: It's a pretty exciting time. I mean, returning to space for the first time in many years and you got to be a part of it right there.

BRANDENSTEIN: Yes. I never saw a launch until STS-3, because I was Capcom also for ascent on STS-2. I still remember a bunch of the wives went down to the launch of STS-1, my wife being one of them, so all I saw of it was on TV. When she came back about two days later after the launch, it was two days later and she was still ricocheting off the ceiling. In all the years we'd been married, I'd never seen my wife half that excited. She was just something else. "You wouldn't believe it. You just can't believe it. What you see on TV is nothing! You ought to be there. You won't believe it."

But I had to wait till STS-3 before I got to see one in person. And it is. I think it's significant that I think it's more exciting watching one as a spectator than being on one. People always look at me like I'm smoking something. But really, I always [have] explanations. I call them pilot explanations for things. I can explain medical things in pilot talk, and it's probably not right, but it at least is a way of explaining it that satisfies me.

But when you're watching one, you have no real responsibility, and it is noisy. You hear the popping and the cracking and the big long flames shooting out and everything like that, and you have no responsibility. I get a lump in my throat and chills up and down the spine and all that. But when you're on board, you're responsible for that baby, so you're checking instruments and you're making sure everything is working all right. You're not there to take it in; you're there to make it work. That's certainly a different perspective. I mean, don't get me wrong, I would never turn down a launch, the opportunity to go fly, to go watch one, but from a pure spectacle standpoint, the spectator point of view is more thrilling than the flying point of view.

BUTLER: I can see where you're coming from with that, definitely. Well, moving into the flying point of view, you were selected as pilot for STS-8. When did you find out that you were going to be on the crew? What were your thoughts at that time?

BRANDENSTEIN: I think it was about nine months before the flight. I don't specifically remember. It always started with, "There's a call over at Mr. Abbey's office." The first six flights had been assigned, and they were all experienced, people that had been around the office a long time. Nobody from our class had flown that. But it was hoping and guessing and rumblings like that, starting with 7, 8, and on, that they'd be picking up some of the new class and stuff.

So I got called over one day and they said that I was going to be Dick [Richard H.] Truly's pilot and was going to fly STS-8. That was obviously great. I was excited about that. That's what you wanted to do. One of the really neat things about it, that was going to be a night launch and a night landing. What drove that was, we were launching a satellite for India, and to get it in the proper place, you kind of worked the problem backwards. Okay, they want the satellite up here, so then you've got to back down all your orbital mechanics and everything, and basically it meant we had to launch at night. The fact we launched at night meant that we would end up landing at night. Just, once again, the way the mission worked out.

So that's pretty early in the program to try something like that. I mean, Dick Truly and I had both done night carrier landings, and the way the Shuttle flies, approaches the end of the runway, and doing that at night, we kind of looked at each other and said, "Oooh. This is going to be interesting."

So we got very much involved in developing a lighting system to enable us to safely land at night. We had other people, and once again it was the job of a technical assignment of somebody in the office, kind of like a support crew. We were out of the support crew business by that time, but the crew didn't have enough time to focus just on that, although we got very much involved because we were obviously the ones doing it first. But [Karol J.] Bobko and then Loren [J.] Shriver and then Mike [Michael J.] Smith were all involved in developing the night lighting system, so we went through a rather long evolution of flood

lights and spotlights and flares and whatnot, trying to develop some way to give us the visual cues we needed to make a successful night landing.

To my knowledge, when I left in '92, the system had not changed. It had a couple of tweaks, but it had not changed significantly from the way we ended up on STS-8. So it's always neat to do something first, for the first time. So, developing that was interesting and a lot of fun, and it was fun being involved in that.

On STS-8, the program was still—we were still testing the vehicle in a lot of ways. We had the INSAT, which was this Indian satellite, it was a weather and a communications satellite, so we deployed that, but then the lion's share of the mission was doing vehicle-type tests. The main part of that was the mechanical arm, the RMS [Remote Manipulator System]. Dale [A.] Gardner was the lead on that. He was one of the mission specialists on that flight, so we had this big test article that we carried in the payload bay, and he pulled it out and put it in, and turned it around and put it in, and pulled it out, and did all that sort of stuff.

We also had Bill [William E.] Thornton on, so he was doing—a lot of people were getting sick going into space, so he was doing—he and actually on the flight before Norm [Norman E.] Thagard got added on a little bit late, because the crews had been announced. The earlier flights, there had been quite a few people that had gotten sick, so they put a medical doctor on each one, and the goal was to try and get some data and better understand why people were getting sick and what to do about it.

So, the medical tests were a big part of that mission, too. I'd never been seasick, airsick, or anything a day in my life, and some of the experiments they had you do on the ground, I mean, they were kind of prepping you. I don't understand half those medical experiments. It's kind of the lab rat comes to mind, and you're it. But they put us in a spinning chair and put a blindfold on us. They spun the chair and then they had you move

your head down, up, right, left, down, up, right, left. Like I say, I was convinced I could never get motion sickness, and, man, in about thirty seconds, I was a sick puppy.

So at that point, all of a sudden I started saying, "Well, gee, am I really going to get sick on orbit?" Because I was convinced I wasn't going to get sick. I thought it was mind over matter. I always thought these guys decided they were going to—everybody was saying they were getting sick, so everybody launching thought they were going to get sick, so they got sick, you know. And so I went into this chair thinking, "Well, I'm not going to get sick," and, man, I got sick, so my "mind over matter" theory kind of got shot out of the water.

Fortunately, when it came flight time, I'm one of the lucky ones that I did a back flip out of my seat when I got on orbit and never looked back, and never had a hiccup in any of my missions or anything. So watching some of the people that did get sick, it's a lot more fun not being sick. It certainly makes your mission more enjoyable if you don't have to deal with that.

But at that point in time, they were trying to decide what made people sick and how to prevent it, and it turned out, after a while they quit trying, and there was no correlation. I mean, we did all this weird stuff and none of it correlated. Some guys that could ride that spinning chair on the ground till the motor burned up didn't get sick, you know, and they got in orbit and ten minutes later they were sick as could be. So basically, I guess, once again in my pilot explanation, they couldn't find any correlation, so they just quit trying.

Ultimately, quite a bit later—in fact, I don't think we figured it out or found the solution until after—I think it was after the *Challenger* [STS 51-L], until we started flying again. But they did find a medicine that if you give somebody a shot, from the time they tried it until the time I left in '92, it worked on everybody except one person. There was only one person that it didn't work on.

Usually in about fifteen minutes, you give them a shot of something called phenegren. They found that apparently they use it in hospitals with people that have had

chemotherapy and get sick, and it helps them. So somebody said, "Why don't we try this." I mean, as soon as somebody would start getting a symptom of space sickness, you'd give them a shot, and in about fifteen minutes they'd be as good as new and were good as new the rest of the flight. So it was really a great find and it made everybody's that did get sick missions a lot more enjoyable. As I say, there was only one person that I know of that it didn't work on. I don't know why, but people have different metabolisms or something.

So, anyhow, that was pretty much—then we came back. We originally, early in the mission, they all landed on the lakebed, but we were the first ones to land on the runway out at Edwards [Air Force Base, California], and the reason we did that is because if we landed on the lakebed with the lights that we had devised to do the night landing, when you land on a lakebed, you kick up a cloud of dust which attenuated the light, and we felt it was safer to take the approach to land on the runway instead of the lakebed. So we landed on the runway using the lighting system that we had devised, and worked great.

BUTLER: And I guess that was some preparation, too, for landing on the runway out at Kennedy [Space Center, Florida], then.

BRANDENSTEIN: Well, we still weren't planning on landing out there, because it was too early in the program and the intent was to land on the lakebed. Even the runway at Edwards had more margin. In other words, if you had some problem and you ran off the side of the runway or something, you weren't going into the moat. At Kennedy, it wasn't very far from the runway to the moat that's around the runway. So that was always the concern at going to Kennedy.

Early in the program, once again we were still testing the vehicle. If you had a bad navigation error, you're pretty much limited in what your options are at Kennedy, but at the lakebed you can land this way or that way or just about any way at the lakebed. Now, in a

night situation, without having lights, it probably wouldn't have worked. Actually I think we had two runways out there that we could have chose from. We had a set of lights on the—I'm trying to remember. I think we had a set of lights on the lakebed, even though we weren't planning on using it, just as a backup in case we needed it and needed to accept the dust problem. But the runway turned out to be the primary one, and it worked out great.

BUTLER: Okay. Good. You mentioned the space sickness and you mentioned the spinning chair. Did you also train on the KC-135 for that?

BRANDENSTEIN: Oh, yes, we went on the KC-135. It never bothered me. That was great. We went on through forty-four parabolas a couple of times, you know, and it was fine once again. A lot of people have trouble with that, but, like I said, I never had troubles with anything. That's why that spinning chair kind of threw me for a loop, because I didn't figure I'd have trouble with that either. I was wrong.

BUTLER: When you did first get up into space and back-vaulted out of your chair, what were your thoughts once you were up there and once you looked out and realized?

BRANDENSTEIN: Well, the first impression is still probably the biggest. The ascent is, you know, really pretty neat. You get a lot of shaking and stuff, but, like I say, you're pretty focused on keeping track of the vehicle. You peek out the window once or twice and you can kind of see the sky go from blue to black and whatnot. But since we launch at night, obviously it was black all the time.

There's a good story that goes with that. Don't let me forget to tell you about the first launch.

BUTLER: Okay.

BRANDENSTEIN: But the first impression was, we launched at night, and then we were crossing Africa when we had—I saw my first sunrise on orbit. And to this day, that is the "Wow!" of my space flight career. Sunrises and sunsets from orbit are just phenomenal, and obviously the first one just knocked my socks off. It's just so different. Well, it happens relatively quickly because you're going so fast, and you just get this vivid spectrum forming at the horizon. When the sun finally pops up, I mean, it's just so bright. It's not attenuated by smog, clouds, or anything, you know. It's really quite something.

So that's obviously my first impression. It wasn't really—even after you're on orbit, you're floating around and that's neat, and you're getting to see the view and that's neat, but, still, after you get up, you've got an awful lot to do in a very short time, getting the vehicle prepared to operate on orbit. And there are checkpoints. If you don't get things done or something doesn't work right, you have to turn right around and come back, you know. So you're pretty much focused for about the first four hours up there, of getting that all done.

Once that was done, well, then you look out the window a little bit more. I remember when the real work of the day was pretty much over and it was time to go to sleep, which you didn't, you looked out the window and stuff. Then you'd kind of sit back and replay the launch in your mind and try and do it a little bit more from a spectator's standpoint. You realize that was really pretty neat.

Anyhow, getting back to the story on ascent, obviously Dick Truly and I were up front, watching the instruments and everything like that, and we had Guy [Guion S.] Bluford [Jr.] and Dale Gardner behind, the mission specialists. You have the overhead windows kind of like a sun roof on the Shuttle, and those guys, Dale in particular, was looking back over his head, and he could look out the window and he could look back at the ground. At night he could see how it lit everything up.

During first stage it's really bright, because you have the solid rocket boosters going. In fact, from the front cockpit looking out, it looks like you're inside of a fire looking out, because you don't really see the flame, but you saw the reflection and the light. But we weren't very far into the launch, and Dale says, "Dan, how do the engines look?" You know, the instrumentation on the engines, are they running all right? I said, "Yes, look fine." Thirty seconds later, he says, "Dan, how do the engines look?" "Fine." A minute later, "Dan, how do the engines look?" "Fine." I don't know how many times this happened. This happened, going up, a whole bunch of times.

Once again, we didn't have a lot of time to chitchat about it, you know, so finally after we kind of got all settled down on orbit, I said, "What was going on?" He said, "I was looking out the window," and when you watch a Shuttle launch, the flame from the engine is real solid. It comes out of the nozzle and it just sits there. It's got a shape and it just kind of goes. During all these engine tests before the first flight, you'd have an engine running on the test stand and the flame would be real solid, and then all of a sudden the flame would kind of flutter and the engine would blow up. And that was usually an indication that something was wrong, and it shortly followed that the engine blew up.

Well, as you get higher in altitude and from the perspective he had, the flames from the engines he saw were fluttering, so his connection was, well, when the flames flutter, the engine blows up. So that was his concern. You just have a different perspective as you get higher in altitude. The air pressure goes way down and you get into a vacuum, so basically what holds your flame real tight is the atmospheric pressure factors in that. Well, you get outside atmosphere pressure, they expand and they flutter a little bit more. Once again, from his perspective, from the inside looking back out at it, the flames were fluttering and he was concerned about that. [Laughter]

BUTLER: I could see that could cause some concern. [Laughter] Gracious. Well, luckily you made it into orbit safely without anything blowing up.

BRANDENSTEIN: Yes.

BUTLER: You mentioned your crew members. How was it as a crew? Did you bond pretty well?

BRANDENSTEIN: Oh, yes. Yes. I mean, you spend so much time working together, and that's part of the process of crew selections. You don't put oil and water together. When I ran the office, I was responsible for crew assignments for the years I did that, and you specifically look at—and generally everybody in the office gets along quite well. I mean, when you get 100 people, you're always going to have a few people that don't have the same personalities or personalities don't match or something. You don't try and cause problems, so you look for people that are compatible. Once again, I can't speak for assignments that were made on me before I was doing them, but it was pretty obvious by even looking at it. I mean, you look for a mix. You look for people that have specialties that mesh with the mission requirements and all those sorts of things.

Yes, it was a good crew. Dick Truly had been around a long time and was a good commander and taught us a lot. Everybody had their strengths and their area of expertise, and you focused on those and shared your experience and your wisdom with the other folks, and we got the job done.

BUTLER: Great. Moving on to your next mission, it was 51-G.

BRANDENSTEIN: Right.

BUTLER: About when were you assigned for that one, do you remember? Or about how long before?

BRANDENSTEIN: I don't remember the whole sequence. It's probably about the same time frame. Generally it was about nine months, is generally when the crew assignments got done. Once again, I don't specifically remember. And after the assignment, originally we were assigned and started training. I'm trying to remember. Yes, that's the flight that we had trained—they were doing a lot of shuffling at that point. We had trained—originally the crew, the NASA astronauts, that's the time we were flying payload specialists, and we had Charlie [Charles D.] Walker and Greg [Gregory B.] Jarvis were originally the payload specialists. We had our L-minus-30; in other words, we were thirty days from launch. We had our L-minus-30 press conference in the morning, and our mission was canceled that afternoon.

BUTLER: Oh!

BRANDENSTEIN: And, gosh, I don't remember what had caused that, but there were missions getting reshuffled and scheduled, because that's when we were trying to be a commercial launch service and were flying a lot of commercial payloads, and with the commercial payloads generally came the payload specialists and the like. Some missions changed or something, and it was kind of a ripple effect.

So anyhow, our mission got canceled, and it wasn't very much later, and the NASA crew, we all stayed together, but there was a shuffle of payload specialists. Greg Jarvis got ultimately moved to the *Challenger* [STS 51-L]. I think that's when [Senator E.] Jake Garn

came in and Bo Bobko's flight had some of their guys shuffled. There was a lot of shuffling going on. I don't even come close to remembering all what was happening, but I know there was a lot of—so anyhow, we ended up on our mission with Prince Sultan Salman Al-Saud and Patrick Baudry.

Then we got a different mission. We went from a similar mission, but different. We ended up on that flight with four satellites. So the core training still held, but we had to go back and do some of the payload and mission-specific training, we had to focus on that. I think we ended up getting shifted about three months, as I recall, from when we originally were going to launch. Like I say, it was a different mission.

Bad news. I think we had—we had an IUS [Inertial Upper Stage] TDRSS [Tracking and Data Relay Satellite System], I think is what we were launching before we got canceled. Then we got canceled and picked up these four satellites. We had one for Mexico, one for the Arab Sat Consortium, one for AT&T, and then we had Spartan, which was run out of Goddard. It was one that we deployed and then came back and recovered two days later. So it was a lot of mission planning changed and we had a couple new crew people that we had to integrate into the crew and all that.

But there was a lot of that going on at that time. There was a lot of scrambling around and missions for a variety of reasons, and the program was still relatively new. That was early '85. We had only been flying four years. The vehicle hadn't matured as you see it today. So they were flying technical problems on a vehicle and they'd have to pull one off the pad. That affected shuffling and payloads didn't come along quite like they figured, and that affected shuffling. So it was sort of a variety of things.

Anyhow, we got kind of wrapped up in that, but it was kind of ironic that the morning you have a press conference, telling everybody what you're going to be doing on your flight thirty days from now, in the afternoon they announce, "Woops. By the way, that flight just

got canceled." Obviously, the big concern with the crew when the flight gets canceled, "What happens to me?" And generally they did a pretty good job of keeping the crews together and getting them flown as soon as possible. But once again, it was kind of the nature of the way the Shuttle was operating. Some people grouse about it, but in reality you've just got to sit back and go with the flow and accept it, because if that's what's happening, that's the way it is.

So anyhow, yes, we got everybody pulled together and we went up and launched all those satellites, and launched the Spartan and came back two days later, and it had run out of gas. It wasn't pointing the way it was supposed to, so John Fabian worked the mechanic arm. He and I, we had to do a little bit of extra work, trying to successfully capture it, because it was supposed to be easy to capture, turned out to be hard to capture. But John was probably the premier arm operator in the office at that point in time, and through his expertise and the fact that I could—the Shuttle, on orbit when you're rendezvousing with something, trying to fly formation on it, it flies so well that it's unbelievable.

You can move it inches this way and inches that way. So where we were supposed to be able to grab it, he couldn't reach it from there, so I just flew in closer and moved over a little bit, and he tried to reach around to get it. You've got to move this way and do that, so I moved a little bit and we kind of together worked around such that he could reach the thing he had to grab to get a hold of the Spartan. Little did I know that that was good experience that would come in handy down the road. [Laughter]

BUTLER: That also shows the influence of having people on a mission, rather than just unmanned missions.

BRANDENSTEIN: Oh, yes. If that had been an autonomous—just programmed with no capability of human interaction, we'd have never got it back. It's as simple as that.

BUTLER: This was your first flight as commander.

BRANDENSTEIN: Right.

BUTLER: Were you involved in the selection not of the payload specialists, but of the mission specialists for the crew?

BRANDENSTEIN: No.

BUTLER: Not at all?

BRANDENSTEIN: Commanders never were. The whole crew was assigned by—at that point in time it was Mr. Abbey, and John [W.] Young was head of the [astronaut] office. But I think everybody pretty much believed that George was the ultimate assigner of crews, so he assigned the crews and it went from there.

BUTLER: So this was quite unique. You mentioned that you had the Prince on board and then a French payload specialist as well. So you had quite an international flavor to the mission.

BRANDENSTEIN: Right.

BUTLER: How did that make things different from your first mission?

BRANDENSTEIN: Well, the very first thing we did when we heard they were assigned, I mean, obviously he was from Saudi Arabia. I guess I didn't even know for a fact, but assumed that his culture and his religion was different. First thing we did was got together with—there was a company down in Houston called ARAMCO, which dealt a lot with oil companies. In fact, they had a big oil company over in Saudi Arabia. We got—I don't remember, somebody from their Human Resource Department. But basically brought them out because, you know, I wanted to know, and I thought the crew should know, as much about the Saudi culture, so we'd make the rest of our crew comfortable.

So we just had them out for a day, and basically got an education on the culture. We didn't want to do anything that made him uncomfortable. We had a better understanding—we'd been around Frenchmen before. I figured we knew and understood that enough, but the other was a total mystery to us. And Sultan had graduated from University of Denver or Denver University or something like that, and he'd spent half his life in the U.S. In fact, it was kind of funny, because he was more attuned to—more Americanized or more attuned to the American way than the Frenchman was. A lot of times we'd say something kind of, you know, a subtle-type joke that the Frenchman didn't understand and the Sultan would lean over and explain it to him.

So it turned out to be a neat crew. We still cross paths periodically. Patrick, he was a payload specialist, although in France he'd been a test pilot. After the flight he said—because this was my first landing. As a pilot, you're just a co-pilot. So it was the first time I landed the Shuttle—After the flight, he said, "It's the first time I've ever flown on a plane for the first time with anybody that was landing it for the first time, where I wasn't doing it." I said, "Well, see, look at that. We were able to walk away from it." It was a good flight.

Then after the flight, post-flight, we went to France and made a tour through France, doing all the appropriate PR things. Then we went to Saudi Arabia and did the same thing. So it was, once again, very interesting.

BUTLER: Definitely different than what you'd done the first time. [Laughter]

BRANDENSTEIN: Yes.

BUTLER: When you got up into orbit, did you notice any differences in your body's reactions at all? I know you didn't get space sick, but—

BRANDENSTEIN: No, not really. They told you about the fluid shift and you get a puffy face and you have to go to the bathroom a lot at first. Floating around in zero gravity, it takes a little training, because you can't really train for that on Earth, because you get in the KC-135 or the zero-g airplane, you get a couple of seconds, but it's not like operating for days and days. So it took a little getting used to. I figure it took about three hours the first time to adapt to really how you operate and stuff the first time, about fifteen minutes the second time.

But, no, I mean, it was just floating around. You get a lot more room. When you're in a simulator, you're in the same volume, but on Earth in the simulator, you're stuck on the floor. With a crew of seven, it gets pretty crowded, but in zero gravity you're not restrained to the floor. So it opens up because you can use the whole volume and not just the floor space. So even with seven people, it wasn't particularly crowded except at dinnertime where everybody wanted to come up on the flight deck and sit in front of the windows and eat. Then with seven people it can get a little crowded. But, no, nothing particular.

BUTLER: And how about on return? We didn't talk about that with your first flight, but how did you adapt upon return to Earth?

BRANDENSTEIN: Well, that's kind of interesting, because, once again, this is one of my pilot talk explanations, but, you know, after spending five, six, seven, whatever days on orbit, your brain reprograms itself to operate in zero gravity. You just move around with a little push of the finger, and so it basically reprograms. And you don't do big pushes. You learn if you give a big push, you get clumsy. It makes you clumsy. You have to be a little more patient and just go with small pushes and float small, slow and controlled. So, basically, once again, my explanation is your brain reprograms itself. It says, just send little messages to the muscle, and so you operate and you get very comfortable during the mission.

Well, we got back and landed. You land, you touch down, you're sitting in the seat, and it takes about thirty minutes to basically reconfigure the Shuttle after you land. And it was time to get out of the seat, you know, and I went to get out of the seat, and nothing happened. So, to get out of the seat, because now you weight 190 pounds again, it takes a conscious thought process to say—you know, kind of like when you pick something heavy up, you kind of, you'll grunt, and it's the same thing. You have to take a conscious thought process to just get up out of your chair, because your natural instinct was of the brain to send just little signals to the muscles, but little signals didn't do it once you're back on the ground.

So, for the first couple hours, a lot of things that used to come naturally are now conscious thought process. Walking up steps was one. Naturally, if you just kind of would amble up a step, you wouldn't raise your foot high enough and you'd trip. So you'd almost stop and look down to make sure your foot's a step high before you move forward with it. And a few things like that. Your inner ear is a little bit desensitized, and you kind of watch people and they kind of drift a little bit. They don't take nice square corners and whatnot.

One of the interesting things, we were flying back from Edwards to Houston, and I felt like I had a cap on, and I couldn't figure out what in the world it was, and it was the weight of my hair, because for five days—I think the first flight was five days—the hair had been kind of floating up, and just the weight of the hair felt like you were wearing a cap.

BUTLER: Interesting. Wow.

BRANDENSTEIN: But it took about twenty-four hours after I got back from the first flight to kind of get pretty much back on a total Earth unconscious operating on Earth. You didn't have to consciously really concentrate on anything anymore, but for a while there you have to be attentive to what you're doing, or you get embarrassed, like falling off the steps or something.

BUTLER: Or trying to leave a cup in mid-air or anything like that?

BRANDENSTEIN: I never did that. I've heard people do that. That one didn't happen to me, but I heard of people that you get used to hanging things in space and it doesn't work down here.

BUTLER: After your second space flight, 51-G, you became Deputy Director of Flight Crew Operations. What were your duties there and responsibilities?

BRANDENSTEIN: George Abbey was head of Flight Crew Operations. Basically the flying program out at Ellington [Field, Houston, Texas] was under Flight Crew Operations and the astronaut was under Flight Crew Operations, so you're doing a lot of work on budgets. It's an administrative-type job—schedules for Shuttle training, aircraft, looking at purchasing new Shuttle training aircraft [STA]. We were in the process, I think, at that time of getting new Shuttle training aircraft. So, looking at that. I'm trying to recall if—I think that came later, but they were in the process of looking at getting another aircraft to carry the Shuttle around,

a Shuttle carrier aircraft [SCA] as opposed to a Shuttle training aircraft. So, did a lot of work on that.

Just kind of assisted Mr. Abbey. He did the big-level stuff and then you went and filled in behind and did those sorts of things. So it was a little broader based, gave you some management experience and the like. That's, I guess, it pretty much in a nutshell. Nothing particularly earthshaking, but it was a different perspective, a little more of this variety of opportunities.

I think the thing that came into play more was getting more involved with the operations, the aircraft operations. John was still running the office at that point in time. We'd work with the Engineering Directorate and the Flight Controller Directorate. We'd work various issues. You always had a crew or a flight operations input into all the major decisions, so it meant going to a lot of program reviews and those sorts of things, representing Mr. Abbey at those and the like. So that involved engineering and operations at a little different level, not so much from the actually crew training standpoint, but from the crew input or crew overview standpoint and the like. So it was, once again, a busy job and a lot of diversity to it.

BUTLER: How did you get selected for that position? Was it Mr. Abbey?

BRANDENSTEIN: Yes. I'm not exactly sure. Actually, I got back from 51-G and I got sent down to the Cape [Canaveral, Florida] to be a Cape Crusader for a while. Then from there I was pulled back to Houston and pulled in as his deputy. Bob [Robert L.] Crippen had been his deputy before me, and as I recall, he got assigned to a flight. So he needed somebody else, and that was me.

BUTLER: You mentioned Cape Crusader. Can you tell us what that was and what you did?

BRANDENSTEIN: There always was a team of from three to six astronauts assigned. It was one of the technical assignments, and they were assigned for support down at the Cape. They worked the same type of thing. They worked crew-related issues as far as getting the vehicle processed, getting experiments integrated, following the various payloads as they were getting checked out. Once again, the crew couldn't be down there all the time.

We kind of switched from having a support crew, supporting one crew. I mean, it was kind of like a support crew for everybody in a particular area, and it was down at the Cape. They're also the ones that help strap the crew in when they launched, and during the countdown they did all the switch positioning, the prepositioning the switches and everything for the crew. So it was, once again, a real interesting job, in that you got to work on the real hardware, and that's always fun. You got to see a lot of Shuttles launched because you were always down there for the launches and the like. So it was another one of the interesting jobs.

BUTLER: While you were Deputy Director of Flight Crew Operations, the *Challenger* accident occurred. What did you help do at the time to help bring things back on line? What were you involved with?

BRANDENSTEIN: I was in Mission Control when the accident happened and throughout the initial response to the accident. I was George's deputy, so, once again, whatever had to be done. One day you're working with the President's Commission, that was investigating it. The next day you're helping arrange for President [Ronald] Reagan to come down and have the memorial service, and you're on a day-to-day basis, very much involved in the recovery—actually, not the recovery effort. I wasn't on site, but I mean it was kind of being run, or at least supervised and followed by the Flight Crew Operations Directorate.

So you got very much involved in that, trying to lend as much support as you could to the families. It was just a vast array from human-nature stuff to highly technical stuff that you got involved in. So it was kind of—I wouldn't say a chaotic time, but there was an awful lot of things happening and going a lot of different directions, just trying to get your arms around the whole thing, understand it. Obviously everybody wanted to do what was right, but wanted to get back flying also. We didn't want to see it bring the program down or anything like that, you know.

And you run into, in my case, having flown in Vietnam and having been in aviation, I lost a lot of close friends. It doesn't make it any easier, but as opposed to people that had never been in that situation before, you could understand it and deal with it better than a lot of people. So you try and help those that have trouble dealing with it and the like.

Like I say, one of the key things was, we wanted to be sure that we found out what caused it, got involved a lot in the investigation analysis and that. Wanted to find out what caused it and get it fixed, and get back flying again. It caused a major reevaluation of all levels, the systems and the like, and you were involved more directing people that were closely tied to that, because there was an awful lot going on. So we got involved in assigning people from the Astronaut Office to follow this and follow that, and get feedback so you could kind of stay on top of what was going on in all the various areas and stuff. It was another busy time. Seems always to be busy.

BUTLER: Well, busy is good sometimes.

BRANDENSTEIN: Yes.

BUTLER: And you were able to find the cause and move on, and the Shuttle went back to flight. You became chief of the Astronaut Office. How did you move into that role and what were your responsibilities there?

BRANDENSTEIN: Well, the analogy used is kind of like the squadron commander in the Navy. I got assigned by Mr. Abbey. John Young got moved to support the center director, and I got assigned to do that. Steve Hawley, "the Attack Astronomer," was my deputy. Basically, you're responsible for the office. You assign the crews. You ensure that they're getting trained. You sign off that they're trained and ready to fly when the time comes. You work all the issues.

Once again, the crew has input to a lot of the technical decisions that have to be made, and you get involved in those. You have to develop an office position. Trying to get 100 people to agree to a position—well, you never do, but ultimately it's your job that you take the inputs from the folks in the office and establish a position. Somebody's got to make the, "Okay, this is the way we're going forward." So you let everybody have their say, then you use your best judgment and say, "Okay, this is the way we'll carry the office position forward. This is what it's going to be and here's why." I made the decision. Like I say, you'll never get everybody to agree, or very seldom. Every once in a while you might find something that's so outrageous that they'll all agree on it, but that rarely happens.

So that was it, and taking care of the care and feeding of 100, plus or minus a few, astronauts and stuff. So that's another full-time job. They're human like anybody else. They come in and they have problems here, and this and that, and they go out and every once in a while go out and do some dumb things, and you've got to try and keep them on the straight and narrow. If you have to have a heart to heart with them, every once in a while you have to do that. If they get blindsided with something, you try and protect them from that. And there's a lot of people tugging and pulling at folks in that position from a lot of different

directions. You try and let them go off and do their job and not be tugged and pulled by extraneous sources. That's part of your job to help with some of that. It was altogether a pretty interesting job.

BUTLER: Sounds like it, definitely. From there you did go on to serve on two other Shuttle crews, and the next one was STS-32, which was quite a significant mission, with the recovery of the LDEF [Long Duration Exposure Facility] satellite. What can you tell us about that mission?

BRANDENSTEIN: Also at that point in time it was a long mission. We had really a lot of medical experiments we were doing on that. We had kind of changed—Dr. [Carolyn] Huntoon was the head of Space and Life Sciences, and John Young was always violently opposed—or not violently, pretty much opposed to astronauts doing medical experiments. I didn't feel that way, although I felt I was very demanding on that the experiments that they do have real merit and be well organized and have a test plan, not a willy-nilly-type experiment. So I kind of convinced the office that, in my mind, that was part of our job and that I would never force anybody to do an experiment, but I thought it was part of our job. If the Space and Life Sciences can show us a good test plan and that it's a well thought out experiment, that we ought to participate in it.

So, once again, you lead by example, so we signed up to do—and several of the astronauts were involved and kind of instigated some of the experiments. Sonny [Manley Lanier] Carter [Jr.] was a medical doctor and he talked us into the granddaddy of all experiments, which was a muscle biopsy. So we all volunteered to have a chunk of muscle pulled out of our leg before the mission and after the mission.

BUTLER: Oh, fun! [Laughter]

BRANDENSTEIN: But we got involved in a lot of those medical experiments. We did strength tests before the flight and right after the flight. It was a twelve-day, long duration type of mission, which was the longest one at that point in time. So that was a big part of what we were doing.

We launched the last of the SYNCOMs, which was a satellite that the Navy was using, that was designed specifically to be launched in the Shuttle. Then we went and retrieved the LDEF, and we retrieved it in a manner—we did a rendezvous on it that had never been done before, so we did a new type of rendezvous to get aligned with it. It was standing vertically as it went around orbit. To get a better grab on it, normally we did a rendezvous, you came up and joined [it from the front], but to be able to grab is easier, instead of joining it that way, which was called a V-bar, or velocity bar, rendezvous, we flew up over the top of it, came down from above, and then we could just rotate the Shuttle…to align properly, to grab it. Bonnie [J.] Dunbar was the arm operator on that.

So, yes, we developed the technique for doing that. Plus we didn't want to put contamination on the LDEF, because part of the reason it was an experiment was to find out what space environment was like, so we didn't want to contaminate it with exhaust from the plumes. So the Shuttle had a mode where you can fly up to something but not shoot plumes at it, but it had never been done before either. So we tried. We agreed that we would try to rendezvous that way and make that approach. If we weren't being successful, we would back out of it and then we'd risk getting a little more contamination on it. But once again, through training and the fact that the Shuttle flies very well, we were able to make the rendezvous and fly right up to it and get stopped, and she grabbed it using that mode.

It was pretty well beat up. Originally it was only supposed to be up there for like ninety days or something. It ended up being up there six years, I guess. I don't know what the exact numbers were. So it was pretty well beat up. Some of the experiments were

essentially lost, but then they gained some other things that they hadn't planned on getting because it had been up there so long. So, once again, that one ended up working out all right.

We came back, and that one turned out to be a night landing, too. We were supposed to come back a day earlier and it was foggy at Edwards, so it got waved off. Then the next day we were coming back and we had a computer problem, so we had to wave off [one orbit]. I always told everybody, I said, you know, we delay the day and then we delay the revolution, I said nobody in the crew wanted to go back and have that second muscle biopsy. [Laughter]

Because what happened, right after we landed, they took another chunk of meat out of your leg. It was pretty gross, the way we did it. In fact, when we were in quarantine, we had it done. When we did it to each other, we were all in the room, we were videoing it and whatnot. So we had our spouses over for dinner that night, so before dinner we ran the tape of the muscle biopsy, and they all lost their appetite, so we got twice as much food.

BUTLER: [Laughter] You mentioned the medical experiments and that this one was a longer flight. Was there any difference in your adaptation, either in space or on return to Earth?

BRANDENSTEIN: No, not really. Nothing I noticed. Really, the adaptation on the first flight is long. It takes probably about three hours going up and about twenty-four hours coming back. After you've been up there, that's when the human mind is really wonderful, because after you've been there once, it can be several years later you go back and about fifteen minutes, the old brain and body think, "Hmm. I've been here before," and kind of thumbs through the file and says, "Ah, here it is." Plugs in how to operate in zero gravity and there you are. And coming back, it's the same way. Probably about three hours after I got back, I was pretty much back to—felt like I was pretty much adapted back and stuff. So it seems to remember all that and just helps you out by getting there faster.

BUTLER: That's good. The human body is a pretty amazing thing.

BRANDENSTEIN: Sure is.

BERGEN: Let me change the tape. [Tape interruption.]

BUTLER: We'll move on now to your last mission, and this was STS-49. You mentioned earlier that you had gotten some good training that would help you out a little bit, that you least expected. This was also the first flight of *Endeavour*, and so you were testing out that Shuttle as well. We'll start with that, about *Endeavour*. What differences were there with *Endeavour* from the others?

BRANDENSTEIN: The only one that really pops out was, it had a drag chute. In other words, when you landed, you popped a parachute. That was one of the steps to beefing up the landing braking system so you could regularly land back at the Cape. Other than that, it was slightly lighter. They found a way to cut some weight out of it. But you strive to keep the vehicle as similar as possible. It makes the training easier and stuff. So, off the top of my head, that's the only significant thing. The basic systems were the same.

They built a beautiful vehicle, because it's based on all the other things that diverted our attention on that flight. It was really nice that the *Endeavour* performed like an old pro. We didn't have to divert a lot of our attention to fixing this glitch or fixing that glitch. That was very beneficial.

BUTLER: Very. On this mission, you retrieved the INTELSAT satellite, and it was planned to be a pretty normal retrieval, from what I have read, but it didn't turn out that way.

BRANDENSTEIN: Not quite. Actually, one of my first concerns when we first got assigned and started working with Hughes on the mission was if we try and grab it, if we bump it, is it going to go out of whack and float away or something like that. Part of the requirements from the customer were that we didn't touch any sensitive area, which left you a very small ring that was somewhat limited, had a limited accessibility, and that was supposed to be the way we grabbed it.

They devised this bar that had latches on it, that you would click on this structural ring, and then it was supposed to clink on it. You had a big grip on this bar, and you'd hold on this bar, and then the mechanical arm was supposed to come and grab the end of the bar and then take the satellite and place it on the motor that we were going to attach to it to take it up to the higher orbit.

From day one, my concern was that if we bump it and it doesn't latch, is it going to be difficult or impossible to catch. There was a lot of analysis done, and we were assured that because it was spinning slightly and it had a lot of mass, we could bump it and it would stay pretty much in place, and it wasn't going to be a problem.

Then they built a simulator and we trained to that. It was on an air-bearing floor. Pierre [J.] Thout could grab it with his eyes closed, and Ricky [Richard J. Heib]—who was also the other person spacewalking on that team, and his back-up to capture it—he could do it with his eyes closed. So we were getting a little more comfort that this system was going to work and everything. But, you know, you're training in 1 G, and there's some artificialities associated with that when compared to what's really happening in zero gravity.

So we got up there and we got all in position and rendezvoused in position. He was out there at the end of the arm, and Bruce [E.] Melnick put him in position. We were all there. He was ready to make his first attempt at it, and he did. The latches didn't latch and the satellite started drifting a little bit.

So then I got in my chase-it mode, because I had to keep him aligned. Well, we trained somewhat for this scenario, so I was able to basically fly the Shuttle and keep aligned with the satellite. He tried again and then he tried again. I think it was the third try—I've kind of lost track, but I think it was after three tries, it was pretty much obvious that the rates were too high on it, and I just burned up a tremendous amount of fuel trying to keep lined up. The chances of being successful were pretty slim.

So we flew formation on it as it was kind of flopping around a little bit. "Flopping" is not really—it's just drifting, but it's still at a rate that you can't effectively capture it. We decided, through consultations with the ground, to get out of there and try another day. That was a pretty low point, because when we left, it had a pretty good rate on it, and it was kind of flat spinning and stuff. We thought we'd lost this 150 million, 200 million-dollar satellite, you know, and you don't like that to happen. And Pierre was particularly depressed, because obviously he thought it was his fault. So we got him back and Rick back inside and flew away and got some distance on it.

About two hours later, the ground called up, and the Hughes people at their control center had gotten it back under control, so that gave us a sigh of relief that we knew at least we were going to have another chance. Because of th[e] experience I had on the other three missions of doing rendezvous, I was fairly proficient at doing a rendezvous without using a lot of fuel, so we had more than enough fuel to try it again.

So the next day we talked about what we thought went wrong, and came up with another idea. Basically what we were going to do is, instead of doing it at night, we were going to wait and do it in daylight. One of the things that by training in one gravity you didn't have, you had the Shuttle, which was trying to fly position on the satellite, then you had the long arm that had some spring into it, and you had a man on the end of the arm. Then you had the man holding this bar. And you never had that whole chain. You could

never train to that, because you weren't in zero gravity in the training facility. There's just no way you can do that on Earth.

So what we did before that day, we said, "Well, let's practice a little bit." So we pretended the rail on the side of the Shuttle payload bay was the satellite. So he took them over there and Pierre did a few practice captures on that, just to kind of learn how to deal with all these dynamics. Then we did it in daylight instead of at night, and Pierre got up in position. We decided we weren't going to even make an attempt until everything was just perfect. We waited and got everything just perfect. Pierre went in, and the rotation slowed way down. In fact, Rick started saying, "By jove, I think you've got—" and then it was obvious he didn't need to, because he actually thought—out there he was watching it real close, he thought he had actually captured it. And he didn't.

So that day I think we made about six more tries on it, and, once again, were flying, chasing it around and getting realigned. At the end of however many tries it was, once again it was totally out of control. Actually, we didn't feel as bad that day as we did the first day, because we knew now that they could regain control of it. So we backed off again and let it go about its way, and backed out and got the crew back in.

Basically then I recommended to the ground that we take a day off. Once again, because of the efficiency of the rendezvous, we actually had enough gas to do another rendezvous. So that was something that had never been done—three rendezvous in one mission. So, basically recommended to the ground that we take a day off, and that I was convinced—the crew was convinced, for that matter—that we had done, with the tools we had and the procedure we had originally developed, that we had done it as well as it could be done, and it still didn't work. So, basically we said, "Let's take a day off. Let's put this one on the shelf and let's come up with another idea."

So we kicked a few ideas around. Then about that time it was almost bedtime, so we claimed we went to sleep. I remember Kevin [P.] Chilton and I were looking out the back

window, scratching our head, trying to—and we'd send a couple of ideas to the ground, but basically we were looking out the window in the payload bay and trying to figure out what raw materials we had and what we could do.

So, a little bit later we were out, and we were supposed to be sleeping. Kevin and I are looking out, and Bruce Melnick was looking out, and we were kind of mumbling things. Then the rest of the crew sleeping on the mid-deck, one by one they kind of popped up, you know. So we started brainstorming and came up with some ideas.

The next morning, we gave them what we thought were ideas. Kevin had sketched something out. We had no way of sending pictures down, but he held it in front of the TV camera so the ground could see the picture of what we'd sketched out. So they went about—it required three people to do a space walk, which had never been done. They went about, on the ground, trying to set up the geometry and make it work, and they were going to send three people into the air lock. The big chokepoint was, can you put three people in the air lock to get them outside. The ground said, "Well, we'll send somebody over to the water tank and see if we can get three people in on that day off."

My biggest worry was that they weren't going to come up with the right answer, so I basically told the three crew people I was going to have do it, I said, "Okay, you guys, we've got a day off here. You guys suit up and you get in this air lock. I don't care what their answer is downstairs. We're going to have our own answer."

Turned out that both answers came out the same, that, yes, it could be done. Even before we suggested it, we had sorted through what we considered all the safety concerns and felt comfortable with, and a plan of attack for everything that we could conceivably think might go wrong, and how to adapt to that. So we basically ended up agreeing that we'd use this approach, and during the night they went and fine-tuned how to set people up, and developing some of the procedures.

One of the things we had done in training is we had taken one of the gloves, and the bottom edge of the satellite had what they called a sun shield on it, which is a thin titanium shield. Everybody was worried that you could cut a glove or something like that. For whatever reasons, in training we had a piece of this sun shield and we had an old glove. Pierre had taken it and had just hacked and thrashed away on it. So we were confident that that really wasn't a problem, so that was one of those safety things that we were worried about.

So, anyhow, the next day we sent three folks out and flew up and rendezvoused, and once again now I had even more experience flying a Shuttle in close proximity, so I didn't—and as I said earlier, you can fly that Shuttle an inch this way, an inch that way, so the control is there. It just all lined up. The satellite had a little bit of wobble to it, so not only we had to get position, but we had to time it right, because they all had to be able to grab it at the same time. So we had to get it so the wobble—so it was flat, so they could all grab it. I could fly the Shuttle so the satellite was right in front of all their noses. Rick Heib was the ringleader out there, and he said, "One, two, three, grab," and one, two, three, and they all grabbed. It stopped and we had it.

Then basically it was a matter of picking up that arm that we had originally, and we still had to use that, but now they had the satellite stabilized and hanging on to it, they could take that and then they could click it up and they could get it to snap into place and tighten it down. Then they grabbed the mechanical arm, then the rest of the procedure was pretty much normal, with one exception.

Then when we were all done and Kathy [Kathryn C.] Thornton was going to deploy it, they had made a change in the wiring of the deploy system, and the change never made it through the process, never got into the checklist. So when she threw the switch to deploy it, it didn't go.

BUTLER: Oops.

BRANDENSTEIN: We just went, "Oh, geez," you know. Fortunately, somebody in Mission Control apparently knew about it or guessed, I'm not sure how, but they just quick called up a different switch sequence and she did that sequence and it went. So we got it off. But it was one of those missions from hell.

Not only that, but it was also Dan [Daniel S.] Goldin's first mission as administrator, so apparently he got a real baptism in fire.

BUTLER: [Laughter] What a way to learn. What a way to learn. On this flight also they tested some Space Station assembly methods. What sorts of results came from those, and were they applied to the recent assembly?

BRANDENSTEIN: Not exact—well, at the point in time the equipment was made for that, the station was going to be assembled kind of Tinker Toy type, so we had those types of tools or equipment on board. And they went through the process. After that, obviously the design changed, but the key thing going through that process, they learned a lot about operating in that environment, trying to assemble things. They had a fair amount of trouble flailing around and whatnot, and it kind of came even with the INTELSAT some, but a lot of the training that they were doing in the water was not good. Some of it was even counterproductive. You were training in the water tank, which is the best you've got, but some of the ways they were doing it were counterproductive.

So Kathy Thornton and Tom [Thomas D. Akers] came back and gave them a very thorough debrief and really did [make] some significant differences in the way they worked training in the tank. Because even in the tank, even though you're weightless because you're weighted to a neutral buoyancy, you still have the resistance of the water, so you can kind of

like kick your feet and swim. Well, in zero gravity—in fact, we've got movies of Tom going to that instinct. You can see him kicking his legs and nothing's happening. Also, if you move something in the water, as soon as you stop moving it, the reason is the water stops it. But in zero gravity, you start moving something and it just keeps moving until you come back on it. So those are the types of things that they learned. Like I say, they gave a very thorough debrief, and they went to change. I think they made some significant changes in the tank training procedures. So, from that perspective it helped. From the actual hardware we were using, it was a different-type hardware.

BUTLER: At this flight, had you already decided that you were ready to retire from NASA?

BRANDENSTEIN: Yes, I think I had probably just casually given it a thought before, but I hadn't really thought about it. But when I came back and I'd flown four times, and I was reaching an age where if I was going to start the third career, I'd better get on with it. I'd had four good flights. My family had tolerated my sticking my neck out in the Navy and at NASA and stuff. So I went through three times, I think, I went through the whole pros and cons thought process. Am I really going to retire or not?

I think the answer would have been, if I knew I could fly forever, I'd have probably stuck around maybe, but you reach a point where you've kind of been there, done that, and you know you can't do it forever, so if you're going to kick off and so something else, you've got to pick an opportune time. And that seemed like an opportune time. So the answer all three times I went through the analysis came up the same: if you're going to do it, now's probably the best time to do it.

The other part of that is, as you do it, don't look back. Convince yourself you're not going to look back and say, "Gee, I miss this, and, gee, I miss that." So I went through all

that and made the decision that now was a good time to leave, so I told them I was getting ready to move on, and I did.

BUTLER: Looking back over your career with NASA, what would you say was the most significant thing for you?

BRANDENSTEIN: I think just having the opportunity to work with such a great team. That's one of the neat things about being an astronaut. Flying in space is neat, but it kind of goes back to that diverse thing. You get to know and work with the people building the vehicle, you get to work with the various people that develop the experiments and the payloads, and the flight controllers. Throughout NASA, many of the guys that process it down at the Cape, and just being able to come in contact with so many dedicated people, it's, in my mind, the best part of being at NASA.

BUTLER: What would you say was the most challenging aspect?

BRANDENSTEIN: Oh, I think from an event-type thing, it was that [STS-]49. I mean, that was the most challenging, because we had a real time. That obviously makes it very rewarding, because you've had a problem with something, you sorted through it, and successfully accomplished what you'd originally set out to do, even though you did it differently. But, once again, that was not just the crew or just myself; that was the whole team kicked in on that. That was, I'm sure, the most challenging, and makes it probably the most rewarding, too.

BUTLER: Absolutely. I think we have just a couple more minutes. If you could tell us a bit about what you're doing now and what Kistler [Aerospace Corporation]'s goals are.

BRANDENSTEIN: Kistler—we're building a launch vehicle to launch satellites. It's not manned. To launch satellites into low Earth orbit. What's unique about it, it's totally a commercial Endeavour, so we're going it all with private financing and no government involvement. And it's fully reusable. We're building five vehicles, and what we do is take communication satellites to low Earth orbit. It doesn't have the carrying capacity of something like the Shuttle or some of these bigger expendable vehicles, but the economy comes in the fact you don't throw the rocket away each time. You bring it back and use it again and again and again.

The advent of these low Earth orbit communication satellite constellations make it economically feasible to do that. So, twenty years ago it wouldn't have been a viable program, but with those satellites now coming on line, it is. So we're off trying to develop the vehicle. We're about probably three-quarters of the way there, and hopefully by the end of this year, more likely early next year, we'll have our first test flights.

We've got a bunch of names you've probably already talked to or will talk to. Aaron Cohen is one of our advisors and was on the design team. And Dr. [George E.] Mueller and Dick [Richard H.] Kohrs works here with us. Henry [O.] Pohl and Dale [D.] Myers all are very much involved with it. So we've got a pretty good think tank worth of experience and knowledge that's being contributed to this.

BUTLER: Absolutely. It sounds like a great group of people.

BRANDENSTEIN: Yes.

BUTLER: We look forward to seeing the results of all this work. I want to thank you for taking the time. We appreciate it.

BRANDENSTEIN: Good.

[End of Interview]