NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY TRANSCRIPT

BROCK R. "RANDY" STONE
INTERVIEWED BY SANDRA JOHNSON
HOUSTON, TEXAS – 31 OCTOBER 2006

JOHNSON: Today is October 31st, 2006. This is the second interview with Randy Stone, and is being conducted in Houston, Texas, for the NASA Johnson Space Center Oral History Project. The interviewer is Sandra Johnson, assisted by Jennifer Ross-Nazzal.

I want to thank you for joining us again today to talk to us.

STONE: You're welcome. It's good to be here.

JOHNSON: Good. I want to start today—the last time we talked, we were still in Landing and Recovery, and I just wanted to get some more background information. If you could, share with us some details about the relationship between NASA and DoD [Department of Defense] during those recovery operations, and how that relationship worked, and what the protocol was while you were on the ship.

STONE: Without the DoD, NASA would have been unable to do the recovery of spacecraft at sea. Clearly we needed the help of the Navy to provide the ships and helicopters and the Air Force to provide the long-range search-and-rescue aircraft. Because of the uncertainties of the early launches, we actually strung ships out across the ocean to accommodate any of the potential aborts that may occur during ascent. So there were a lot of involvement with the Navy, and in some cases, the Merchant Marine, when there weren't Navy ships that we could

schedule—could not schedule underneath the flight path of the vehicle; we would look to see where merchant ships were, and have arrangements if we needed to use one of those ships as an emergency recovery vehicle.

We had a very strong working relationship with the Air Force and the Navy. We actually had a number of liaison officers within Landing and Recovery to help us with the DoD interface. Without that it would have been just hugely complicated. Because of the presidential directive to go to the Moon, we had a lot of resources from the DoD that were easily obtainable, even though in the early stages of Apollo, we were involved in the Vietnam War and there was a lot of other things that the military was doing with their ships and aircraft.

But it was a big logistical effort to schedule all these things for a flight, and then if the flight slipped, you kept rescheduling and rescheduling, and oftentimes one ship that was available for the flight the first time, if it slipped, was not available, and some other ship had to be substituted. For the primary recovery ships, they did commit those for an extended period of time, so we were never surprised with the primary recovery ship. Once they made the commitment to commit that ship to recovering the vehicle, then it stayed that way even if we had multiple slips.

But it was a very good working relationship, and it was very interesting to see the cooperation, even on the lesser ships that many of us served on, that were really probably never going to see an Apollo Command Module, because of the low probability that they would be used, but they went through their drills and their training with as much enthusiasm as the primary recovery ship.

NASA provided all of the training to the DoD, both the Air Force Pararescue men that would jump into the water if the spacecraft did not land close to a ship. They provided the first

response to safe the spacecraft and make sure that it had the flotation devices installed and was safe to just bob around out there until a ship got to them. And we did all the training for the Navy dive teams. Typically we used the Underwater Demolition Team [UDT] divers as our primary rescue swimmers on board the ships, or at least the primary recovery ships. We did all the training for them; taught them how to use the flotation collars and the special rafts and the special procedures, when we were coming back from the Moon, to help quarantine the crew.

So NASA engineers, we built the training manuals and delivered them to the DoD, and then followed up and went out and helped them train. Oftentimes we delivered a boilerplate spacecraft for them to practice with, to take out of the water and put on the deck of the ship, and show them where the hazardous areas on the spacecraft were and that sort of thing.

So that was the relationship. It was a huge team and a huge team effort. On an aircraft carrier primary recovery ship, we would have upwards of thirty to forty NASA folks on board on the primary recovery ships in support of the recovery of the spacecraft, training of the swimmers, training of the ship's complement for handling the spacecraft, bringing it on board, and running the Quarantine Facility.

JOHNSON: How early would you go out on a primary recovery ship before the actual splashdown?

STONE: We would typically train at least once with the dive teams before we ever deployed the ship. It depended oftentimes on how far the ship had to go from whatever port it was at to the landing site. But it could be anywhere from one to three weeks prior to the predicted launch time that the ship would set sail, and then we'd stop and do training en route to the recovery zone. So

it really depended where the ship was coming from, how far it had to go, on how much earlier you deployed. Typically we deployed with a ship about two weeks before launch; got to the ship, and then depending on how far it would go, we might do some of our training in port before it would sail.

JOHNSON: What was the protocol on the ship, especially during that training time and then during the actual mission? You mentioned that you had thirty to forty NASA people on the primary recovery ship, and then you had the Navy and who answered to who on that ship. How did that relationship work and who directed that?

STONE: The NASA team had a team leader, and he dealt with the senior officers of the ship. All of the NASA team, whether there were two of us on a secondary ship or thirty of us on a primary ship, would be treated as an officer, in that our quarters would be in officers' country. We dined in the officers' mess. But clearly we operated within the protocol of the military chain of command. They tried to stay out of our way when we were doing something that was very specific to our job and didn't involve military people. But when we were working as a team, we went through the normal chain of command; with the swimmers. Our senior training person would work with the officer in charge of the swimmers. So it was a very regimented way of dealing in a military environment.

JOHNSON: You mentioned last time it was the same ship for Apollo 11 and then again with [Apollo] 12. Did you work with the same divers and the same personnel?

STONE: We did on [Apollo] 11 and 12. It was the same UDT team that recovered the spacecraft, so, of course, the second time it was easier. It was the same deck officer that was responsible for our accommodations in the hangar deck, and it was the same captain of the ship. It was Captain [Carl J.] Seiberlich on 11 and 12. He just recently passed away, and some of the folks that were on Apollo 11 and 12 actually went to his memorial service at Arlington [National Cemetery, Arlington, Virginia].

JOHNSON: So the relationship while you were working with the DoD personnel, obviously you got close to them, living in close quarters for two or three weeks at a time.

STONE: Yes, and oftentimes we made friends that became lifelong friends from those events. I still keep track of a couple of the young officers that were on board ship when I was. Of course, they're not young anymore. They're in their sixties just like I am.

JOHNSON: Being from Texas, when you first started in Landing and Recovery, was this the first time you were exposed to being on ships and boats and that sort of thing?

STONE: I had been on small boats. I'd been out in the Gulf [of Mexico] fishing often with my father. But I had never been on a large ship at all, and so it was just a great adventure for a twenty-three-year-old.

JOHNSON: I just wanted to ask a question about when you first joined NASA. There was something in some of the research [about] qualification tests for recovery engineers. Back in the

late sixties when you joined, you went to Carswell Air Force Base in Fort Worth [Texas] for a high-altitude chamber qualification test?

STONE: Actually, by the time I came on board in 1967, we had an altitude chamber here at NASA. It had been installed at NASA. So I didn't go to the one at Carswell. I did my altitude chamber runs here at JSC [Johnson Space Center, Houston, Texas].

But the early folks did, and that was just to—when we were going to fly on military aircraft, there was a requirement to understand high altitude or relatively high altitude hypoxia event, if you had a depressurization of the aircraft. It's not like an airliner where the little oxygen mask flips down. You had to take some specific action to get to where there was a walk-around bottle to breathe, or you were going to be unconscious when they got down to altitude. Of course, you'd probably revive. But we all went through that training, because we were going to be flying on military aircraft.

JOHNSON: If you'd like, let's move on to Apollo 13 and talk about your assignment for that mission and if you were on a ship, and, then, of course, after the accident and what role you played during that.

STONE: Well, I was still a part of the Mobile Quarantine Facility team on Apollo 13. I was one of the folks who was going to operate the outside of the trailer. I believe Buddy [Ralph H.] Culbertson was the engineer that was going to run the trailer from the inside and be in quarantine with the crew. We deployed out of Hawaii with the Quarantine Facility, and I believe that was the USS *New Orleans* that we were on for that flight. We sailed into the South Pacific, and the

period of time before Apollo 13 launched, we were going through our normal training exercises with the Navy divers.

This was a different dive team, a different helicopter team, so there was some amount of restart on the training that we had to do. And we were getting to know a new ship, understanding its idiosyncrasies on using its power and making sure the trailer operated well in that shipboard environment.

Once Apollo 13 launched, it felt just like a normal flight. The daily routine on a Navy ship, until it comes time to work on the recovery, there's four highlights of the day, breakfast, lunch, dinner, and the movie. Just looking back at it, most of us don't remember exactly what we were doing when unless it's a major event, and Apollo 13, when it was declared in danger, was one of those events where you remember exactly where you were. For us on board the ship, we were way out in the Pacific Ocean and several times zones away from Houston.

So we were eating dinner, or had finished dinner and were in a movie in the wardroom when the captain of the ship called all the NASA people to the CIC, the Command Information Center, where we did all of our briefings and things, and we were told that there was a problem. A movie as bad as this one was you would never remember, but the name of the movie was *The Green Slime,* and to this day I remember the movie. I actually bought a copy of it. I found a copy of it in a video store several years ago, and I said, "Well, I probably will never watch it, but this is a really good souvenir," so I've got it with my Apollo 13 stuff. So that's what I was doing when we were told.

Of course, we felt quite helpless, being so far away. We couldn't participate in any of the planning to get them home safely. The only thing we could do is work with the Recovery Control Center back in Houston to make sure that we were positioning the ship resources and the

aircraft resources in the most optimum place for return. Of course, for a couple of days when they were outbound and were going to go around the Moon, it was really unknown what part of the ocean they were going to land in, because they'd had some trajectory disturbances with the explosion of the oxygen tank, and they had been unable to do the precision tweak burns that we do to be right on target to land close to the ship, just because everything was turned off in the Command Module.

But in the two days coming back, where they were really getting good radar tracking, we could determine better where they were going to land. We repositioned the ship and the aircraft assets to be in what we hoped was the most optimum place for Apollo 13. And then we were just as nervous as everybody else, probably more so, because we couldn't contribute in the [Mission Operations] Control Center. So we were just waiting.

The morning that Apollo 13 reentered, we actually, on board the ship—if you saw the movie, there was a long period of time where they didn't hear. We actually saw the spacecraft and the chutes before the Control Center got the crew on the radio. We were trying to tell them we had them in sight, but the communications delays—I don't know whether we got to them before they really got radio voice with the crew or not, but it was close, because we were trying to tell them we saw them with three good chutes. But that was just an amazing feeling to see this spacecraft float down, and we got to it with the swimmers, and clearly the crew was physically and emotionally spent.

They recovered very quickly once we got them on board the ship. Fred [W.] Haise [Jr.] was the crewman that had suffered the most. He actually was ill by the time he got back, suffering from an infection, and he went straight to sick bay. But the other two crewman, [James A.] Lovell [Jr.] and [John L.] Swigert [Jr.], within thirty minutes they were bouncing around on

the hangar deck, looking at the spacecraft, and they actually had dinner with the officers that night and we had a big celebration. Fred didn't feel like coming, so he was still in sick bay. But the other two guys were doing great.

But being part of the quarantine team, we really didn't have anything to do since they didn't go to the Moon, other than help the other guys with the spacecraft deactivation and the work that we normally do to make the spacecraft safe to take back to shore. We did provide all of the personal com [communications] for the crews. They did get to talk to the President, like they did on [Apollo] 11 and 12, and then we set up personal com for them so they could talk to their families through our communications gear in the quarantine trailer. It gave them a private place to go and to be able to talk to their families.

JOHNSON: That was quite an experience to see firsthand.

STONE: Oh, it was. It certainly was.

JOHNSON: After Apollo 13, what was your assignment on 14? Were you again on the prime ship?

STONE: No, I actually was not. I did not go out anymore after Apollo 13. I started a transition to the world of flight control. I had moved into the Flight Control Division and had begun training as a Guidance Officer for the follow-on Apollo missions. By the time the program was cancelled, I had served two planning shifts, or off shifts, in the Control Center as a Guidance Officer.

So I did not go out anymore after Apollo 13 on a recovery ship, though I did get deployed on Apollo 14, associated with a scientific experiment where the Ames Research Center [Moffett Field, California] was doing a study on supersonic shock waves in near-space environment. So we actually went out and got underneath the flight path of the Saturn V on [Apollo] 14. When it got up very, very high, we were trying to measure the shock waves that were being generated at very, very high altitudes.

We were on an oceangoing tugboat called the USS *Grasp*. It's interesting, because I saw a thing on the Discovery Channel the other day. The USS *Grasp* is still in existence as an oceangoing tugboat for the Navy.

But that's where I was for the launch of Apollo 14 is about forty miles offshore, watching this thing fly overhead, being real quiet so we could listen for shock waves with these real sensitive microphones. That is the only Apollo launch that I ever got to see was Apollo 14, because 15 and 16 and 17, I was training in the Control Center and was unable to go to a launch down at the Cape [Canaveral, Florida].

JOHNSON: What brought about this transition to Guidance Officer?

STONE: Well, it was clear that we had done all of the prep work for doing recoveries at sea, so the need for the design and the test groups was rapidly falling off. So instead of a hundred people, we needed about thirty to forty people to deploy on the ships, and we didn't need the other organizations in that division.

The division was actually disbanded, and they started moving the people into other disciplines. About forty people stayed on to fly out the rest of the Apollo Program, and then, of

course, we did Skylab and ASTP [Apollo-Soyuz Test Project], but it was this smaller group of people. So the division had been disbanded, and it actually became a branch in the Flight Control Division to finish flying out the use of the Apollo Command Module.

Because of my background in aero [aerospace], I was really anxious to get on with something that was more aligned with my education, and the guidance position in the Control Center was a good place to be. It was just kind of a random selection. I thought it would be good, and so did they, and they were shorthanded, so that's how I started down my path as a Flight Controller.

JOHNSON: If you will, talk about that early training as a Guidance Officer and what that entailed, and, as you said, you were involved in the planning shifts, and those last Apollo flights.

STONE: The training program was becoming more and more sophisticated as we went farther and farther into the program. It started out, a lot of it was just you worked on the system, became an expert, and you kind of learned as you went in the Control Center. By the time I started the process, they did have a number of training manuals that were designed for the specific positions in the Control Center. I went through that self-training using the manuals, and then I started doing simulations with an experienced Guidance Officer, learning how to use the tools in the Control Center and learning the spacecraft better and better. So it was really an on-the-job training and working in that area, building procedures and working on malfunction procedures that we kept doing right up until the last Apollo Command Module flew. I'll bet we redid and got smarter every flight, and redid procedures nearly every cycle. So that was how we went through the training process.

I guess one of the funny stories that I like to tell people, typically the training path for a Flight Controller is to start in the back room, where they're responsible for looking at a specific data screen, learning everything there is about the discipline, and consulting with a senior Flight Controller in the front room that actually talks to the Flight Director and is the primary interface. But my boss called me in and said, "Hey, we want you to start training, and we've decided that you probably aren't smart enough to be in the back room, so we're going to make you a front-room operator."

I did have the ability to communicate fairly well, and that was kind of a leg up on some people. I had the ability to look at lots of data and boil it down. So I got the opportunity. They had plenty of back-room people in the guidance area that truly did not want to go to the front room. They just wanted to be the data folks and the analysis folks, and so in the guidance area they were actually shorthanded for people that could take it, boil it down, and talk to somebody else about the problems and the solutions.

So I got an opportunity that a lot of people didn't get to have, where I didn't go through that two or three years of training in the back room. And it may not have been an opportunity. It may have been, "Hey, I got shortchanged in my training." But it finally all worked out.

JOHNSON: If you will, just talk about that position in the Control Room itself, and where you were located and who you worked with during those missions.

STONE: Okay. Well, the Guidance Officer was part of the "trench", and I'm sure you've had Flight Dynamics Officers, FIDOs, and other people that were in the trench talk about the tradition of the trench where, hey, we were the guys that were really in charge and knew it all.

So there was a little bit of rivalry from the front row, which was the trench, and the folks up in the back of the room.

The Guidance Officer was the person that actually commanded the Command Module computer and uploaded state vectors and burn targets and that sort of thing. Things that the Flight Dynamics Officer computed, we were responsible for getting on board, making sure it was in the computer properly and cycling proper in the computer. The Guidance Officer was responsible for all of the onboard computer system for the Apollo Command Module, and so it kind of spanned a lot of positions, because the computer operated the engines and actually ran the guidance software. It kind of cut across all the various systems. So it was a great place to learn about the spacecraft and to be a part of that.

The last two flights, because my training was moving along okay, but I wasn't ready to be the guy that flew launch or the guy that was responsible for configuring the spacecraft to return or go to the Moon or that sort of thing. I did a lot of shifts at night when the flight crew was asleep. But it was a great experience to be part of the history of the Control Center and learning more and more about the discipline. Because even though we weren't going to go to the Moon again after Apollo 17, the Command Module was going to be the principal transport vehicle to orbit for Skylab and then the Apollo-Soyuz Project.

After Apollo I became one of the Guidance Officers that did ascents, that did rendezvous in Skylab, and then I was the lead Guidance Officer that did all of the flight integration work for that position for the Apollo-Soyuz Project. So it was a great transition from riding ships to being in the Control Center.

JOHNSON: If you will, go ahead and discuss a little bit about the Skylab missions and the simulations and how you trained for that, and your duties during those missions.

STONE: Okay. The first Skylab launch was an unmanned launch, and, of course, since there wasn't a Command Module, we weren't there. But that put up the lab and started the process.

One of the things that NASA had never done, leading up to Skylab, was continuous operations in space, and so we had a lot to learn about twenty-four hours a day, seven days a week, forever and ever type operations. There were going to be some of us that were going to do those things all the time, and then there were going to be some of us, like Guidance Officers, that we operated the Command Module up through rendezvous, and up through power-down once it got attached to Skylab. Then once a week we came in, and the crew powered everything up, and we looked at the ship, and then they powered it down, and we went away.

So the guidance position was really a cool position in Skylab, because we weren't there seven days a week. We were there once a week. We were there when they did EVAs, Extravehicular Activities, going outside, because we had the Command Module powered up as an emergency lifeboat if something happened while you were doing that. Anytime there was a critical operation, we powered the spacecraft up, and a couple of times we actually used the Command Module to reorient the Space Station to desaturate its CMGs [Control Moment Gyros], the big rotating gyroscopes that they use to hold its position. So we came in just for special events.

Unfortunately, a lot of those special events were Christmas, New Year's, Thanksgiving. So I think the guys that were there twenty-four hours a day, seven days a week, scheduled these special events so the other guys who had it so good had to come in on holidays.

On the first manned mission, it was the first launch that I participated in as a Guidance Officer. I did that with Ken [Kenneth W.] Russell. He was the lead on that flight, and then I actually took over after we had begun the rendezvous to finish the rendezvous with Skylab. Then the next two manned parts of the Skylab mission, I was the Guidance Officer for ascent and entry for those missions.

JOHNSON: Before the launch of the first Skylab, it was almost delayed because of some of the software, and they had to speed up that development. Do you have any memories of that?

STONE: We did have some involvement in the Skylab software. Most of that Skylab software development was a Marshall [Space Flight Center, Huntsville, Alabama] activity, not a JSC activity. But we had a number of interfaces between the Command Module software and the Station for flight control system. So we did a lot of simulating working those interfaces when they were trying to speed up the development. But I was not a part of that development team at all, other than the fact that we simmed with it and figured out what wasn't working and what was working.

JOHNSON: Did you have any involvement during SMEAT [Skylab Medical Experiments Altitude Test]?

STONE: No, none at all.

JOHNSON: You mentioned that you would be there for the rendezvous and then you would go away and then come back every once in a while. What were you doing in between, on those times when you weren't on duty in the Control Center?

STONE: Typical office work; following the mission and then working on planning for the next mission.

JOHNSON: Is there anything about Skylab that you'd like to mention that we haven't talked about?

STONE: Well, it was interesting, quite interesting for me. I had gotten married just before we started Skylab. My wife worked at NASA, and she was one of the teleprinter operators for Skylab, the person that put together the messages and shipped them up. Skylab was the first mission that we had that we had like a teleprinter. It was not as good as a fax machine, but it was how we communicated with data, written word, with the crew. It always seemed like we were—when I was doing shift work in the Control Center on the Command Module, she was always on a different shift, and so several weeks in a row we'd kind of pass in the night as we were working odd shifts. It made me absolutely certain I did not want to be a shift worker forever, for long period of times.

JOHNSON: Yes, it could be a little difficult on a marriage even after you've been married a while.

STONE: That's right. That's right. But I guess the two most memorable things was the first manned flight with Pete [Charles Peter] Conrad [Jr.] and the work they did to save the Skylab vehicle, because it was wounded seriously during the ascent, losing one of the solar arrays. Without the incredible design team on the ground that built the solar heat shield and the work of Pete and his crew to get all that installed, we would not have had a Skylab mission. It was an amazing engineering feat, both on the ground and in space, to make all that happen.

JOHNSON: Did you stay in that area? I think you said you stayed in it for Apollo-Soyuz, also. What were your duties during that time?

STONE: Yes. Well, when we were getting ready for Apollo-Soyuz, it was an interesting challenge. Obviously, we knew how to operate the Apollo Command Module, but we were going to have to interface with the Apollo-Soyuz docking module. We were going to have to rendezvous and dock with a Russian spacecraft. So the procedures and the interfaces that we had to develop with our Russian counterparts were extensive and really made that flight complicated from the standpoint that there was a language barrier; there was kind of a distrust of each other. We certainly didn't trust them. They certainly didn't trust us. And in the Russian culture, you have to build that one-on-one trust before you can get anything done technically, and that was a big challenge.

We had a number of Russians come here, and a number of us went to Moscow [Russia]. I did not have a direct counterpart on the Russian flight control team, so I never went to Moscow during ASTP. But I helped build all of the procedures that we were going to use to interface with them when we rendezvoused and docked. So there was a lot of iteration of changing

procedures and building procedures and simulating with the Russians to get to the point that it was really safe to fly the Apollo-Soyuz mission.

I was the Guidance Officer for the launch of the Command Module going to dock with the Soyuz, and I was also on console for the docking with the Soyuz spacecraft. So it was neat to be part of history. Then it just seemed like, "Boy, this is hard work, working with the Russians." And "I hope we don't ever have to do it again," was kind of my thought. Little did we know that here nearly twenty years later we would be building an International Space Station with the Russians, and that interface that we built back in Apollo-Soyuz was very, very important.

We'll talk about it when we get to Space Station, but some of the people that in Russia that the Americans worked with on Apollo-Soyuz were the same people that we worked with at the beginning of Space Station. Russian engineers in their space program seldom ever change positions. They did the same thing their entire career. If they were a structures guy, they were a structures guy forever. If they were a Flight Director for Apollo-Soyuz, they were still a Flight Director when we got to flying Space Station. So it was very interesting. Many of the names I recognized when I started working Space Station, and yea, verily, they were the same people.

JOHNSON: You mentioned that some of the Russians came here, and you didn't have a direct counterpart, but you did have dealings with as far as some interaction?

STONE: Some interaction, but for me not very much.

JOHNSON: You were on console when the actual docking took place. Can you just describe that time for us?

STONE: Yes. You know, Apollo-Soyuz, the crew was a pretty unique crew. General [Thomas P.] Stafford was the commander. "Deke" [Donald K.] Slayton was the Command Module pilot for docking, and Vance [D.] Brand was the Command Module pilot for deorbit and entry. So everybody was going to get to do something, so it was an interesting cockpit management, I'm sure, for General Stafford and the crew, because here are three experienced crewmen, and even though it was Deke Slayton's first and only flight, Deke was probably the most experienced astronaut of the bunch. He had trained and trained and trained and trained, and had been head of the Astronaut Office. So he was just as much a commander of the vehicle and people as General Stafford, so I'm sure that was an interesting interplay.

But Deke was the Command Module pilot that did the rendezvous and docking and actually flying the ship right up close. Watching the docking, the Russian hardware really expected a small amount of delta V to force it together for us to dock to it, and looking at the final phases, comparing it to the way we fly a Shuttle up to the Space Station today, it looked pretty scary, because the closing velocities, though not high, were definitely you could see them coming together much more rapid than you see in a Shuttle docking. I think Deke was always afraid he was going to bounce off and not make a good interface, so right at the last minute he kind of punched it, and it was a fairly significant whack.

Those of us in the Control Center that were looking at the velocities kind of took a big gulp, and we were really relieved when the crew said they had capture and the latches were latching. We were wondering if something was going to be broken. But, it was completely within the acceptable parameters of it, it was just on the high end, and there was a pretty good

bump. If you talk to them today, the crewmen that are still with us, they'll tell you it was a pretty good bump when they docked.

But it was exciting to dock with a Russian spacecraft and know that it was—this was one of those things that isn't going to happen very often, especially with our relationship with the Russians at the time. Of course, it's gotten much better over the years, but then there was a lot of tension, and we knew it was something historical, the beginning of something that might change the world someday.

JOHNSON: After Apollo-Soyuz, did you stay in the same section during that time?

STONE: I went to a group that we started working on Shuttle things, Orbiter things, and the group I was in was a Flight Test Group. We were just kind of struggling to figure out what to do next to get ready. Those of us that had some Landing and Recovery background—and aero background—were in this Flight Test Group that was to figure out what flight test was going to look like for the Shuttle. So we benchmarked some of the big aircraft programs, and B-70 was one of them, the B-52 Flight Test Program, because they were big aircraft, complex aircraft, looking at those flight test programs. We built kind of a "straw-man," here's what you've got to do to test the Orbiter as an aerodynamic vehicle, not as a spacecraft.

So I worked on that for, I guess, about a year, and then it was clear that my background as a Guidance Officer and onboard computer systems might have a better place working in the flight control area for Shuttle on the flight software and the flight computer system. I joined a group that became the Data Processing System Group, and the DPS—the acronym for it was the DPS Officer that was going to be responsible in the Control Center. I went back to work for Ken

Russell, who was my mentor in becoming a Guidance Officer and showing me the ways of the flight control world.

I got heavily involved in the development of the Shuttle software, the flight control software, and the computer system. It was a very unique computer system, in that it had four computers running together in parallel, and then everything divided up between these four computers so you had redundancy for every major thing on the spacecraft that the computers were controlling. So I was on the design team that was trying to help IBM [International Business Machine, Inc.] learn how to run computers in sync and do the same thing at the same time, talk back and forth, and so I worked on that for a number of years until we got close enough that, yea, verily, we're really going to fly on Orbiter.

Then we started building displays to be able to look at the computer system on board the Orbiter. And because of the complexity of the system and the way everything on the Orbiter was tied together through the general-purpose computers, you became—because you were working on the data system—you became somewhat of an expert on everybody else's system, the propulsion system, the reaction control system, the environmental system. Because all of these things fed inputs into the computers and were being talked back and forth in this redundant set. So it was a wonderful time of systems engineering on figuring out how this was really going to work.

We had some really, really good programmers that had put all this stuff together, but making it work was an ops problem, and we spent several years building the display so you could see into the computer system, see all of the systems and subsystems, and how it played together. And then how does the crew interface with all of this without it being so overwhelming that their workload is too high to be safe? That was a real challenge, because this was the first

time we had so much data in one place we were actually overwhelming the flight crews with data. So that was an interesting time, turning data into information on displays and working the crew interface for the Shuttle cockpit.

Then once that all kind of started coming together and it was clear we had to establish some leads to get ready to fly the first flight, I was assigned as the lead to do ascent for the data processing system. Darrell [E.] Stamper was assigned the lead to do all the entry things. Then he and I were just going to—STS-1, the first Shuttle mission, was going to be a short mission, and we were just going to leapfrog each other. I'd work a ten-hour shift and go away and then come back and do the next planning shift, and then he'd take over and do entry. So it was only a fifty-some-hour mission, so there were only two of us that they did have a planning shift guy in there someplace or a second-shift guy. Now, I don't remember who it is at this point.

But getting ready to fly the first ascent and getting ready to fly the first entry was arduous. The simulator didn't work very good in the beginning, and we'd fly part of an ascent, and the simulator would break. We'd fly a full ascent, and then we'd debate for two hours whether it flew it right and we were getting the right data and the flight dynamics were right and this, that, and the other. So the early simulations for the first flight of the Orbiter were difficult, because you didn't get much accomplished in an eight- or ten-hour day.

But by the time we got that working smoothly, and before we launched the Space Shuttle the very first time, those of us on the ascent did over a thousand ascent runs. So we had seen what we thought was just about every kind of failure that you could imagine and knew how to deal with it. So we were fairly confident we knew how to operate the vehicle. We weren't real confident what the vehicle was going to do for real during ascent. So as we got closer and closer

to flight, and the simulations ran better and better and had higher and higher fidelity, we started realizing that there are a lot of things that can go wrong that will keep you from getting to orbit.

But by the time we got there, we felt like we were extremely, extremely well trained, probably better trained than any other team in the history of the program, at least in the number of sims [simulations] and the number of different failures that we had seen and dealt with during our training period. And that, what I've just talked about, spans a number of years, the development of the software, the learning how to operate the software, building the simulation capability, and then starting to train.

The Mission Control Center was way more sophisticated than it was in the early Apollo days, but it was still very difficult to reconfigure and get new displays into it. So the set of displays we flew for STS-1 started being installed in the Control Center probably a year and a half, two years before we actually flew. During that period of time we learned so much about the system that for STS-2 and [STS-]3 and [STS-]4 there were going to be lots of changes to these displays in the Control Center.

So the Control Center being not very flexible, we'd fly one mission on one floor; get ready to fly the next mission on another floor. So we had two separate software systems, two separate hardware systems. So the way the Control Center was configured was really a boon for us, because we could get ready to fly in one FCR [Flight Control Room**]** while we're working on the next flight in the other Flight Control Room.

But by the time we got to STS-1 we figured we knew just about everything there was to know about the software and how it was going to react; pretty naïve, I might add. But when we started counting down for the first mission, I had a number of people in my back room, Jerry

Canori [phonetic], Bill [William E.] Lychwick, and a couple of others, that were in training that were very, very knowledgeable of the Shuttle primary and backup software systems.

As we came up on the time in the count that the spacecraft needed to go to flight mode—it had been in a preflight mode in the computers up to this point, for the whole countdown, the hours and hours and hours of countdown. But at *t*-minus-twenty minutes we had to reconfigure the spacecraft to a flight configuration, in that we took these four synchronized computers and transitioned them into flight mode. And we transitioned the fifth computer, which was the backup computer, which was completely independent software, into flight mode, and those two computer systems actually talked to share data.

When we came out of the *t*-minus-twenty-minute hold, we had four good primary computers, but the backup computer couldn't see two of the flight control strings in the vehicle. Clearly it was unacceptable to fly your first flight when the two systems didn't match, and then the debate started to rage about, "Can we back out of this and see if it was just some funky phenomenon? We'll transition again, and if everything's okay, can we launch?"

My back room was analyzing the data, and Jerry Canori [phonetic] came up. Everybody thought there was something wrong with the backup machine, and he was my backup flight computer specialist. The other guy that was back there, Jim Hill [phonetic], a guy with a huge amount of experience, even then, he is still a Flight Controller in the Control Center, getting ready to fly his last flight. He's nearly seventy years old; I guess he is seventy years old. But they came to me on the loop and said, "There is nothing wrong with the backup. The problem is with the primary computer system. It's not sending data."

Well, everything is still raging in the Control Center and down at the Cape. All of the IBM experts are looking, and this can't happen. So we all decided that we were going to go back

into the prelaunch mode, which was called OPS-9, and we transitioned everything back to OPS-9. The computers all looked good, and I'm thinking, "Man, if we come out of this hold and it works, am I go to fly?"

I've talked to my back room, and Jerry Canori [phonetic] and Jim Hill [phonetic] and Bill Lychwick all said, "We don't understand it. We don't want to fly today." And we don't know what the Cape is going to do, because we'd been counting down. We'd tried launch, and the first flight had slipped and slipped and slipped. So it was really on everybody's mind that today was a good day to go fly. Beautiful weather.

But I made a decision with the help of the folks in the back room that it is not the right day to go fly. So I got on the flight loop and told Neil [B.] Hutchinson, who was the Flight Director. I said, "Flight, I don't care what happens when we come out of the *t*-minus-nine-minute hold. DPS is no go for launch." And man, you could have heard a pin drop in that room. I mean, it went from a lot of buzz to quiet.

The Flight Director asked me, "Are you sure you are no go for launch?"

I said, "Yes, sir. We do not understand what happened here. If it works this next time, I can't guarantee it's going to work through ascent, and I can't guarantee it's going to work when we bring these computers back alive to do entry. I am no go for launch."

He says, "Boy, I'm sure glad you are no go for launch, because I was, and I didn't have a good reason." [Laughs]

So we did come out and thank goodness, we didn't have to make that hard decision, because it still was a problem. The computers still didn't match up. But that has always been my claim to fame is I was the guy that was no go for launch on STS-1 before we ever found out if it was okay or was going to work when we came out of the hold again. And truly, I believe

that was a turning point in my decision-making process where I was confident enough to say no in an environment when everybody else wanted to say yes.

Shortly after that and after we flew STS-1 successfully—and it took several days to figure out what was wrong with it, and it was, by the way, the primary computer system, just like Jerry Canori [phonetic] said. It was a timing problem that was in the computers. When you brought them up from the mass memory and started them, one in six hundred times or something you're going to get this funny timing problem, and it wouldn't work with the backup machine. IBM fixed it, and we never had the problem again after the first flight. Once we understood it, we were prepared to just recycle the machines and move forward on the next attempt. But after that first flight IBM fixed the flaw in the software so it couldn't happen, and we moved on.

But Dr. [Christopher C.] Kraft, after we landed, came down and told me that the ascent call I made being no go for launch was the right one, and if I hadn't of done it, he was going to come down and slap me around. So I was really glad I had done that. And about three weeks later I got selected to be a Flight Director, so it was kind of an event that was scary at the time, but it actually probably benefited my career as much as anything I had done to that point, as far as recognition was concerned.

JOHNSON: After that flight, and if three weeks later you were selected to be a Flight Director, did you continue working in the data processing system for the following flights?

STONE: I did for two more flights. For STS-2 and [STS-]3 I did the entry. Darrell Stamper and I flip-flopped. He did ascent on [STS-]2 and I did entry on flight 2. Then we flip-flopped again,

and I did ascent on [STS-]3 and he did entry on 3. By that time we had enough other DPS people trained for the front room. We had people working the other shifts, and they were ready.

But I had started already training for the Flight Director position and running what they called Flight Techniques meetings before I ever finished my DPS tour of duty, and was actually, on STS-4, one of the assigned Flight Directors to do what we today—or then—called Team 4. If something happened during the flight, this fourth team would activate with all of the right experts to try to give the on-console flight control team some support. So, flight 3 I was a DPS. Flight 4, I was actually a Flight Director, and I actually flew my first shift as a Flight Director on STS-6, two flights later.

The training program for the Flight Director then was not very regimented. It was mainly based on your previous history of getting ready to be an operator, and then on-the-job training in this Flight Techniques environment was part of your training ground. Today the Flight Director training syllabus is very well documented and has about a six-month flow before you're ready to really sim and get ready for your first flight. In the early Shuttle days we transitioned very quickly from a Flight Controller to a Flight Director. From STS-4, where I had my first taste of getting ready for a flight, to STS-6 was only several months, six or seven months, so it wasn't a lot of training time.

JOHNSON: What exactly were the Flight Techniques meetings?

STONE: Flight Techniques, because every flight was a new flight. Everything we put in the payload bay was something new we'd never done before. So we had to go through an analysis

of, one, whatever the payload was we were going to do, how we were going to operate it; what impacts it would have on the Orbiter.

Flight 4 was interesting. We had a DoD payload in the bay, and we're doing some remote manipulator arm testing and some flight testing on the payload bay doors, exposing them to different attitudes with respect to the sun to look at the physical warping of the Orbiter because of heating. So the Flight Techniques for STS-4 were divided into this payload bay door activity, this DoD payload activity, which had to be operated at the secret level and you couldn't talk about it.

So we had two kinds of Flight Techniques. We had the test Flight Techniques, where everybody could be there. We had the Defense Department Flight Techniques, where we're going to operate their payload. Then we had the Flight Techniques where we were going to do the testing with the RMS [Remote Manipulator System]. We were still trying to understand the characteristics of the Orbiter at that time and do payload operations, so it was a great learning ground for everybody.

We had to build the procedures. We had to understand what these thermal things were going to do to the doors. We had to understand what we were doing with the arm and the loads we were putting on the arm. Very little was known about this arm, using it in space. We'd done a lot of simulations on the ground.

So it was a real flight test program, and that's what Flight Techniques did. It pulled all the procedures together. It made sure that we had identified all the things they ought to analyze. We had looked at the analysis, and we weren't doing anything dangerous. We knew how to recover from things.

We knew we were actually going to put the spacecraft in a position where you could not close the doors, potentially, because there was enough warp that they wouldn't close, and we wanted to demonstrate that you could warp it and then unwarp it by going to a different attitude, and yea, verily, that all came to pass, and yea, verily, it wouldn't close. When we did one of the door tests, it actually hung up, and we had to stop and reopen the doors and reorient the spacecraft to get it out of the banana shape into a straight shape so the doors would close.

That's the kind of things we did in Flight Techniques.

JOHNSON: Before we go on to the first flight, the STS-6 flight, where you were on the first shift, at the end of Apollo and then Skylab and Apollo-Soyuz, the Center itself was going through a lot of transition and getting ready for Shuttle. In the late seventies there were a lot of layoffs and those RIFs [reduction in force].

STONE: Lots of turmoil.

JOHNSON: Lots of things going on. If you can, share some of your memories of that time period as far as the Center was concerned, and the morale at the Center at the time.

STONE: Those of us in Flight Control Division felt like that we had really been somewhat protected from the RIFs because of the formal training program that Gene [Eugene F.] Krantz had put into place; that because of the intensive training programs to get you to the point where you were a Flight Controller, it made you less susceptible to being RIFed, because you had some valuable tools that were costly to re-create later. So our morale was pretty good, in that we

believed that we were part of the core that was going to go forward, though you could see around us some people getting RIFed and that's a very uncomfortable thing.

In fact, when the Landing and Recovery Division was shutting down, they actually went through a RIF and a gentleman in another area that got RIFed was going to bump my position, and I would have been the one that went out the door. Because he had the seniority and the educational background, he could have taken my job. As it turns out, he decided to retire, and I didn't get RIFed. So I went through that for a real short period of time, that kind of uncertainty.

But transition from the excitement of Apollo to the little bit lesser activity of Skylab and Apollo-Soyuz—not that they weren't really great programs to work on, but they weren't bigger than life, like going to the Moon. That transition down was difficult for a lot of people, and at that time a lot of people actually left and went to other industries, because they saw it as a better future. I have a number of friends that left at the end of Apollo and worked in the oil patch here, in the chemical industry, the rest of their careers.

So I felt very fortunate that I was on a career path that actually transitioned relatively smoothly from the shutdown of Apollo to Skylab to Apollo-Soyuz, and then I was in the big middle of getting Shuttle ready to go from the software standpoint. So I know all that stuff was going on around me, but I felt very, very secure as long as we didn't lose the funding to build the Orbiters.

JOHNSON: There were a number of other changes going on. For one thing, the [19]'78 class of astronauts came through, and for the first time there were women and minorities involved there, and also women were starting to show up in Flight Control. Do you have any memories of that time period and those transitions?

STONE: Well, of course, the women starting to show up in Flight Control started to happen at the tail end of Apollo. We didn't have any front room operators, but we did have some back room people that transitioned in. We had some front room operators in Skylab, a limited number of women. But by the time we finished Apollo-Soyuz and we were getting ready to go for the first flight of the Space Shuttle, there were women popping up in all of the different disciplines in Flight Control.

Most people, most of the Flight Controllers that I know, especially the ones my age, thought that was great. There was no competitive thing going on. We were just glad that women now felt comfortable sticking to the engineering curriculum and going out into what had once been almost completely a man's world. No women graduated my engineering class in 1967, zero. So I thought it was a good thing. And, of course, the women astronauts that they selected were outstanding individuals, easy to work with, as capable as anybody that had come before them in their own disciplines.

So that transition, to me, did not cause any problem. It probably caused more difficulty in the astronaut corps itself than it did outside in the other disciplines, because the astronaut corps at that time was still almost 100 percent fighter pilots, and "women didn't belong in the cockpit" type folks. I mean, it changed. There's still probably some strain there a little bit, but that transition has gone as well as one could expect, I guess.

But I guess my claim to fame on women in the Control Center, I was the first Flight Director that had more than one woman on his flight control team on a given shift, and that was on STS-6. I actually had three women in the Control Center on the front room flight control team for that flight, so it was kind of unique. Mimi [Cheevon B.] Lau was my Flight Activities

Officer, and that was the first time we'd had a woman in that key position of FAO in the Control Center. I didn't think anything about it, but it got quite a bit of notoriety at the time.

JOHNSON: All the Flight Directors got to pick a color. What was your color and what was the reason behind picking it?

STONE: Well, by the time I became a Flight Director, there weren't a lot of good colors left. We had one of the historians of NASA, Bob [Robert D.] Legler. I don't know whether you know Bob, but if you haven't had him come through on the oral history, you really need to have him do that. He was kind of the local historian. He sent out a note to us new Flight Directors. "Here are all the colors that have been used, and here are all of the other options that you may have."

Well, he called me up personally, and he says, "You need to be infrared flight." I thought about it a minute, and the acronym, IR, IR flight, I decided that wasn't good. Fuchsia didn't sound like a good color. The good [University of Texas, Austin, Texas] Longhorn Pete [M. Peter] Frank had already taken orange, and, you know, red was gone. White was gone. Black was gone. Green was gone. The primary colors were all used, and so as I'm looking through the list, I decided on amber, and probably for no other reason than it sounded okay.

I didn't want to be yellow flight. That one has never been used, by the way. I don't think there's a yellow flight. I don't think so. It implies unpleasant things. But amber just seemed like it was still a color, and it didn't have any connotation that I was worried about. So I picked amber flight, so that was my team name. Then after that people started picking rocks and stars and stuff, so we've gotten away from the colors by necessity.

JOHNSON: You just ran out.

STONE: Just ran out.

JOHNSON: Well, speaking of running out, I think we're going to need to change our tape.

STONE: All right.

[End of interview]