

**NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY TRANSCRIPT**

BREWSTER H. SHAW, JR.
INTERVIEWED BY KEVIN M. RUSNAK
HOUSTON, TEXAS – 19 APRIL 2002

RUSNAK: Today is April 19, 2002. This interview with Brewster Shaw is being conducted in the Boeing Building in Houston, Texas, the Johnson Space Center Oral History Project. The interviewer is Kevin Rusnak, assisted by Rebecca Wright and Sandra Johnson.

I'd like to thank you for taking time out this morning to spend with us.

SHAW: My pleasure, I'm sure.

RUSNAK: Well, I hope it will be.

SHAW: I guess we'll find out, won't we.

RUSNAK: That's right. Well, at least it will be my pleasure, I'm sure. If we can start out by discussing a little bit about of your background, what brought you into engineering and aviation, these kinds of early interests that led you into the space program eventually.

SHAW: Okay. Well, the background and how I got to be part of the Space Shuttle Program will be unbelievably boring, because it will be like a lot of my compatriots. I grew up on a farm in Michigan. My dad had been educated as an engineer, although he didn't really practice engineering. He was in construction, and farming was his hobby. It was my life when I was a kid. But engineering, I got interested in engineering because as I flipped through the book from the University of Wisconsin [Madison, Wisconsin] and read the description of the career paths

and titles, etc., engineering was something that seemed to be most compatible with what I was good at—math, science, that sort of thing.

So I went to the University of Wisconsin in engineering mechanics and had no ideas about space, none whatsoever. Had never thought about it. You know, I'd listened to the Sputnik stuff and that, but that was it.

When I was in school in Wisconsin, I started flying airplanes, light airplanes. Got a private pilot's license. Got taught to fly by the drummer in our rock and roll band. That's how I paid for college. And then I took a celestial mechanics course in school from Professor Bud Schlack, and I really enjoyed that course and found it intriguing.

This was during the timeframe of Gemini leading up to Apollo—Mercury, Gemini and Apollo, and on top of all this was the Vietnam War and the fact that we were going to a lottery process in draft, the draft of the United States at that time. So my draft board had deferred me for college, and then they deferred me again to get a master's degree in engineering, also from Wisconsin. But they said, "When you finish your master's program, we're not going to defer you any longer." I also had a fairly low lottery number, so my chances of going to Vietnam were pretty high.

Because I liked flying very much, because I was interested in this celestial stuff, and because I was likely to get drafted, I decided to join the Air Force. So I went down to the local recruiter in Madison, Wisconsin, and took a bunch of tests. The Air Force recruiter said, "Jeez, I'm really sorry. We just don't have any engineering openings right now. The only thing we could offer you would be a pilot slot."

And so I said, "Throw me into that briar patch."

I joined the Air Force through officers' training school at Lackland [Air Force Base] in San Antonio [Texas], starting there in February of '69. I finished my master's degree in January of '69, went to OTS [Officer Training School] in San Antonio, "ninety-day wonder" school they

call it, and got commissioned in May of '69. I think it was May 15th, as I recall, and my birthday is on May 16th, and on May 24th I married my wife of almost thirty-three years now.

When I graduated from OTS, we went outside, some quadrangle, and they had all of our assignments posted on a big board. I looked at that, and then I went to a pay phone and called [wife] Kathy and asked her, "Where would you least like to go for pilot training?"

And she said, "Alabama."

And I said, "You got it."

So Kathy and I spent our honeymoon driving from Madison, Wisconsin, to Selma, Alabama, where I went through pilot training, undergraduate pilot training, it's called in the Air Force. And Kathy got a job teaching school. She was an English major at Wisconsin. She got a job teaching school in an all-black rural school about fifteen miles outside Selma, Alabama. There was Kathy and one other Caucasian teacher at this school. All the students were black students, and all the rest of the faculty was black. Having come from Madison, Wisconsin, that was a broadening experience for Kathy, needless to say.

Anyhow, we had a lot of fun in Selma, Alabama. Pilot training was great there, and we still have friends that we went through that year with.

So then I went to F-100 training out at Luke Air Force Base in Phoenix [Arizona], and then I went to Vietnam, and Kathy went back to Madison, Wisconsin, with our first child, who was born when we were out there in Phoenix. I flew F-100s in Vietnam out of Phan Rang Air Base, Republic of Vietnam, and after I'd been there not very long, two or three months, I got hepatitis and got grounded, sent to Cam Rahn Bay, at the hospital in Cam Rahn Bay, which was as close to being a POW [prisoner of war] as I can imagine, because they didn't let you do anything. You were captive there. I didn't feel very bad, and so I was ready to go, but I was locked up in the hospital in Cam Rahn Bay.

Then they flew me back to the States to Chanute Air Force Base at Kankakee, Illinois, where I recuperated until they decided I was cured. Then my orders were to George Air Force

Base in California to check out in the F-4 and go back over to Southeast Asia. So Kathy and I went to George, and I went through F-4 school. Then Kathy went back to Madison again. She was from Madison, Wisconsin.

I went to Ubon Royal Thai Air Force Base in Thailand, and I flew a year there, from March of '72 to March of '73. That was when we were flying all the Linebacker series of flights and we went to Hanoi [North Vietnam] a lot. I flew as a fast-forward air controller over North Vietnam in F-4s during that timeframe, too. Anyhow, a long year, a lot of flying, a bad experience all around. The whole damn war was a bad experience.

Then I came back to George Air Force Base as an F-4 instructor, very much disillusioned with the war effort and the military, and so I started thinking about getting out of the Air Force, and I applied to various law schools, got accepted to two or three of them, including University of Michigan Law School, which I was pretty sure would be a good thing for me to do.

RUSNAK: Why law school?

SHAW: Why law school? I don't know. Because I thought that a combination of engineering and law would be a good combination at that time. And I had two brother-in-laws, one was a judge and the other was a corporate lawyer, you know, and I talked to them some. Just seemed like a reasonable path, and I wanted to have some kind of professional career.

But about the same time, I got accepted to test pilot school at Edwards [Air Force Base, California], so I had to make this life career choice. I decided that I'd go to test pilot school, because back in the back of my mind I still had this idea that I came out of college with, you know, I want to go into the Air Force here and these guys are flying in space. They're going to go land on the Moon. In fact, we were at Selma, Alabama, in July of '69, when [Neil A.] Armstrong and [Edwin E. "Buzz"] Aldrin [Jr.] landed on the Moon, and I remember watching that

on TV in our substandard housing at Craig Air Force Base in Selma, Alabama. So I still had that in the back of my mind, that I'd like to go do that.

So I went to test pilot school and stayed at Edwards after graduation. Then in 1977, NASA came out with solicitations for the Space Shuttle Program, and I and 10,000 other people applied. A lot of my buddies out there at Edwards and friends that had gone through Edwards and were at Eglin [Air Force Base] in Florida and various other places applied. The military, the Air Force, all of the services went through their own screening process, and for some reason I was standing in the right place at the right time, and I got selected.

So that brings us to how did we find out about getting selected. Well, I got a phone call from Mr. [George W. S.] Abbey, and Mr. Abbey said, "Are you still interested in coming to Houston?" And I said yes. So in July of '78, we showed up in Houston, Texas, having driven there from Edwards Air Force Base, where it's very dry and very warm. I remember pulling up in front of the Nassau Bay Hotel, which is now—I don't know what it is now. It's across the street from the Holiday Inn there. Used to be Radisson, or I don't know what it's called now. And opening the door and getting out and thinking, "Holy smokes." [Laughs] Because it was still 100 degrees and 100 percent [humidity], and that was ten o'clock at night.

RUSNAK: Do you remember the application and interview process?

SHAW: Yes, I do. I remember the interview process and the week spent down here. We all discovered that there's no way you can keep up with George, partying at night and working in the daytime, although many of us foolishly tried to do that. I remember falling asleep during the EEG [electroencephalogram] or one of those things where they wire you up, and it was a great chance to catch up on some Zs, falling asleep.

I remember the interview process, and the thing that seemed to interest George the most was the rock and roll band in college. Of course, at that time I had no idea that that would ever

come into play, but eventually it did. Then George gave me a ride back from the building where we did the interviews to wherever I was going next, and I remember talking to George about, “Jeez, that didn’t go very well and I didn’t feel very good about that.” He smiled. [Laughs] You know, it turned out the way it turned out.

RUSNAK: He was more interested in your singing than your flying?

SHAW: Well, when I was at Edwards, Tom [Thomas P.] Stafford was the commander out at Edwards at that time, and John [W.] Young came out one Christmas and spoke to us at the Officers’ Club and gave this great John Young talk, as only John can do. Then I gave him a ride back to Houston in an F-4. So John and I flew back all the way from Houston, and he wondered why we couldn’t do it in one flight, and I kept telling him that we’d run out of gas before we got here and that we might ought to stop. So we did. So, anyhow, we got to fly together. So John knew I could fly airplanes, and I figured that that wasn’t an issue. So it turned out that other things were more important than whether you could fly or not, because it was assumed that you were going to be able to fly.

Anyhow, how did we feel about it, about coming here? Well, I was pretty happy, and I think Kathy was pretty supportive of it. By that time, we had three children. Of course, they didn’t have a clue. They didn’t know how bad it was going to end up being for them at that time.

But I remember one of the questions that George asked during the interview was, you know, “This is a time-consuming job, and have you thought about the impact that this is going to have on your family and how you’re going to deal with that?” And I answered it the best way I could, that I thought you had to establish priorities and you had to make time for the things that were really important, and that my family was really important to me, so I’d have to figure out how to handle that. I don’t know whether that was a good answer or a bad answer, but I got hired anyhow.

So we showed up in July of '78 with thirty-four other AsCans [astronaut candidates] in the '78 group, and I liked everybody. I was real impressed with the people that were there and hired. It kind of made me wonder how the hell I ended up being there. I wondered even more when things would happen. Like I remember we were having an interview one time, and I was in this interview and there was another pilot in the interview. I can't remember who it was. And there was Kathy [Kathryn D.] Sullivan. Kathy, bless her heart, said something that shocked me at the time but turned out to be pretty much the way it was when she made the comment that the pilots were going to be just like taxi drivers and that it was the mission specialists who were going to do all the significant work on the Space Shuttle Program. Turns out, by golly, she was pretty much right. But at the time, being a macho test pilot, I was a little appalled at her statement. But, bless her heart, she was smarter than I was, probably I'm sure she still is.

Anyhow, we went through that first year and had a great time. We got spoon fed a lot of information, and we learned a tremendous amount about NASA, about the program, about the Johnson Space Center, about all the people and the history of human space flight and how we were just going to be kind of passing through, and that the people who were here at the Johnson Space Center, who had done Mercury, Gemini, Apollo, Skylab, and now were going to do Space Shuttle, they were the real people that made all this happen, and if we were nice to them, they might let us fly their spacecraft. That was a good perspective. It's pretty accurate, I think.

I didn't have any expectations other than flying Space Shuttle, and I soon learned that the percentage of the time you got to fly the Space Shuttle was pretty miniscule, relative to the percentage of the time that you were here working for the agency, and that there was a lot of other things you were going to do that would take up all your time, and that was made clear to us pretty soon. So we all got assigned various technical assignments. You talk about some of them here.

One of the early things we did was work on the Skylab reboost support, and then Skylab deorbited and we lost a job because we were too late getting there. But that was fun.

RUSNAK: Did it seem like a practical thing to do, to get the Shuttle up there and actually—

SHAW: Well, I mean, it wasn't practical, because the timing was wrong. We didn't fly the Shuttle for the first time until way after the Skylab de-orbited, and on the first flight of the Shuttle we weren't prepared to go rendezvous with the Skylab and do something to help save it. So it turns out it wasn't practical. But when I got here, when thirty-five of us got here in '78, we were going to fly in a couple of years, and it turned out—well, we were going to fly in a year or less, as a matter of fact, and it turned out it was three years before we ended up flying the first flight, STS-1.

Anyhow, I'm having one of those senior moments. Al [Alan L.] Bean. It just came to me. Al Bean was our mother hen when we got here. When Al wasn't painting and came to work, he would provide us advice and guidance and counsel. I remember the first time I asked Al for some significant advice, I wished I hadn't, because he gave me the wrong advice, as it turns out. And that had to do with the fact that Mike [Richard M.] Mullane and I were out flying T-38s one day out here at Ellington [Field, Texas], and in the Air Force one of the first things in the F-4 two-seat airplane, one of the first things I did over in Southeast Asia was when I got assigned a WSO, weapons system operator, who was the guy who flew in the backseat, non-pilots, one of the first things I did was teach him how to land the airplane in case we ever took a hit that made me unable to fly, and if he was still able to fly, he could get us back and land the airplane. So I taught him to refuel and I taught him to land the airplane, and he could actually even take the airplane off. But to me that was a matter of survival, and most guys did that.

Mike Mullane was a WSO in the Air Force, and so he and I were flying and I was letting him fly the airplane from the backseat and we were doing some touch-and-gos. It hadn't been talked about, really, before, and nobody had said, really, that we weren't supposed to do that. So I was doing it because that's the way I operated.

So we were shooting touch-and-gos, and Mike was flying the airplane and he made this one landing and then he didn't hold the nose off the ground. When the nose wheel came down, it came down right on the cable, the barrier cable that runs across the runway, and it bent the flange of the wheel, the nose gear back like that, and let all the air out of the tire. Well, you know, when it happened, I don't remember if I told Mike to get the nose back up or whether I took the airplane. But, anyhow, we got the nose back up and so we never knew that there was a problem with the nose gear and we shot some more touch-and-gos. And then on the final landing, the full-stop landing, which I made when I let the nose gear come down onto the runway, it was obvious we had a flat tire. So we just stopped the airplane straight ahead just like you're supposed to, and they came out with this little dolly and jacked the airplane up and put it on this dolly and we towed the airplane off and all that. You know, it was a Friday afternoon, as I recall. So we went home not thinking too much about it.

Well, Monday morning we come in for our Monday morning astronaut meeting, and our buddy Dave [David M.] Walker, who was the astronaut safety rep at that time, flying safety guy, came in and he had my nose wheel with him. He forgot to tell me he was going to do this. He came in and he flops this nose gear down, and he starts talking about how we got this flat tire. Then all of these questions started coming about, you know, "Gee, how did that happen and everything?"

And I said, "Oh, well, I went into the touch-and-gos, and the nose gear inadvertently came down and must have landed on the cable and that's how that happened and everything." And I was starting to get this idea in the back of my head, somebody's probing at something here. And I'm thinking, "Hmm, maybe Mullane shouldn't have been shooting touch-and-gos from the backseat." [Laughs] So I thought, "Well, you know, I don't want to get Mike in trouble." Here it never occurred to me, being as naïve as I was, it never occurred to me that I was going to get in trouble for letting Mullane fly the airplane at this time. So, you know, I just

said the nose came down and must have hit right on that cable and that's how that happened, and didn't say much more about it. And I didn't really answer the question, "Who was flying?"

So later I went in and I talked to Al Bean, and I said, "Jeez, Al, you know, there's all this hall talking, rumbling going on out here. I think I should go tell John." John Young, the head of the Astronaut Office. "I think I should go tell John what really happened."

And he says, "No, no. Don't do that. Don't go talk to John about this."

And I said, "Okay."

That was a mistake. I should have gone and told John, because John eventually found out exactly what had happened. I mean, eventually I got asked the question directly and I had to answer the question about who was flying the airplane, and so I did.

So John found out about it. Then John called me into his office, and I didn't enjoy that, that session with John very much at all. And had I gone in right away and told John what was going on and why it was going on, I think it would have turned out a lot better. But, you know, this is one of these times when you see your career as a fledgling astronaut pass in front of your face and you think, "Well, I'll get my walking papers here pretty quickly." But, fortunately, that didn't happen. But, anyhow, I quit asking Al Bean for advice after that. [Laughs] Bless his heart, I'm sure he thought he was telling me the right thing.

So then we go through our AsCan training and we get assigned these technical things and there was the Skylab thing for a little while, and then I got assigned to SAIL. J.O. Creighton and I were the first two guys that got assigned to the Shuttle Avionics Integration Laboratory. They had two guys over there, Jim [James E.] Westom and—I'll think of his name, the other guy, who still works here the last time I ran into him, and I'll think of his name in a minute. Anyhow, these guys worked for, I think, Rockwell [International] at that time, and they had been hired to fly the SAIL as pilots.

So here come these numb-nut fledgling astronauts who are going to come over and take over from them, and they didn't receive that too well. And, of course, we weren't too sensitive

to their feelings, because we figured that was our job. So J.O. and I went in there and we started flying the ascent profiles in the SAIL and, of course, found lots of problems and learned a tremendous amount about how the Shuttle system worked. That was really a great learning experience for J.O. and I. Eventually we set up a whole cadre of pilots to come and fly test cases in the SAIL system. I don't remember how long I was there or how long J.O. was there, but eventually we left and went on to other jobs, and then they cycled people through this cadre of SAIL pilots out of the Astronaut Office.

It turned out to be a very effective way to do that, both from having people who were invested in the success and the quality of the avionics system to be looking at it, train test pilots, for the most part, etc., as well as from the standpoint of everybody who went through there learned a great deal about how the Shuttle worked.

So that was a good job, very tiring, long job. I remember when there were only two of us, sometimes we'd work two shifts, two eight-hour shifts a day each of us, because we had a lot of testing to get done. We were trying to get ready for April 12, 1981, and there was a lot of work to do. So it was very tiring and demanding, but, boy, you sure learned a lot about it.

I also supported Crip, as kind of a support crew person for a while prior to that flight. Worked on autoland. I remember Dave [S. David] Griggs was kind of the lead on that, and we would go up and fly in the VMS, the Vertical Motion Simulator, out at Ames [Research Center, Moffett Field, California] at lot on developing autoland. Then later we worked on the heads-up display out there. Actually, it was the heads-up display thing that Dave was really the lead on. We were developing that system, and I think that system first flew on STS-6, I think, -5 or -6. So, let's see. I guess that's about enough of that.

Crew support for [STS-]3 and 4, CapCom. CapCom is a great job. You get to learn a lot. You get to work closely with the crew. I enjoyed that, supporting [Jack R.] Lousma and [C. Gordon Fullerton and [Thomas K.] Mattingly and [Henry W.] Hartsfield on 3 and 4.

You ask here about the landing at White Sands [Test Facility, New Mexico], what do I remember of the decision to land at White Sands. I don't really remember very much about the decision to do it, but I remember it was real popular with the White Sands folks and the people from West Texas and New Mexico to do that. This was part of our demonstration of autoland, and Jack was going to re-engage auto part of the way down after he had taken over manually, and then we were looking for the best point for him to take manual flight back before the landing, because we weren't ready to commit to the landing, but we wanted to see the autoland system fly the airplane for a while.

So we tried to identify the precise point where it was best for Jack to take control of the vehicle back, and he did, but it didn't work out real well, because he took over and he landed the Shuttle okay, as I recall, and then the Shuttle pitched up after. I think during the landing rollout, as I recall, it pitched up, and that was unexpected and was a bad result. So that didn't turn out as well as we had hoped, and I don't really think it had very much to do with the autoland system; I think it had to do more with crew coordination. Maybe it was prior to landing. I can't remember. But we decided that crew coordination wasn't what it should have been, and after that we started having the pilot be a lot more active in supporting the commander with calls about altitude, air speed, sink rate, that sort of thing, during the landing itself. I think we're still doing that, and that worked out very well.

So when and how did you learn about STS-9? I don't remember exactly when it was. George told me I was thrilled. I was thrilled to have a flight assignment. I was more thrilled to be able to fly with John Young, and I thought back about that conversation he and I had had in his office and wondered, just wondered, how it ended up that I was going to fly with John. But I was absolutely thrilled to have that opportunity, and it was a great experience that I'll never forget.

Now, there was another situation, though, that occurred where my career passed before my eyes and I figured I was going to get fired, and that was when John and I and Owen [K.]

Garriott and Bob [Robert A. R.] Parker flew up to Marshall. We landed at the little runway there at the Redstone Arsenal [Huntsville, Alabama]. We were going to Marshall [Space Flight Center] because that's where Owen and Bob and Ulf Merbold and Byron [K.] Lichtenberg had done a lot of their training, their science training. In fact, they had been training for years and years. John and I had only been on the flight, I guess, around a year before we flew.

Anyhow, we all flew up there and we did whatever training it was we were going to do and we were going to come back, fly back to Houston. I had been in John's back seat on the way up, and was going to be in my back seat on the way back. I thought that was very benevolent of John to let me fly. So we were going to be number two, and Bob and Owen were in the other airplane. I don't remember. I think Bob was flying on the way back, but I'm not positive.

Anyhow, we did about a fifteen-second-formation flight briefing on the way walking out to the airplanes, and that runway is a narrow runway, so we decided we wouldn't do a formation takeoff. We would stagger our takeoffs. I understood that and I acknowledged that.

We get out there on the runway and Bob gives a run-up signal to check them out and my head's down looking at the engine instruments. I'm checking out the instruments and everything, and out of the corner of my eye I see this airplane leave, and I just reacted because of all my formation-flying training. My reaction was, "My God, he's leaving me. You know, he didn't give me a release brake signal or anything. He just took off, that stinker. And, you know, I'm going to be late now. We're screwing up our takeoff," not remembering that we had briefed to make individual takeoffs.

So I release brakes and stroke the burners, and we start rolling. So we have exactly the wrong spacing between these two airplanes on this very narrow runway. Bob gets into the air, you know, and we roll down, and when the airplane reaches flying speed, I get it into the air, and we're right in all of his wake, his vortices coming off his airplane. Dirty, dirty air. The next thing I know, we're about twenty feet in the air and we're at ninety degrees of bank, because the

dirty wind kicked the airplane over. So I'm standing on top rudder as hard as I can and I've got full aileron in, and from the back seat I hear this, "Brewster." This is John talking.

So, you know, this dirty air is spinning air, and as you move back and forth across it, it does different things to the airplane. So the next thing I know we're in ninety degrees of bank the other way, and I got the other top rudder in and the aileron the other way. From the back seat I hear, "Brewster!" So I'm still struggling with this airplane.

Finally, I get it squared away, and we get out of this dirty air and I go up and I join up on Parker and we fly back to Houston, and not another word is said between John and I the whole way back until we're letting down in Houston and I think to myself, "Well, remember the lesson you learned when you didn't tell John anything about the touch-and-go landing. You've got to say something to John." But what do you say? And all I could think to say, "God, John, I'm sorry." [Laughs]

I figured, you know, when we landed and got in there, that the next morning I'd be called in and I'd be replaced as his pilot on STS-9. But, bless his heart, he didn't do that. So we got to go fly STS-9 together, or rather I got to go fly it with John and the rest of the guys.

And it was a great experience, STS-9. This was the first time we worked twenty-four hours, two shifts, so we divided up one pilot and two scientists on each shift, and you were on duty twelve hours and then you were kind of off duty for twelve hours, and we did this little hand-off. Since there was only one of us awake on the flight deck, one of us pilot types, you didn't want to leave the vehicle unattended very much, because this is still STS-9, fairly early in the program. We hadn't worked out all the bugs and everything, and neither John or I felt too comfortable leaving the flight deck unattended, so we spent most of our time there.

We had a few maneuvers to do once in a while with the vehicle, and then the rest of the time you were monitoring systems. After a few days of that, boy, it got pretty boring, quite frankly. You spent a lot of time looking out the window and taking pictures and all that. But

there was nobody to talk to, because the other guys were back in the back end in the Spacelab working away, and, you know, you just, “Gosh, I wish I had something to do,” kind of feeling.

But the flight went fine and we did a great bunch of science. Then we had another lesson on the landing of STS-9, and the lesson was, “never let them change the software in the flight control system without having adequate opportunity to train with it.”

The lesson came about this way. There were gains in the flight control system, and the gains changed depending upon what phase of flight you’re in. When you’re flying a final, there are certain gains that make the vehicle respond a certain way to the inputs the pilot makes on the stick. Then when the main gear touch down, the gains change and the gains are set up so you can de-rotate the vehicle and get the nose gear on the ground in an appropriate way.

So we had done all our training in a simulator with a certain set of gains, and then they changed the software, the flight software, and they changed these gains so that when it came time for John to land the vehicle in real flight, the gains were different than he’d done all his training on. I don’t remember if we knew about that or didn’t know about that. I can’t remember that. But certainly when John grabbed a hold—I mean, he didn’t grab a hold of it, he was flying the vehicle, certainly when he started to de-rotate the vehicle, it responded differently than he had trained on.

The way we had trained it, it was loose control, and so you’d start it down and then you’d let the RHC, the [rotational] hand controller, come back into detent, and it would just fall nicely down. Well, they tightened up the gains. So when John started it and got the rate going, then he let it come back to detent, the way it always, it stopped. So the nose stopped right there. Whoa, look at that. And so he had to then get back in a loop and command it on down. So that delay meant that we were decelerating all the time. So we were going pretty slow when the nose gear hit the ground, and the ailerons, basically saturated, couldn’t control the rate, so it fell through.

So here we are. John’s flying the vehicle. I’m giving him all the altitude and air speed calls and everything, and you feel this nice main gear gently settling onto the lakebed. From

downstairs where the rest of the guys were sitting, there were only two of us on the flight deck, as I recall, because we still had the ejection seats in Columbia at that time. They hadn't been taken out. So there was no room for another seat. So the rest of the guys, as I remember, the other four were on the mid-deck, and you hear this, "Yay!" and clapping when the main gear touched the ground very gently. Then John gets the thing de-rotated and we're down to about 150 knots or so when the nose gear hits the ground, and it goes "smash!" So it changes from this "Yay! Yay!" to "Jesus Christ! What was that?" [Laughter]

That was just really funny, and I got all of that on tape, because I had a tape recorder going. And poor John, he was embarrassed because of this, the way the nose gear hit down, but it wasn't his fault. They had changed this thing without him being able to practice using the new flight control system. So that was a good lesson.

Then, of course, we got called the next day, because during the landing rollout we had had an APU [auxiliary power unit] fire just prior to landing. I can't remember, again, exactly the sequence. But we had one APU shut down, and then when we shut the other two APUs down, normally after landing, it turns out one of them was also on fire.

The reason the first one shut down was it was on fire and the fuel wasn't getting to the catalyst bed, and so it undersped and it automatically shut itself down. Then in response to that, I configured some of the flight control systems and the APUs. So the next one didn't shut down until we actually shut it down. But there were two of them that were burning, and we had a generic failure of a little tube of metal where the fuel went through and was injected into the catalyst bed and it cracked. So we had a fire outside the APUs that when we shut them down and shut the ammonia off to them, the fires went out. So we had some damage back there, but the fires stopped. But we didn't know anything about that till the next day. I got this call and John says, "Hey, did you know that the APUs were burning?" No, I sure didn't.

Also on that flight was when we had the two GPCs, the two [general purpose] computers, fail, and that was an interesting thing, too. John and I were in the de-orbit prep, and he was in

his seat and I was just kind of floating over the console with the checklist there reading the steps to him and we were going through, and we were reconfiguring the GPCs and the flight control systems and the RCS [reaction control system] jets and stuff. We had come off the vernier jets and we were now on the big main thrusters.

About the time that we were reconfiguring the computers, we had a couple of thruster firings, and the big jets in the front fired and it's like these big cannons—boom! boom!—and it shocks the vehicle. You know, you really can feel it if you're touching the structure.

So we had one of these firings and we got the big X pole fail on the CRT, meaning the computer had failed. This is the first computer failure we had on the program. Our eyes got about that big. So I get out the emergency procedure checklist and say, "Okay, first GPC fail. Here's what we do." We started going through the steps and everything. And in just a couple of minutes we had another one fail the same way, a firing of the jets and the computer failed. So now we were really interested in what was going on.

So we ended up waiving off our de-orbit at that time. That was on an ascending pass to Edwards we were going to de-orbit. So about six revs later or so, you've got some descending pass opportunities into Edwards. So the ground decided, no, we're going to wait and try to figure out what's going on with these computers.

In the meantime, it was the end of John's shift and John was tired, so he went down to take a nap. We had sleep stations. This was the first time we flew these sleep bunks. So John went in there and was trying to get some rest. I'm up on the flight deck. As I recall, Bob Parker came up and was up there with me part of the time, too, and we're just kind of babysitting the thing.

Well, during that timeframe, all of a sudden there starts this [demonstrates] kind of noise, bang, bang, bang, bang, bang, bang, bang, gang. The next thing, one of our three IMUs [inertial measurement units] fails, and we didn't know why or anything. But, sure enough, it failed and

we couldn't recover it. It turned out its gimbal was failing and it was beating itself to death against the gimbal stop, and that was the banging noise.

So after a few hours, John comes back upstairs and says, "You know, I really appreciate you guys making all that banging noise when I'm trying to sleep down there."

You know, I said, "Jeez, John, I've got some bad news. Man, we lost an [IMU]." And John's eyes get this big again, because we've had two GPC failures and now an IMU failure.

Anyhow, we got through all that and we entered and landed, and when the nose gear slapped down, one of the GPCs that had recovered failed again. One of them didn't recover and we flew down with one less computer, but that computer failed again, and that's why I reconfigured flight control systems, as I remember now, because of that computer failure.

So, anyhow, that was STS-9. Great flight.

RUSNAK: Did you find out the cause of the computer failures?

SHAW: Yes. It turns out there were little, itty bitty slivers of solder that were loose in those two computers, and when those jets fired and the solder was floating in there, the jets fired, it made the solder sit down across two memory locations, changed the state of the memory location, the computers always doing a self-test, and it sees this memory location change value and it says, "Something's wrong. I'm outta here." And it self-failed. And the same thing happened to two of those computers.

So we went up to Oswego, New York, where IBM had a plant that built these computers, after flight and watched them do PIND, Particle Impact Noise Detection, testing. That's where they put microphones on the GPC box, and they put it on a shaker and they shake it, and they listen for loose particles inside. That became a standard screening criteria after that time.

RUSNAK: Did you have any involvement with any of the experiments on that flight or all?

SHAW: Helen's balls. I did Helen's balls. I remember that one. Helen's balls was—Helen was a principal investigator, and she had a bunch of little yellow balls that were different mass, different weight. What you were supposed to do, since there's no weight, there's only mass in zero-G, we had to try and differentiate between the mass of these balls. You would take a ball in your hand and you would shake it and you would feel the mass of it by the inertia and the momentum of the ball as you would start and stop the motion. Then you'd take another one and you'd try and differentiate between, and eventually you'd try and rank order of the balls. They were numbered as to which was the most massive to the least massive. We did that several times during the flight. And, quite frankly, that's the only experiment I remember doing. But I haven't thought about STS-9 for a long time.

RUSNAK: John Young had said every time he tried to venture down to Spacelab they'd want to draw his blood, so he stopped doing that after a while.

SHAW: Yes. Yes. Well, they weren't supposed to take our blood, as I recall, and I don't remember anybody. I don't think anybody took any of my blood.

RUSNAK: Can you say a few words about any of the other crew members from that flight? You have Owen Garriott, who was a Skylab veteran and such.

SHAW: Well, yes. Owen was the only other experienced guy. John and Owen were the only two guys who had flown. Parker had never flown. I'd never flown, and Ulf and Byron had never flown before. So John and Owen were the experienced guys, and they kind of were the mentors of the rest of us. It was fun to watch Owen Garriott back in the module, because you could tell right from the beginning he'd been in space before, because he knew exactly how to handle

himself, how to keep himself still, how to move without banging all around the other place. And the rest of us, besides he and John, the rest of us were bouncing off the walls until we figured out how to operate. But Owen, it was just like, man, he was here yesterday, you know, and it really had been years and years.

RUSNAK: It had been ten years.

SHAW: Yes, but you remember. Your body remembers that stuff. The human body is remarkable in its ability to remember and remember adapting to a previous thing.

So Owen was the leader from the mission specialist standpoint, and John, of course, from the overall mission standpoint, was the leader and the person that everybody listened to and looked to.

But I enjoyed working with all those guys. They're all very smart guys, and they'd been training for three or four or five years on these experiments, and things went very well. We used the little scientific airlock where we put stuff up out of the roof of the Spacelab.

Probably the most difficult aspect of the whole thing was after we got on orbit, we couldn't get the hatch open, so we couldn't get back into the Spacelab at all. I mean, I remember thinking, "Holy smokes. This mission's not going to go well if we can't get into the lab." [Laughs] But we finally managed to get the hatch open, but it took us a few minutes. Looking at Owen and Bob's faces, I remember thinking, "Boy, these guys are seeing their lives pass in front of their face, if we can't in there to do the stuff that they've been training for all these years to do." But we did, and it was a very successful, very successful mission.

We learned a lot from that flight, a tremendous amount. I mean, we did investigations in all of the various areas of interest, from human physiology, materials processing, fluids, all kinds of stuff. Seventy-seven different investigations, as I recall, on that mission. It was a tremendous success. Learned that the human immune system isn't as active on orbit as it is on the ground, so

you shouldn't cut yourself or you shouldn't get sick on orbit, because you're not going to fight it off as well. That was one of the things that was learned out of that flight. Surprisingly they hadn't already learned that in Skylab. Maybe they had and everybody forgot. I don't know.

RUSNAK: That may very well be.

SHAW: That happens a lot, as a matter of fact.

RUSNAK: So did you feel like a taxi driver, as Kathy Sullivan had predicted?

SHAW: Well, yes, actually, especially on that flight where our role was very minimal, John and mine, because we didn't have to maneuver the vehicle very much, but we had to monitor the systems a lot. So we didn't get to participate to a great length in the science that was going on. So, yes, pretty much. We got it up there and we got it back. In the meantime, the other guys did all the work.

So on the next flight it was a lot more interactive, which I really enjoyed, on 61-B, where we deployed three satellites, two Hughes 376 satellites and one built by RCA. The 376s belonged to Mexico and Australia, and the RCA, one belonged to RCA Americom, and that was a commercial communications outfit. So we did that and we did two days' worth of spacewalks, Jerry [L.] Ross' first spacewalk, doing EASE/ACCESS [Experimental Assembly of Structures in Extravehicular Activity / Assembly Concept for Construction of Erectable Space Structures], he and Woody [Sherwood C.] Spring. I remember that was very interesting.

Mary [L.] Cleave was the RMS [remote manipulator system] operator on that. You know, Mary's a short little gal, and in order for her to get up and be able to look out the window and operate the controls on the RMS, we'd strung a bungee across the panel and she'd stick her

legs in front of that bungee and it would hold her against the panel and that helped fixate her so she could be high enough and see and be in the right position to operate the RMS.

Mary was really focused on these two EVAs, because we put one of them on the end of the RMS, and I don't think that had been done before, and then we moved them around as we built this. The ACCESS experiment, I think, was the one where these—it was a Tinker Toy buildup of all of these elements that they'd put together and one bay on top of another bay on top of another bay, and they built it. It went up forty feet or so. I think it was forty feet long. Then we took it loose, and somebody would be on the end of the arm of the RMS, and they'd maneuver it around to see if you could maneuver large structures and that sort of thing. Turns out you could do that very well.

But I remember coming up behind Mary once, when she was operating the RMS and there was somebody on the end of the arm. I put my hand on her shoulder, and her whole body was quivering, because she was so intent on doing this job right and not hurting anybody, and so focused and so conscientious, not wanting to do anything wrong, because she knew she had somebody out there on the end of this arm, and she was just quivering, and that just impressed the hell out of me, because I thought, you know, what a challenge, what a task for her to buy into doing when it obviously stressed her so. You know, she was so nervous about it. But she did a great job, absolutely great.

Anyhow, that was a fun flight. We also had Rodolfo Neri Vela on that flight. This was really the first—I don't remember if it was the first time we flew somebody like that or not, to tell you the truth. The first time I had flown with somebody that we didn't know very well. You know, Ulf Merbold was a German, but he'd been training with those guys a long time. They knew him well. We didn't know Rodolfo very well. He kind of showed up late in the process and wasn't here all the time and stuff, and so you didn't really get to know him well. So I wasn't too sure about his human reliability. I'm probably a paranoid kind of guy, but I didn't know what he was going to do on orbit.

So I remember I got this padlock, and when we got on orbit, I went down to the hatch on the side of the Orbiter, and I padlocked the hatch control so that you could not open the hatch. I mean, on the Orbiter on orbit you can go down there and you just flip this little thing and you crank that handle once [demonstrates], the hatch opens and all the air goes out and everybody goes out with it, just like that. And I thought to myself, "Jeez, I don't know this guy very well. He might flip out or something." So I padlocked the hatch shut right after we got on orbit, and I didn't take the padlock off until we were in de-orbit prep. I don't know if I was supposed to do that or not, but that's a decision I made as being responsible for my crew and I just did it.

RUSNAK: Did any of the rest of the crew notice it?

SHAW: Yes. I don't think Rodolfo noticed it, but some of the other crew noticed it. But everything went just fine. He turned out to be a great guy, and we had a lot of fun on that mission. That was a very successful mission, as were all three of the times I got to fly. In fact, we have not really had an unsuccessful Space Shuttle mission except for *Challenger*.

RUSNAK: How different was it being the commander of the flight instead of the pilot?

SHAW: Well, a whole set of different responsibilities and feeling of being accountable for your crew, which was a big responsibility, but I enjoyed the responsibility, and I felt good about having that responsibility and thinking about my crew and thinking about who should get assigned what tasks and who would be good at what and what would they enjoy doing and that sort of thing, because I'd been a single-seat fighter pilot and then a two-seater for a while, never had big crews to deal with before. So that was something that I enjoyed doing. And I had a lot of confidence in my own ability to fly the vehicle, so I wasn't concerned about that, being a

macho test pilot guy. It turned out I learned later that I should have been more worried about that. [Laughs] But on this flight I wasn't, and the flight went great.

Let's see. Charlie [Charles D.] Walker and I were the only two on that flight that had flown before. Charlie had flown on what? STS-something, with Henry [W.] Hartsfield. I don't remember which number that was. But Charlie did the CFES, Continuous Flow Electrophoresis System, that experiment, which he got to fly several times, great experiment. Too bad that during the *Challenger* down period people lost interest in it.

Anyhow, 61-B was a lot of fun. I really enjoyed flying with all those people. I thought we had a great crew. Everybody did super. We got everything done we were supposed to get done.

Then it was flying back on the airplane from Edwards after the 61-B landing that George [Abbey] told me I was going to fly a classified mission my next flight. And 61-B was in what? November, landing in December, of '85, and in January of '86, of course, we had the Challenger, and so all these flights got put on hold. But I ended up staying on basically the same flight, STS-28, that flew after we got going back flying again.

Now, during this down period is where the rock and roll came into play, because I think it was in early '88 and morale in the office was pretty low. We weren't flying again yet, you know, we weren't really sure when we were going to be able to fly again because they were redesigning the solid rocket boosters. And morale was pretty low, and we thought, jeez, we ought to come up with some way to pick people up a little bit.

So I got talking to Hoot [Robert L.] Gibson, and we decided, "Let's have a sock hop." And not only let's have a sock hop, but let's put together a little band that could play at this sock hop, and the band would be all astronauts. Hoot declared as how he could play lead guitar. Hoot and I had played guitars a little bit together before. I could play rhythm guitar. And we got Pinky [George D.] to play bass guitar, which he didn't play, really, but he learned. He learns everything in a heartbeat, so he picked that up overnight.

And it turns out that Wetherbee had been a drummer. So we got the four of us together and we practiced a bunch and learned, I don't know, three or four songs, and we played at this sock hop down in the pavilion down at the park in League City on Highway 3. Going down to League City there was a pavilion, that has since burned down and been rebuilt.

But, anyhow, we had this sock hop, and I think we played three or four songs or something like that, but it was a great time. Everybody had a lot of fun, and it absolutely did what we'd hoped it would do. It gave people a diversion and they quit thinking about not flying and how we were grounded. So I was real glad we did it, and then the band just kept going, and the band is still going to this day. I think Wetherbee is the only original member of that band still in it, because he's the only drummer, I think, and, you know, he likes to do it. But that's where the rock and roll came back in, after the comment during the interview.

So then *Challenger* happened, and I remember I was standing in the doorway of George Abbey's office watching the TV when that happened, and within about two hours, I was in a T-38 headed for the Cape to go down and be with the families, because a lot of the crew, of course, was out of the TFNG ["Thirty-Five New Guys"] group, the '78 group.

Then I got sent up to D.C. to help the Rogers Commission [Presidential Commission on the Space Shuttle *Challenger* Accident], and Sally [K.] Ride was on the commission and [John M.] Fabian was up there as a staff support person and so was I, and other people would come and go, and we did whatever we could to support that.

Then after we got done with that, I got sent out to Downey, to Rockwell Space Systems Division, to work on safety enhancements for the Orbiter. So I spent a lot of time out there and flying back and forth to California, landing at Los Alamos, I think is the name of it, Army Air Field out there by Seal Beach, California, which was the closest place to the Downey facility we could land a T-38.

I remember one day Rob [Robert A.] Rivers and I were flying out there. He was just giving me a ride out. He was in the front seat. I was in the back. We were letting down into Los

Alamitos there, and we got hit by lightning, and the lightning created an arc in the fuel tank on NASA 914 and blew the whole back end spine of the airplane, blew that completely off. All these fuel bladders were sitting there full of JP4 fuel cooking away. We had fire lights on both engines. Rob shut one of them down. We had smoke in the cockpit, so he's turned off the generators, and we landed no flaps at Los Alamos or Los Alamitos, I can't remember what it is.

RUSNAK: Alamitos, I think.

SHAW: On fire, rolled down to the end of the runway, stopped the airplane, unstrap. Jeez, there's fire all around. The fuel's underneath the airplane spreading out and the back end is just blazing away there. So we jump over the side and run away, and the guys come and spray cow guts on the airplane. That's what they use; the foam is made up of cow guts or something like that. And put the fire out.

That was the second time I had been on fire in an airplane. The first time we had to eject because the airplane became unflyable. That was in an F-4 when I was an instructor at George [Air Force Base] after coming back from Southeast Asia. I had a German pilot. We were teaching Germans to fly F-4s, because they were buying the F-4F model at that time. A German pilot in the front seat. I was the instructor in the back, and this F-4 caught on fire, and it burned through the controls. So the stick became disengaged from the flight controls and the airplane started to pitch up, and we had no choice but to eject. So we did.

So this T-38 was the second time I'd been in a burning jet, same sort of sound indications when a fuel bladder or a flame front propagates in an airplane. I heard that on that T-38 and I thought to myself, "Oh, this is not good. I've heard that sound before, and I know what it means." And it wasn't good. But, fortunately, we got the airplane on the ground, and that airplane is flying again today, because the miraculous guys out here in Ellington put it back together.

Okay. So then STS-28 happened, and that was a classified mission, great crew again. Really enjoyed flying with those guys: Dick [Richard N.] Richards and Dave [David C.] Leestma and Jim [James C.] Adamson and Mark [N.] Brown. They've declassified some of that stuff, but I can never remember what's been declassified and what hasn't, so I just don't talk about any of it. But it was very successful. We accomplished our mission and it worked great.

Now, here's where I learned that I wasn't such a hot pilot as I thought. When I landed 61-B, it was on the runway at Edwards, a concrete runway that's got defined boundaries and everything, and it's easy to judge sink rate and your height above the runway when you have defined boundaries. On STS-28, we landed on the lakebed at Edwards, which has stripes painted on the lakebed. You know, it's kind of like oil that they put down there so it outlines the runway, but it's not a well-defined thing and you don't have—or at least I don't have—the same kind of depth perception that I had.

So when we came down and I flared the Orbiter, I flared it, and I don't know how high we were, you know. Looking at the photographs, we weren't very high, but I basically leveled the vehicle off and then it floated and floated and floated and floated and floated and floated. So instead of landing at 195 knots the way we were supposed to, we landed at 155 knots.

So this was Columbia again, and so here we are on the main gear on the runway at 155 knots decelerating fast, and I've got to get the nose on the ground. So the same thing that happened to John on STS-9 happened to me, and the nose goes "bam!" on the ground. I felt terrible about that, because I let this thing float for 40 knots' worth of deceleration. Got a lot of great data about low-speed flying qualities on the Orbiter, but it wasn't supposed to work out that way. [Laughs]

RUSNAK: The ground-effect experiment.

SHAW: Yes, right, ground-effect experiment. So I was real embarrassed about that. But, you know, what the heck. We walked away from it.

So after that, and addressing another question in here, [Daniel C.] Brandenstein was now the head of the Astronaut Office, and I went in to see Brandenstein to talk about flight assignments, and he told me that it was going to be at least three or four years before I got to fly again.

[Robert L.] Crippen, during the same timeframe, Crippen asked me if I would come down to Kennedy and take the job that he'd been doing as the Ops [Operations] Manager or the Deputy Program Manager for Operations down at Kennedy. And so I decided, yep, I would go do that, and I asked for two things, and I asked them of my good buddy, the Associate Administrator for Space Flight, Bill [William B.] Lenoir, and my other good buddy, the Administrator of the National Aerospace and Space Administration, Dick [Richard H.] Truly. I said, "Yep, I'll be glad to go do this for Crip. I would like to remain on T-38 flying status, and I'd like to remain eligible for space flight." And the answer was no and no.

So, different than it is now where we take people out of the office and put them into other jobs and then they have the opportunity to come back and fly the Shuttle again, and in the meantime they stay on T-38 flight status, at that time the answer was no. So I had to quit flying T-38s, and basically my Space Shuttle flying career was over. But I did it anyhow, and it turned out it was okay.

So I spent four years down in Florida working for Crip as the ops manager down there, and the ops manager at that time had a little bit broader scope of responsibility than the current position holds. I was responsible, as was Crip before me and [Loren J.] Shriver after me, responsible for the vehicle from the time that it goes into start processing, all the way through the processing, the launch, the mission conduct, the recovery and getting it back to Florida to start all over again. So there was broad responsibility. So every time we'd fly a mission I'd come here to Houston and spend the whole mission here, conduct the daily MMTs, Mission Management

Team, meetings, and that sort of thing. When I was in Florida, I would conduct the noon meetings relative to the processing of the vehicles and all that kind of stuff. So it was a very responsible job, and I enjoyed doing it.

During that timeframe, Leonard [Nicholson] was here in Houston running the technical side of the program and Crip was the program manager, and he was in Washington, D.C. And during that timeframe was when we had the hydrogen leaks out of the ET [external tank] disconnects, and we had to ground the fleet for a whole summer while we solved that technical issue and redesigned the little seals a little bit. But we flew many, many, many, many successful flights during that timeframe.

One of those flights I remember was the INTELSAT retrieve mission, where we were going to go up and rendezvous with the INTELSAT satellite and we were going to put a new motor on the bottom of it. It was trapped in a unusable orbit, and so we were going to take up a new motor, as I recall, and mount it to that thing and send it on its way. We had trouble. The mechanism that we had designed and tested on the ground to capture it wouldn't work. So we ended up having three guys EVA. We'd never done that before. Three guys outside there and they just grabbed this thing with their hands and we got it down in there and everything.

But during this flight, this was the first mission after Dan [Daniel S.] Goldin became the Administrator of NASA, and Dan Goldin decided that during this mission he was going to send a red team to Houston to see whether we were conducting this mission properly or not. And that was a real eye-opener of things to come under the Dan Goldin administration of the National Aeronautics and Space Administration. It was a real indicator of things to come. Enough said about that.

So from '89 to '93, I spent in Florida doing that job then. In the summer of '93, I came back to Houston, and I became the Space Shuttle program manager for NASA, badged to Headquarters, and I ran the Space Shuttle Program from the summer of '93 until about August or so of '95, when I declared my intent to leave the agency in November.

The timing of my departure from that job was driven primarily by the fact that it was clear the agency was going to create the SFOC [Space Flight Operations Contract] contract and was going to hire USA [United Space Alliance] to be the operations contractor for the Space Shuttle Program.

Preceding that or leading up to that was the Chris [Christopher C.] Kraft [Jr.] Committee, commission, that was looking into what to do to move the Space Shuttle Program into a more cost-effective posture and move it toward privatization. Chris had his own ideas about that, and he had a bunch of people on his team, and I remember having an interview with him once where I got so mad that I got up and left the interview. I said, "So that I don't say something I'll regret later, I'm just going to leave." And I got up and walked out because of the way the conversation was going. I don't know how Chris felt about that at the time, but since then he and I, I think, get along real well.

So here I am, Shuttle Program manager. I've got all these project managers for the various projects, the Shuttle, the ET, the SRBs [solid rocket boosters], the RSRMs [redesigned solid rocket motors], the SSMEs [space shuttle main engines], etc., and we all get together and decide, "Hey, you know, this program is going to go to private industry if we don't do something. So let's figure out what we can do."

So we put our heads together and we came up with a new plan that really went a long way towards backing the government out of the day-to-day management of the program and gave the contractors a lot more responsibility, etc., etc., and it was a hard fight. I remember Jay [H.] Greene and I would go head to head, because Jay was in the Orbiter Project at that time. We would go head to head in these meetings, but we finally got a consensus where we said, "Okay, we can agree to these steps." And then we figured out how much money that would save. We estimated that by 2000 we would be saving a billion dollars a year on Space Shuttle operation costs, which is pretty close to what USA has been able to achieve, by doing many, many, many of the things that we laid out we would do in order to reduce cost on the program.

So we went up and briefed our plan to Wayne Little's was the AA [Associate Administrator] for Space Flight at that time at Headquarters. Wayne was there and George Abbey was there and the other Center Directors were there. We went up and gave our briefing, and our briefing was a good briefing, and it showed exactly how we're going to reduce these costs and everything. And they said, "Thank you very much." And we left. The decision had already been made that they were going to do the SFOC and they were going to hire USA to go do this thing.

As soon as that became clear to me, I told Wayne Little's I was leaving the program, and the reason I did that was because I loved the Space Shuttle Program and I wanted to have the ability to continue to work on that program. If I stayed around while the SFOC came in, I wouldn't be able to go work for USA ever. But if I left then, I would not get contaminated by being part of the team that brought SFOC in. So someday, if it worked out that I could someday, I would be able to work for the United Space Alliance. I had no clue whether that would ever happen or not, but I wanted to have that as a possibility. I was only going to stay in the Shuttle program management job for a certain period of time anyhow. You shouldn't have people in that job too long. So I knew I was going to leave eventually. So I just adjusted my timing based upon that criteria. And that's all there was to that.

RUSNAK: Why had you been opposed to more significant changes in the way the Shuttle Program was being run?

SHAW: Why had we been opposed to it? Just because we'd done it the way we'd always done it and we didn't want to change. We were resistant to change. We felt a great sense of responsibility to the program, and we didn't want to take more risk, and we figured that was going to be more risk, and that's exactly the same way people feel today and people will always feel that way, because that's human nature.

RUSNAK: Well, if we can pause for just a minute to swap out our tape and then finish up.

SHAW: Okay.

So, let's see. You want to know about the relationship between the astronaut corps and the other parts of NASA, etc., etc., etc. Well, I talked a little bit about that earlier. There are a lot of people in NASA that listen to everything astronauts have to say, because astronauts are going to be the ones operating the hardware, and there are other people in the agency that consider astronauts a necessary evil, kind of, and that astronauts are to be kind of controlled and to be patted on the head and supported, but they're not really the ones that make stuff happen, and that's largely true. It turns out it takes everybody. It takes the whole team to make the program go, the people who fly it in space and the people who control it and manage it from the ground. It takes the whole team, and the more we can work together, the better we all perform.

RUSNAK: When you got into management, did that change your perspective a little bit on the role of the astronaut?

SHAW: Oh, of course. It absolutely did. You bet it did. When I was flying, however, as a commander, I felt coming from flying operational airplanes in the war and stuff, you had all these airplanes and they were all the same, and you didn't get to ask somebody to change the airplane because you were going to fly it and you wanted it to have it different for you because you liked this and you didn't like this, etc. You flew what they had available, and that's just the way it was. So I felt the same way kind of about the Orbiters. I could see, even when I was in the crew office, I could see that we could drive a lot of costs and a lot of work simply by having our own personal preferences and trying to get those preferences accommodated, and in my opinion, we shouldn't be doing that. We should be using what we had available for the most

part. If we wanted to work with the whole community to make improvements or changes, that was one thing. But just because we're going to fly a certain mission, to ask for all of this tailored stuff and this personal preference stuff, I didn't think was appropriate. So when I got into management, I still had that attitude and that perspective, and so lots of times I pushed back hard on the requests that came out of the office if I felt they were simply personal preference kinds of things.

Now, you talk about public relations and what we had to do. You know, as AsCans [Astronaut Candidates], even before I showed up, I ended up having to go be on a TV program someplace, and I found that to be a terribly embarrassing situation, because I wasn't really an astronaut. I hadn't flown. I wasn't even really an AsCan yet. I was going to be one. So I felt like the only credibility I had was what I brought with me as being a fighter pilot and a test pilot, and I felt very uncomfortable in that situation. But we had to do a lot of public appearances like that. George liked to use astronauts as tickets, and George would use astronauts to buy chits that people owed him, and then he could call them in when he wanted to. He was terribly effective at using people that way. He might take offense that some of us feel that way, but I think that's, to a certain degree, how it went.

But all of that speaking helped out, because when I was here in Houston as the program manager, we had another occasion to ground the fleet, and that was when we were getting unusual erosion and pocketing on the nozzles of the solid rocket boosters, the interior nozzles. We had to figure out what was going on, what was happening there, and so we had to ground the fleet. Having gone through the *Challenger* experience, having gone through the hydrogen leak experience relative to how the media treated us, I decided that I was going to every week on Friday afternoon, I think it was, I was going to hold a press conference over in Building 2, and I would go over there and I would explain everything that had happened this week resolving this issue, what tests we had done, what the results were, what the problems were, what we were

thinking about doing next, and how we were working our way through resolving this technical issue so that we could go fly again.

So I did that for many weeks in a row, and I found that that was an effective way of keeping the negative press down to a low roar by giving them so much technical information that they just could hardly deal with it all. But we weren't hiding anything. They couldn't say, "Oh, you're not telling us what's going on," etc., etc., etc. So I thought that worked out well.

Let's see. What else do you want to talk about here?

RUSNAK: One of the recommendations of the Rogers Commission was to have astronauts in management positions more so than they had been previously. Obviously, later you kind of slid into that. What are some of the advantages and disadvantages of that?

SHAW: Well, it depends on the individual, of course. You bring a perspective from the operator. You bring the perspective of, "I've been there. I've used this equipment. I understand that aspect of it." And that's a perspective that nobody else can bring to the table when you're arguing about things and when you're talking about risk management.

My wife tells me that I'm a risk-taker, and it's probably true, because when I was running the program I would be willing to do things from a risk management standpoint that a lot of the people around me weren't willing to do. I would have long arguments with people about why I thought it was okay to take a certain position, a technical position relative to being able to operate something and having the safety probabilities at a high enough level that it was okay to go do it.

But I felt like I had a perspective, having been there and operated the equipment and understanding it very well. I felt like that gave me an advantage when it came to evaluating how much risk was reasonable to assume, although I never discounted what the engineering community or the MOD [Mission Operations Directorate] community or anybody else had to

say. I just felt that that was something else I could draw upon when I had to make decisions. Lots of times you cannot get a strong consensus, and lots of times whoever is responsible has to make a decision or you get stymied, you know, you can't progress. So you have to do that. And so I felt that having that perspective helped me in a lot of cases make those decisions.

I think astronauts, number one, most astronauts are highly motivated, very intelligent, well educated, broad-based, have broad perspectives. I think that's one of the big criteria of how you select astronauts is you don't hire people who are narrowly focused in a particular field. You want to be able to assign a doctor a job working with flight software or a physicist a job working with toilets on the Space Shuttle or whatever job you want to be able to assign them those tasks and have them be successful. So you've got to have people who have a wide range of interests, and who will apply their talents and their energies to any job you give them. Those kind of people are effective in management roles. So I think that astronauts have a lot of capability relative to being able to function in management roles, and they also bring this perspective of being the user of the end product.

Now, you have to balance that against egos, which many of us astronauts have huge ones, and people's ability to operate as part of a team and listen to other people's opinions, and not just run herd over the organization and that sort of thing, because you do have to operate very much as part of a broader team in this business. So you weigh those off, and some people come out of the Astronaut Office and make good managers and some people don't, and you try to pick the ones who you think will when you give them management jobs. But for the most part, I think astronauts have been quite successful in management roles and have helped the agency and helped the program, programs.

RUSNAK: I think that's turned out to be the case. We even had one as an Administrator.

SHAW: Right.

RUSNAK: Relative to your management experience as head of the Shuttle program here, can we talk about the Shuttle-Mir program a little bit?

SHAW: Sure. Shuttle-Mir, yes. That happened while I was here. When I was here as the program manager, Tommy [W.] Holloway was my deputy. When we started doing Shuttle-Mir stuff, it became evident that the agency, NASA Headquarters, didn't want Shuttle-Mir to be part of the Shuttle Program. They wanted to have a separate entity manage that as, quote, Phase I of ISS [International Space Station].

So we formed a Shuttle-Mir office, and Tommy Holloway was assigned the role of managing that office. So he stopped working directly for me and went to work as the Shuttle-Mir program manager, although since Shuttle-Mir starts with Shuttle, we worked very closely together, because all of the Shuttle flights I was responsible for as the Shuttle program manager. And that turned out to work very well.

That came on the heels of the first Hubble [Space Telescope] servicing mission, which again NASA Headquarters—and I think driven largely by Dan Goldin—decided that they wanted to have an independent management structure for this highly complex, extremely important mission. So that was the first assignment, the first effective assignment, that Randy Brinkley was given when he came to work for NASA as the manager of the HST servicing mission, the very first one. Although they didn't give Randy very much authority. He had a tough job, because he was supposed to be doing all this independent review and independent management and everything, and yet the mission was really managed by the Shuttle Program.

But that was the first foray into that kind of a structure, and then the next thing was the Shuttle-Mir Project or Program Office that Tommy ran, and then Frank [L.] Culbertson [Jr.] after Tommy, when Tommy went into the Shuttle Program management job after I left. What else about that?

RUSNAK: Actually, since we're running short on time, I wanted to give Rebecca and Sandra a change to ask questions, if they had any.

WRIGHT: [Unclear].

RUSNAK: All right. Did you want to say anything about your job since you've left NASA? Because you've stayed involved with the space program, clearly.

SHAW: Well, yes. When I left NASA, I went to work for Rockwell Aerospace and Defense Systems out in Seal Beach, California, and I was given a staff job initially, working in the engineering and operations part at the Headquarters-level of this thing. Staff jobs, I don't know if you've ever had a staff job, but they're not really my cup of tea. I like to be involved more than a staff job allows you to be. But I did what they wanted me to do relative to that.

Then later that year, that was '96, we got bought by Boeing, and then the next year I was assigned to go to Canoga Park and run the Space Station power contract out of Canoga Park, which was one of the work packages that was part of the Space Station Program. So that was when I got back into human space flight was when I went to Canoga Park. So I stayed at Canoga Park about seven months or so.

Then I went to Huntington Beach and was given responsibility for all of the flight elements, in other words, all of the work packages, flight elements and subsystems, we call it. I was given the responsibility for all of that, because we were trying to integrate now to Heritage Rockwell, Heritage McDonnell-Douglas and Heritage Boeing parts of the International Space Station together.

So I was working for Doug Stone, who was the program manager here at the time for Boeing for ISS, and trying to pull all that together. I was assigned to go down to Huntington

Beach, where we had some significant problems. Eventually, the guy who was the vice-president running Huntington Beach part of that was reassigned, and I took over responsibility for that as well, so Huntington Beach and the rest of the overall pulling together of the rest of the flight elements. I did that for, I don't know, six months or so.

Then Doug brought me here to Houston as a deputy to him, because it was clear that he was going to retire in the next year. So I came to Houston to work with Doug Stone and Royce Mitchell, and I was the heir apparent to Doug for the program manager job, which I got in May of the next year, May of '99. So I got to work on the power system. I got to work on the interior trusses and the node directly. And then from Houston here, of course, I got to work on all of it, with all of the teams

Now, how has that gone? You know, it's hard for me to evaluate myself specifically. It's easier for me to evaluate the team, and the team, I think, has been very successful because we've got Phase 2 complete on orbit, everything's working great. We just took up the first element of Phase 3, and that's all going great. All of these missions have gone well. Everything's fit together well. Technically our performance is excellent on this program, and we struggle, like everybody else, with keeping the costs under control. But if you look at the Boeing contract, the value of our contract now is over \$10 billion on the International Space Station, 10K contract, and our overrun is in the neighborhood of between 10 and 12 percent overall on our contract. And when you think of a development contract of this magnitude, that's pretty reasonable performance for the team.

Now, the total cost has grown by way more than 12 percent, because a lot of stuff has come to us by change order. You know, it's not our performance; it's the government's asked us to do more and more and more things as people realize, "Jeez, you know, in the original contract we didn't really account for having to do this. Now we've got to do it."

Like MEIT, all the Mated Element Integrated Tests, that we've done down at Kennedy. That wasn't in the original deal. In fact, that was taken out of the original deal. We were going

to ship and shoot. Well, ship and shoot doesn't work when you're trying to integrate this stuff on orbit like that. So that kind of thing got added back into the program, and the program cost has gone up a lot. But the Boeing performance on our contract is, I think, very reasonable, and our technical performance, I believe, is excellent. So I would give the team high marks relative to that.

RUSNAK: Had you followed the development of Space Station from its Freedom days up until the current configuration?

SHAW: Well, some. Some. I remember Bryan [D.] O'Connor, who I got to fly with on 61-B. He was the pilot on that flight. Great guy. I remember he was working up at NASA Headquarters, and he and I would go to some of the meetings over in Crystal City [Virginia], when they were redesigning the Space Station. Bill [William M.] Shepherd was in the middle of that, and Dan Goldin and George Abbey would show up late every afternoon and keep people till late into the night going over what had gotten done that day. A lot of people were in the middle of that, and that's when we had decided that Reston [Virginia] wasn't working out very well, and we needed to redo this thing or we were going to lose it. So we started getting some insight at that point, and that was in the early to mid-nineties when all that was going on.

I remember when I was the Shuttle program manager here when Randy Brinkley and the Station team came to JSC. I remember getting a hold of Randy and saying "Hey, we're here. We've got all this experience. We've been doing all this flying, all this operations stuff. We can help you. Just let us know what we can do to help you." Some people thought, well, the Shuttle guys are going to try and take over. I said, "No, we don't want to do that. We just want to help, because it's got to be successful because our future is largely tied up in the Space Station. So we just want to help you be successful."

Well, it was clear that the marching orders he had from NASA Headquarters, i.e., Dan Goldin, were that however the Shuttle was doing, it was wrong, because the Shuttle was this terribly expensive operation, and “We’re going to do Space Station faster, better, cheaper, and so stay away from those Shuttle guys.”

So the Space Station team, when it first got here, was very, very arms-length, very standoffish. They didn’t want our help. They didn’t want JSC engineering’s help. They didn’t want anybody’s help. They thought that their marching orders were, “You guys do it differently and do it yourselves.” It took a long time for the team to realize that that’s a very tall order, and they really ought to use all the capabilities available to them to help be successful.

RUSNAK: And the reason JSC is the lead center for that, I mean, your expertise is here, this engineering capability that you mentioned, and to not take advantage of all that just seems to be—

SHAW: Was a little short-sighted.

RUSNAK: Right. Well, since we’re about out of time, I want to give you a chance to make any final comments, any other remarks or anything else to wrap up.

SHAW: Well, this is a history. I mean, we’re talking about history here. We don’t know what history is going to say about this program. We know what history said about Apollo: it was a great success. And then history quickly forgot about Apollo. Instead of flying several rockets we had lined up to go to the Moon, we just parked them out here. So, history is fickle and it’s certainly subject to politics and the winds of the nation.

So the history of the Space Shuttle Program and human space flight, as we know it now, has yet to be written, but I hope that the historians are reasonable and are kind, because I think

that the Space Shuttle is a wonderful accomplishment and so is the Space Station. If we don't continue to do things like this, our whole lives will end up being virtual and not real from the aspect of human knowledge and human exploration and humans understanding our world and our lives, and that would be a great travesty if we virtualize our future rather than living it.

RUSNAK: Thank you very much for taking the time this morning.

SHAW: Yes, okay.

[End of interview]