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ORAL HISTORY TRANSCRIPT

BRYAN D. O'CONNOR
INTERVIEWED BY SANDRA JOHNSON
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JOHNSON: Today is April 20th, 2006. This oral history with Bryan O'Connor is being conducted for the Johnson Space Center Oral History Project at NASA Headquarters in Washington, D.C. It is a continuation of his first interview on March 17th, 2004. Sandra Johnson is the interviewer, assisted by Rebecca Wright.

I want to thank you for joining us again today. The last time we talked, we ended at the time of the [Space Shuttle] *Challenger* [STS 51-L] accident, and you were actually on your way to California for a hometown visit. You had stopped in El Paso [Texas] when you heard the news, so if you can start there and talk about what you did immediately after that and some of your duties right after the *Challenger*.

O'CONNOR: Well, of course, when I saw what happened, and they were replaying it on the television in the Operations Building there, I called back home to Houston [Texas] to my office and cancelled my flight plan; revectored my flight plan to go back to Houston. Called out to California and told them I was calling off my visit and went back to Houston.

Almost immediately after I got back, I was asked to go directly to the Cape [Canaveral, Florida], I think it was by George [W. S.] Abbey, or maybe somebody else, but I think it was George, who was looking for how the [Astronaut] Crew Office could help some of the immediate activities going on.

There was a fellow named Lou Ullian from the Range Safety Office at the Kennedy—actually, Air Force side of Cape Canaveral, who was a Shuttle Range Safety person, and who was assigned to the task of trying to see if this was an inadvertent range safety destruct that had just happened to the Shuttle, if somehow the destruct package on the tank or the solid rockets had blown up. So he was doing some analysis, and he also went down to the pier. Shortly after I got there, the next day I got there, I went down to the pier with him to see some of the things that were coming back from the ships that were out collecting debris off the water. That started almost immediately.

I remember there was a Coast Guard cutter that came in and had some pieces and parts of the external tank, and one of these ships—and it was on the second or third day, I think—one of these ships actually had a piece of the range safety destruct system from the external tank, intact for about halfway and then ripped up the other half of it. When he looked at that, he could tell that it hadn't been a destruct. It was damaged due to the tank tearing up or hitting the water, but it hadn't been an inadvertent destruct. So when he saw that, he realized, "Well, if this one didn't blow up, then none of them did," so there was some relief there within a day or two of what wasn't the cause of the accident.

Right after that, if I remember right, I stayed down at the Cape and talked with the people who were working the recovery efforts. They needed somebody to help them set up a place where we could reconstruct the vehicle, and I was assigned the task of working that issue. So I worked with [NASA] KSC [Kennedy Space Center, Florida]. We had a Project Manager assigned from KSC—I wish I could remember his name now; I can't—and he and I worked this.

Now, the reason I was on it is because I was a trained accident investigator, and people knew that. I had volunteered that, and they said, "Great. He's been to the accident investigation

course. Maybe he can help us set this up." And that's what I did for several days. I remember we put tape down on the floor. We got a big room in the Logistics Center. They moved stuff out of the way. As time went on, the need increased for space, and we actually ended up putting some things outside the Logistics Center, like the main engines and some of the other things. But the Orbiter pretty much was reassembled piece by piece over a period of time as the parts and pieces were salvaged out of the water, most of them floating debris, but some, I think was picked up from subsurface.

What started off as just a few ships ended up as a big fleet of ships. They had quite an operation there. It was one of the biggest salvage efforts ever is what I heard at the time. They had underwater robotic camera vessels. They had Navy and Coast Guard vessels, unmanned submarine kind of things, and all kinds of stuff that was put into effect. Over a period of time, we were able to rebuild quite a bit of the Orbiter, laying it out on the floor, and in some cases, actually putting it in a vertical structure. Like the forward fuselage, for example, we tried to make a three-dimensional model from the pieces that we recovered there.

Again, the idea originally was to see if we could find some smoking gun that would give us a clue as to what the cause was. After a while the rational became what was the effect, because it was through the photography activities that Dan [M.] Germany was heading up down there [in Houston] that they were able to see and put together the story of what happened. It was the photography that showed them the plume coming out of the solid rocket, the smoke right at liftoff, and then the plume as they climbed out. The photography of the breakup and then the pieces falling, they were able to do a lot of good photo analysis of that and put the story together pretty well.

But we still wanted to continue with the activity in the Logistics Center to see what the effects were on the various parts of the Orbiter and so on. So that took up my immediate time shortly after the accident happened.

JOHNSON: How long were you there?

O'CONNOR: Seems to me it was several weeks. Then I remember that two weeks after the—well, actually, it was a few days after the accident, Dick [Richard H.] Truly and the Acting Administrator [William R. Graham] were down at KSC. Again, because I had accident investigation training, they had a discussion about what's the next steps here. We have the immediate actions going on. What about the mishap investigation procedures, the [mishap] board—should we put a board together—and sort of the process that we had laid out in our policies on major accident investigations.

The Acting Administrator, it turned out he was very reluctant to put a board together, a formal board. We had an Accident Investigation Team that was assembling; eventually became under the cognizance of J. R. [James R.] Thompson [Jr.]. We had a bunch of subteams under him, and then he was reporting to Dick Truly. But we never called out a formal board, and I think there was more or less a political feel that this is such high visibility that we know for sure that the Congress or the President or both are going to want to have some sort of independent investigation here, so let's not make it look like we're trying to investigate our own mishap here. And that's why he decided not to do what our policy said, which is to create a [mishap investigation] board. We stopped short of that.

Then two weeks after the accident the board, which became known as the Rogers Commission, was in place. It was probably sometime in the middle period, maybe a week later or a week and a half, that the President decided to do it, and they called the people together and assembled the members of that board. But I remember the board itself started officially about two weeks after the accident.

At that point, as they began to start their work and the first two or three weeks of their work was more or less organized and trying to get started and figuring out what they wanted to do, it became obvious to Dick Truly that we were going to need a good interface between NASA and that board up at Headquarters, because the board decided to do their investigation in Washington, or at least to have their board centered there. So Dick decided that the thing to do would be to create a mechanism for this external board to get NASA information and to field requests.

So he wanted to set up an action center here in Washington. Again, he asked me, "Okay, thanks for doing all that stuff down there at the Cape. Now I need you to come up here and set up an action center." So I set up for Dick Truly an action center up here [in Washington]. Took about a week or so to get that started, and I'd say by the time that we were six weeks or so after the accident, we had an action center that we had set up.

I had a couple of folks that he gave me. We put it in the area of what was called Code M, the Office of Space Flight. They created a room for me, cleared out all the desks and so on. We put a bunch of status boards; very old-fashioned by today's standard, when I think about it. It was more like World War II's technology. We had chalkboards. We had a paper tracking system, an IBM [International Business Machine] typewriter in there and so on. It all seemed so ancient by today's standards, virtually nothing electronic.

But it was a tracking system for all the requests that the board had. It was a place where people could come and see what the status of the investigation was. We had telecons [teleconferences] every day where J. R. Thompson would call all his team members and us, and everybody would report in, what they had done, where they were, where they were on the fault tree analysis that we were doing to *x* out various potential cause factors. I remember the action center became more than just a place where we coordinated between NASA and the blue-ribbon panel. It was also a place where people could come from the [Capitol] Hill or the White House. We had quite a few visitors that came, and Dick Truly would bring them down to the action center to show them where we were in the investigation. So it had to kind of take on that role, too, of publicly accessible communication device.

I did that job for some weeks, and then we rotated people. [Admiral Truly] asked that George Abbey continue—George had people available now that were not going to fly anytime soon, so he offered a bunch of high-quality people, and I was replaced by, I think it was, Bonnie [J.] Dunbar, and then she was replaced by Sid [Sidney M.] Gutierrez, and we just had a rotation going of people coming up and manning that action center.

So shortly after I was relieved from that, I basically got out of the investigation role and into the "what are we going to do about it" role, and was assigned by George to the Shuttle Program Office.

Maybe this is a good time to stop if you've got other questions.

JOHNSON: Well, actually, that's the next one I was going to ask you. In March of [19]'86, that's when you became assistant to Arnie [Arnold D.] Aldrich and you were also the Chairman of NASA's new Space Flight Safety Panel.

O'CONNOR: Now, that one came a little later, but early on when we were working with the blue-ribbon panel and then reacting to their report—which was at about six months, I think, their report came out. I had moved. I was relieved of my job on a crew right away. I think they called it [STS] 61-M, which was a mission I was assigned to right after I got back from [STS] 61-B. In fact, before the accident happened I was reassigned. I can't remember who all the members were, but my officemate, Sally [K.] Ride, and I were both assigned to that same mission, 61-M.

Of course, when the accident happened, all that stuff became questionable and we stopped training altogether. I don't think that mission ever resurrected. It may have with some other name or number, but the crew was totally redone later, and two of us got other assignments. Of course, Sally was assigned to the blue-ribbon panel.

My assignment, longer term assignment after the initial things I just told you about, was to go over and be Assistant Program Manager for Ops [Operations] and Safety, I think is what my title was. I was actually assigned to Dick [Richard H.] Kohrs, who was the Deputy Program Director, or by today's terminology, he was the Program Manager. I was his assistant, and he gave me several tasks to do, including coordinating how we were going to respond to a couple of the major recommendations that came out of the blue-ribbon panel.

They had ten recommendations, and one of them had to do with how to respond to the silent safety program recommendation, how to restructure and organize the Safety Program at NASA. Another one—and I had some workings in that. Then the other one was about wheels, tires, brakes, and nose wheel steering. It was all the landing systems. Now, that may sound strange, because that had nothing to do with this accident, but the *Challenger* blue-ribbon panel

saw that, as they were looking at our history on Shuttle, they saw that one of the bigger problems we were addressing technically with that vehicle was landing rollout. We had a series of cases where we had broken up the brakes on rollout by overheating them or overstressing them. We had some concerns about automatic landings. We had some concerns about steering on the runway in cases of a blown tire or something like that. So they chose to recommend that we do something about these things, put more emphasis on it, make some changes and upgrades in that area.

I was assigned that action to coordinate, so I spent an awful lot of my time over the next couple of years, really, working on those things. I had the honor and the pleasure of working with Scott Crossfield, who was one of the X-15 guys and early contractor experimental test pilots working with NASA. I think he was a Rockwell, North American Rockwell [Corporation] guy, and had a long history at [NASA] Dryden [Flight Research Center, Edwards, California] as part of that activity in the early days. It turned out he was assigned by the staff of our oversight committee, House Science Committee, to help them with the congressional investigation of the accident.

A lot of people forget that we didn't just have the blue-ribbon panel, Rogers Commission, but we had a no-kidding, formal congressional investigation of that accident, and he was the guy they assigned to do the same thing I got assigned to do for the program, and that is look at the wheels, tires, and brakes, landing rollout issues. So I got the chance to work with him very closely in surveying what it was we were doing at NASA and coming up with a plan on how to address those issues. It was a real treat for me, because he's a renowned, crotchety old guy that questions everything and is smart as can be; knows everything about aerospace, and I learned a lot from that little detail I had.

I'm thinking of that because his picture was in the paper today.

JOHNSON: That's what we heard.

O'CONNOR: Yes. But anyway, that's pretty much what I was involved with. One of the actions that came out of the blue-ribbon panel was to create a separate Flight Safety Panel, so that was the third thing that I got to work on. I was asked to be the first chair of the Space Flight Safety Panel, and that was our answer to that particular recommendation of the blue-ribbon panel.

What we did was we said we'll have an experienced astronaut chair it. We'll have a Flight Director from the Johnson Space Center [Houston, Texas, JSC] MOD [Mission Operations Directorate]. We'll have a Launch Director from Kennedy, and we'll have a Mission Manager or a Project Manager from [NASA] Marshall [Space Flight Center, Huntsville, Alabama]. That group of four will be part of the Space Flight Safety Panel for a couple of years, and then they'll be replaced by someone else.

The job of the Space Flight Safety Panel was to be an independent assessment team for the Associate Administrator, for Dick Truly at the time. We had a kind of a dotted line to the Chief of Safety and Mission Assurance for the Agency, but really we were meant to be a special arm and assessment team for Dick Truly at the time. Over time that panel has found itself more or less engaged in independent reviews and assessments, close call investigations, and so on.

Of course, I come back now with the job I have, and that panel still exists. It's got new members, of course, on it, and as recently as a couple of months ago I asked them to go do a close call investigation for me. So I was kind of glad to see that that concept survived all this time, although we're not using it nearly as much as we did when it first began.

It was almost a full-time job for me the first two years. We did audits and assessments and looked at just about everything that was going on that had human flight safety implications. We went around and surveyed people. We worked with the Code Q [Office of Safety and Mission Assurance], which is the old term for this office, to develop the NASA Safety Reporting System, which is still in effect today.

That's the system that people can send in safety issues if they don't think they can get them handled any other way. It's kind of a check valve in the system. Their name doesn't go with it, so it's an anonymous reporting system. But it turns out—I was checking the other day—that system has been used [over] 650 times since we set it up back in I think it was 1988.

So again, I look at that, and I say, "Well, there's something that we helped establish back then, and it is still finding some use." So that's good. I was happy to have been sort of on the front end of something that's found some use in the agency.

JOHNSON: You've mentioned the landing system, and changes were made after things were looked at. What type of changes were made as far as safety was concerned during that time period?

O'CONNOR: Well, there were changes on several fronts. One was people. We found that in our safety organization we had not been very good at rotating people in and out, keeping a fresh look in there; that we had stuck people into Safety and Mission Assurance organization too long. So we decided let's freshen that up every now and then, and let's allow people to move from Safety and Mission Assurance over to Engineering and Ops, and vice versa. So we established something like that. It was informal. It was just the Center Director's discretion, and they did it.

We got some really good people into Safety and Mission Assurance who might not have otherwise had a chance to do that work.

On the products side there were several changes made to the Space Shuttle design. Of course, everybody remembers that we redesigned the solid rocket motors. Not just that one joint that hurt us on *Challenger*, but we looked at all of the field joints, in the nozzle and all up and down the [field joint] design, and made them redundant. And made some other changes in the solid rockets. That became the long pole in the tent to getting back to Return To Flight was all those mods [modifications] that we made to the solids.

We also put an escape system in the Orbiter and changed the escape philosophy for that system to where, for controlled gliding flight, the crew could actually get out; whereas we didn't have that capability before the accident. So that meant that the crew was now wearing much more bulky equipment and parachutes and survival equipment and rafts and all that, and they also had oxygen available. JSC engineers, in-house, designed what we called the pole, which is an extendable pole that would stick out the hatch in flight, and it would allow crew members to get a vector below the wing.

Now, I know a little bit about this one because one of the other jobs I was given was during that time was to co-chair the team that was looking at survival and escape, which was another recommendation that came out of the blue-ribbon panel. A fellow named Al Louviere and I were the co-chairs. He was from Engineering. We had a whole bunch of team members put together to decide how to improve the escape system on the Shuttle.

The one we came up with in the end, after looking at a wide variety of things, was this pole bail-out system. Now, it had its limits. Controlled gliding flight was where it was designed for, but I always thought, and still do, that that escape system is better than that; that if we'd have

had that system on the *Challenger* accident, I think there's a good chance we would have got the crew out, or some of them, anyway, even on that accident, because of the fact that it would have given them a way to jettison the hatch. Even if they didn't use the pole, they could at least jump out [during the 2 ½ minute fall] and have a parachute and oxygen. Of course, they had none of those things on the *Challenger* accident. So that was sort of the changes in safety dealing with the product.

We also made some changes over time—not immediately, but over time we made some extensive changes to wheels, tires, brakes, and nose wheel steering on the Orbiter. I got a chance to, again, following up on those, I got a chance to go fly a lot of simulation and work with the engineers on gains for the nose wheel steering system, how to use it at higher speed. The thing was designed for nose wheel steering to be used only at the very end of the runway, just to sort of line yourself up in the middle [of the runway] at low speeds; never designed for high speed.

But when we had done some work in the simulations, we found that if you blow the tires, especially on a soft runway, or even if you blow one tire, the other one will blow if it happens at high speed, and then you don't have redundancy. If you blow both tires at high speed, you don't have the control authority to keep it on the runway. So this was a big Crit-1 [criticality 1] discussion that we had.

So over time we made a lot of changes. We got it to where nose wheel steering could be used at higher speed. We improved the brakes so they had a lot more energy and wouldn't break up and cause the tires to blow at low speed. Then we also put a drag chute in eventually to help slow down the vehicle. So those were some significant changes.

Then we changed how we're organized. One of the recommendations that the *Challenger* accident board made was that at Headquarters there was no independent safety and

mission assurance organization, although they had a safety professional and a quality professional and a reliability professional in the Chief Engineer's office up here. We had learned from the earlier times at NASA, after the Apollo [1, AS-204] fire, for example, that there needs to be an independence between Safety and Mission Assurance, and Engineering. That independence was pretty much set up at all the Centers, and we had SR&QA [Safety, Reliability and Quality Assurance] offices independently reporting to Center Directors at most of our Centers, but up here in Washington we never did that. So one of their recommendations was to create what became Code Q and the office I'm in now. So that was another structural change that was made.

The other thing they did was change the way the program reports. When the *Challenger* accident happened, the Program Manager worked for the Center Director. They thought that there was a slight risk imposed on the program when you have the Center owning and managing a huge multicenter program like that. The case they made was that it could cause communications barriers, a hesitance for one Center's projects to report to another Center's Program Office, because of Center-to-Center rivalries and that sort of thing.

That was a big part of the investigation when they went to the root cause stuff, and so they recommended that the program be a Headquarters program, and that, although it would stay at Johnson Space Center, the Program Manager would not be beholden to or working for the Center Director, but actually be a Headquarters employee.

They did that for quite some time. They actually held that—that's what I call "host Center" as opposed to "lead Center." So basically what they said is lead Center is not a good idea; go to host Center. It was a configuration that the DoD [Department of Defense] had gone to in the early eighties, and the blue-ribbon panel thought that was a good idea for us to do. It

was also a throwback to how we had done it in Apollo. In Apollo we had host Center. It was basically a Headquarters program hosted at the Johnson Space Center, and they thought that was probably the right way to do things.

So that's a long answer, but it's several aspects of the safety changes we made after the *Challenger* accident investigation report came out. A lot of other smaller things, but those were some of the big ones.

JOHNSON: What was your next assignment then after you were Assistant to [Dick Kohrs]? Was that when you became the Deputy Director of Flight Crew Operations?

O'CONNOR: Yes.

JOHNSON: Okay, well, let's talk about that.

O'CONNOR: Yes, I was given the job of Deputy to the Director of Flight Crew Operations. At the time that job was held by Don [Donald R.] Puddy, who, as you know, has since passed away. I got a chance to get into a little management job, working a lot of personnel issues, dealing with some policies on flight qualifications, currency requirements for our [airplane] pilots. He had me looking at a lot of what goes on out in the Ellington [Field, Houston, Texas] operations. But the pilots that we had out there flying the [Super] Guppy [cargo aircraft] and the KC-135 [microgravity research aircraft], the T-38 training, and all that stuff, he asked me to kind of work some of those issues.

Of course, I wasn't new to that. I'd been flying a T-38 with them for years, and the Shuttle Training Aircraft. But it did allow me to see more of the management side of that and a broader understanding of how they operate, how their engineering, maintenance, quality structure was set up; then some personnel things about getting new people and replacing Joe [Joseph S.] Algranti. I think he left at that time. He had been the chief out there, and we needed a replacement. So that's pretty much the kind of things I worked. Some astronaut-related issues, but I think we had someone else up there in Flight Crew Ops that did most of that. Can't remember who it was now, but mine was a little different.

It was interesting, because Don Puddy came from MOD, and there had been a long love-hate relationship between FCOD [Flight Crew Operations Directorate] and MOD in previous years. So here now we were being run by one of the MOD folks, and in a way, I think it was a healing experience for us, because as far as I could tell, we were getting along great [between] Flight Crew Ops and Mission Ops. So I think that was one of the things that Don probably brought to it, even though he wasn't a pilot, he wasn't a former astronaut, and he certainly was not George Abbey, who had run FCOD for so long.

But he brought a fresh look at things, and I really appreciated how he deferred in certain ways to some of us who had a pilot background [on flying issues]. He didn't try to get involved with too much of that. If we had a pilot that we needed to review something they had done, he wouldn't do that. He'd defer to myself, Mike [Michael L.] Coats, some of the other folks that were in the Crew Office for that. I enjoyed working for Don Puddy.

JOHNSON: During that time period you received your assignment for your next flight.

O'CONNOR: Yes, right. In fact, while I was training for that flight, I was in that job. I think I still had that job when I flew. Of course, after I flew that flight, that's when I left NASA. But I was assigned to STS-40, SLS-1 [Spacelab Life Sciences-1], and began training for that. It turned out it was about two years of training, because we slipped a year while I was there. That mission itself had slipped for many years before I was even assigned to it, and the science crew that was on that flight had been assigned to that mission for quite some time.

The NASA people on it were Jim [James P.] Bagian and [Margaret] Rhea Seddon on the science crew, and then Tammy [Tamara E.] Jernigan and Sid Gutierrez and I were assigned as the Orbiter crew. So we got to see that this is a project that's been going for a long time. These two mission specialists and the three payload specialists, two of which would fly, had known each other and been working with each other and training for many years on this, so it's kind of an unusual mix of new people and experienced people with each other on that crew.

JOHNSON: Well, tell us some about the training and, since it was a Spacelab Life Sciences mission and the first one, and how the crew integrated since they had been assigned for so long, and how that training went, and especially you coming in as the commander after previously being a pilot, how you managed to bring that crew together as a commander.

O'CONNOR: Yes, that was one of the biggest challenges I'd had at NASA was to take on that role of commander of that mission. The technical job of a commander of a mission is a pretty good size pile of work and responsibility and challenge on its own, but here we also had the people-working-together-as-a-team issues that went with this.

There were a couple of things about this that made that a little more unusual or difficult, I think, than it might have been otherwise, one of which was that the two payload specialists who were assigned, one of them became physically ineligible for the flight while we were first getting started in our training as a team together. In fact, I think it was shortly after I was assigned to the mission that [Dr.] Bob [Robert W.] Phillips, who was one of the two payload specialists, had a heart problem and could not pass his physical, and so he was taken off the mission.

Then we brought up his backup, Millie [E.] Hughes-Fulford. Drew Gaffney was the other payload specialist. Now, the three of them had been working for years together, but this was a change in role for Millie, and so she had to get a lot more involved than she had been before when she had been the backup. Sometimes I've thought that Millie and Drew were like oil and water, and it was a pleasant surprise for me when, seeing how they operated or didn't operate together in the office or after the training's done or whatever, to where they would take all that baggage, old concerns with one another's performance or whatever it was, disagreements about the science, and we'd get into the [simulator], and there was none of that. These two trained like two professionals. Yet when they'd leave the [simulator], it was like the Hatfields and McCoys [feud], you know.

That dynamic I had never seen before [on a flight crew], so that was a big challenge for me, because I was a little concerned that maybe that [Dr.] Jekyll and [Mr.] Hyde trick that allowed us to function as a crew and then worry about each other between training periods, I was worried that that might break down sometime, and that maybe we might have a case where we wouldn't function effectively as a crew, and especially how are we going to operate on orbit if this thing gets to where some of these underlying issues they've got with each other bust out when we're trying to get our job done on orbit. So I was concerned about that the whole time.

It was something new for me. I had come from a tradition in the Marine Corps of single-pilot aircraft, not crewed aircraft, so I was probably experiencing some of the things that are normal for bomber pilots or big transport pilots, trying to get crews to work together and that sort of thing. So it was a big learning experience for me.

The crew was diverse personality-wise, so even if I had experience in bombers and so on, we had some personality types that I was not all that familiar with from my military career. I didn't know this at the time, but we had some interesting leadership and communications training that they had set up down there at the time, run by a guy who was an experienced personality profile analyst.

He was one of the guys who was in the medical community, very experienced, former Air Force flight surgeon, and trained psychiatrist, who had degrees in psychology and all these other things. He was a guy who really knew a lot about personality profiles. [You may be familiar with the Meyers Briggs personality profile testing.] That wasn't what he gave, but he gave [us] something like that, and he would use [the results] to help people see how best to communicate with one another, what kind of things drive one personality type versus another.

We had a variety of personality types on our crew. He told me that in the military you tend to have two, maybe three personality types, out of the six, which dominate. That kind of helps you figure out how best to [communicate and] operate in that environment. But when you have a crew with such diverse personality types as we had, then that says you've got to broaden your understanding. You've got to be a little more forgiving of certain things and be more sensitive to other things to communicate properly and to operate as a crew.

We got a whole batch of training on that, which, luckily, was available. They were doing all the crews with it. I think it was an experiment to see if that kind of crew coordination and

communication training based on personality profiles would make a difference. I don't know if they're still doing that down there or not. But I think we were the first crew that went through that, first or second. I found that that was extremely valuable for me as a commander.

It's that type of thing that you see in management training all the time, these kind of things, and that was very valuable, I thought. But that played a lot more of a role for me than it really should have, I think. It was a little bit of a distracter for me, and comparing notes with some of the other crews, they didn't have nearly the baggage. It could be unique to a case where you've had people working for so long together who have such diverse opinions about how certain experiments ought to be done and so on. Some of our other crews, the crew—even the payload crew came together relatively later. They didn't have five years of working together, and so they didn't have time to develop some of those mismatches.

But, as I said, my concerns were how [are we] going to operate on orbit. When we flew together, [our] crew worked like a well-oiled machine. There was no bad baggage. There was a tremendous amount of respect and professionalism, and it made me real proud of those people that they were able to—and I don't give myself any credit for this; it was them deciding that they owed it to their country not to let any of that old stuff get in their way. After the mission was over, they probably never spoke to each other again, but they sure did a good job on orbit. We completed 100 percent plus of our objectives, and it was a very full agenda we had. We had over twenty major experiments up there, and they did a great job.

JOHNSON: Did you personally have to take part in any of the life sciences experiments?

O'CONNOR: Yes. Sid and I [knew] that one of the things that scientists at NASA like, especially the life scientists, is lots of data points, and that we were going to go up there for nine or ten days, and as long as the Orbiter is behaving, there are not a lot of activities for us, as an Orbiter crew, to do. Tammy Jernigan had already signed up for everything. She was a test subject and an operator, she became part of the science crew, even though she was a member of the Orbiter crew. But she was a scientist herself [by education] and certainly was interested and very engaged in the science training.

For us, we couldn't do a lot of training, because we were doing our own flying-the-Orbiter training and Shuttle Training Aircraft and all that kind of stuff. But we did say that we would make ourselves available for I think it was seventeen of the twenty experiments as test subjects, or guinea pigs.

The ones that we bailed out of and were not interested in were the ones we considered to be some small risk to our ability to do our job of flying. They had one or two experiments that dealt with the eyeball, where they would put a little lens on your eye, and there was some risk there that you could scratch your eyeball, and although it was very small, we said, "We don't need to take that risk."

There was also one of them that was designed to see how far you can go exacerbating your vestibular system before you feel sick and get symptoms of Space Adaptation Syndrome, or space sickness. We clearly were not interested in that. We didn't want to make ourselves sick and then find that, "Oh, we've got to deorbit this afternoon because something has happened," and not be up to it. But other than that, we did everything.

JOHNSON: You flew before *Challenger*, and then flying again after *Challenger*, maybe, if you can for just a moment, compare the differences between flying pre-*Challenger* and after *Challenger*.

O'CONNOR: Yes. I guess the big difference was philosophically we thought of ourselves as somewhat akin to a commercial activity pre-*Challenger*. In fact, on my first mission we delivered three satellites on orbit for paying customers, communications satellites. Nothing to do with science or NASA R&D [research and development] kind of activities; it was strictly payment for services, delivering commercial assets on orbit.

After *Challenger* that was totally gone. That whole concept was gone. It was such an eye-opener for us that this was really a fairly high risk activity. It is not something that we're ready to be flying passengers on, to be doing commercial activities with, and so on. It's an R&D activity, and probably will be for a long time.

You'll remember, one of the aspects of that was the Teacher in Space thing got put on hold for a long time after *Challenger*, and we had a policy that came out of the government after *Challenger* that said we will only fly Space Shuttles on missions that it's uniquely qualified to do. If you can fly a payload on something else, like a Titan or a Delta or an Atlas, then that's where you do it.

So that whole philosophy change was there. It showed itself in many ways, in the way we were structured, the way we approached risk assessment, the way we did our flight readiness reviews, the fact that we're now wearing survival equipment and having a parachute system strapped onto us. The whole thing took us right back to a flight test mentality rather than a Flying Tiger Airline mentality. So I'd say that was the biggest thing that was different about it.

JOHNSON: I read on that flight, also—there was an article that talked about the fact that one of the hatches was padlocked. Do you want to just talk about that for a second? Was that something that was normally done?

O'CONNOR: Well, for me it was. We had done that on my first flight—Brewster [H.] Shaw [Jr.] being the commander and me the pilot—padlock on the hatch, the rationale being that you've got a couple of people on this flight that you don't know that well. They're the "payload specialists." They're not career aviators. They haven't been through all the training we have. We try to make sure they don't hurt themselves or anybody else. It was a due diligence thing, because, in theory, although it would be tough to do it inadvertently, there was a button and a turn of a knob that could actually open up that hatch, and the hatch was very dangerous, because it was an out-opening hatch.

There were probably a lot of good reasons why they did that, one of which might be room in the cabin or whatever, but one of the bad things about that is that the pressure in the cabin will blow that hatch off if the latches aren't latched. You would like to have a system where the pressure will keep the hatch closed, not open it. But that's not the way that one was structured. So that was a risk area. Some of the other commanders before had had concerns about that hatch, and so when it came time for my second flight, I ordered up the lock when we were down in quarantine at the Cape and said, "Okay, get that lock and be sure you put that on the hatch, or put it in the vehicle so that when we get up on orbit, we can put it on the hatch."

I could tell from the response when I made that request that this might be a little unusual, but it didn't hit me too hard, because I didn't really check to see how often this was done or

anything. I pretty much thought that was standard. But the guy did say, "Ooh, are you sure you need that?"

I said, "Oh yeah."

"Okay."

So, I got that kind of response, and it put a little question mark in my mind. But we did that. And I remember the two payload specialists, each of them, one at a time, coming in to ask me about that. "Hey, I heard we put a padlock in there. What's that for?"

And I told them, "It's because we don't know you guys all that well. It's due diligence, and I did it last time, and don't worry about it." [Laughs] I told each one of them.

So they may not have liked that. They probably thought, "Well, this is a fine how-do-you-do. We train for two years together, and they don't trust us."

Maybe it was a bad judgment. It might have been one of those things if I'd thought more about it, maybe I would have said, "I don't really need to do this. There's a potential downside in that it creates concern among the crew about trust and all that." But I [erred] on the side of due diligence and kept it on there. And I was honest with the two payload specialists. I didn't try to hide anything or whatever. I just told them, "Yeah, and the NASA members get the combination, but you guys don't. That's the way this works."

So I could tell they were a little bit concerned about it. I have to say, though, that in each case, it was kind of funny—this is human nature. Remember I told you they didn't get along too well with one another? I didn't say that it was "because of both of you." I just said, "This is a thing about payload specialists.". I didn't say, "It's because of you personally." I genericized it.

And I could tell that each one of them was thinking, and the wheels were turning, "Oh, it must be for that other one." I didn't try to dissuade them of that. So if that's the way they felt good about it, that was fine with me. [Laughter]

JOHNSON: And knowing those personality types.

O'CONNOR: Yes. That was one of the humorous things about it, I guess.

JOHNSON: Was there anything else about that flight that we haven't talked about?

O'CONNOR: Okay. One of the other things about that mission was that it allowed me an opportunity to learn a lot more about the human side of space flight than I ever would have learned otherwise. A dedicated life science mission opened my eyes about what actually the scientists worry about with human space flight, and why, and how they address these things. It gave me a much better appreciation for how they do their science and the importance of [multiple] data points, which came in handy for me later when we were negotiating with the Russians on Shuttle-*Mir*, and I got a chance to see how the equivalent Russian scientists looked at it quite differently.

They weren't big on lots of data points. With the same protocol, the same menus, the same treadmill training protocols and so on, which is what we try to do. Our science community thought that it was important to have statistical relevance before you come out with a finding. The Russians had a different approach, and they said, "We're going to change everything every time and get data points of one, but lots of them." From that broader, holistic, experiential thing,

they would then make their conclusions. So it was interesting to see those two different approaches.

I also got to talk to a lot of people that I wouldn't have otherwise about what's actually going on in my body when I'm up there in zero-G [gravity]. Why do I not feel good the first day? What's happening there? What about my heart? Why does it grow in size and then get back down to a smaller size? They actually took pictures of it shortly after we got up there.

One of the crew members was wearing a catheter in his heart during ascent, and they had measurements of the pressure, the venal pressure in the heart, during ascent. That was the first time that had ever happened. There was a lot of engineering to do with that, because we're supposed to be wearing a pressure suit that you can escape with.

So how do you sit in your chair during ascent with a catheter in your heart hooked up to some electronics that goes into the Orbiter's recording systems, and then be able to bail out or egress from the cabin on the launch pad if you have to very quickly? You wouldn't have believed the effort and the training and the planning that went into that simple question, and the modifications they made to the hardware and the quick disconnect so you don't bleed to death and all of that stuff. Very interesting stuff. I never would have had a chance to get involved in those kind of things if I'd have been on a satellite deploy mission.

JOHNSON: You also flew jellyfish for the first time, and there were rats on board.

O'CONNOR: Yes, [NASA] Ames [Research Center, Moffett Field, California] had some animal experiments. Got a chance to work with the Ames people, wonderful folks, looking at animal analogies. There were some cell [experiments] that we were doing up there.

The jellyfish was a vestibular experiment. What happens when you take gravity vector away from a little jellyfish, who really needs to know what up and down is? You see pictures of jellyfish in the ocean, and they're always pulsing up towards the surface, and then they come down, and then pulsing up towards the surface, and they have a sense of which way gravity's going. Or is there more of a light thing that's helping them, or do they do this at night?

Well, if you take gravity out of the equation, there's a mathematician in the Science community who can write an equation for everything, and one of the equations would be the equation for the vestibular balance function of a jellyfish. It's probably got a whole lot of terms in there, and one of them is gravity. So the uniqueness of the Space Shuttle or Space Station is that you can take all these equations for various things that happen in your body, and you can take the G out of there and see what happens. You can't do that anywhere on Earth, except for maybe a few seconds.

So this is one of those. Took the G out, and what did they do? Their equation went bonkers. They did little spirals.

So that showed us that G is a powerful piece of their equation, the equation that says why they go up and down. They didn't do it anymore. They went around in spirals. I'm probably totally violating the entire principle of what's going on here, but that was my simple pilot's view of what was happening there. It was kind of fun to watch them, too.

The rats was a matter of not testing rats or doing tests on rats, per se, but we had twenty-one rats up there in cages, and we also had a glove box. The idea was to demonstrate the ability to do experiments on animals up there. We didn't do any experiments, but we transported a rat cage from its stockade of rat cages over to the glove box, and then allowing the rat to get into the

glove box, where you could then grab onto the rat with your hands and inject them or whatever you're going to do.

Then we also just verified that the functions of these rat cages were okay; that they were feeding okay, they were growing all right. Of course, they had a whole lot of rats on the ground that were the same vintage rats that were the ground truth rats. One of the things that they did with them was after the flight they checked their bone densities to compare with the bone densities of the rats on the ground, and got some idea of what happens to a floating rat's leg bones after nine days in orbit. But that was a postflight investigation.

So those were the animal experiments as I remember them.

JOHNSON: You had a very successful mission overall for all of the experiments.

O'CONNOR: Yes, they said we got 100 percent plus of what we were supposed to do. There were a couple of experiments that were on the ragged edge of failing, but they made it okay. Because they were the ones where we were collecting data primarily for Carolyn [L.] Huntoon, who was a PI, Primary Investigator, on at least one of our experiments that had to do with what goes on in the blood system, transport of nutrients, and that sort of thing.

We had saliva, urine, and blood samples that were collected the whole flight, and, of course, we had to keep them in a refrigerator. We had three refrigerator [freezers] on board. One of them failed outright, and the other two were acting up the whole mission. We had to shut it down and defrost it and then fire it up, and then shut the other one down and defrost it and then fire it up. We had to do this in a way that always gave us one refrigerator freezer to collect all these samples in.

It was a design problem. It was a zero-G design issue with the Freon flowing through the coolant tubes and so on in zero-G was not efficient and effective. It worked fine on the ground, but in zero gravity, it didn't. So that was a case where we almost lost the science, but we did learn about how to do refrigerator freezers because of that experiment.

JOHNSON: Was that the first flight that one had been on?

O'CONNOR: I think that they had had these before. It might have been another model; I'm not sure. I don't remember. But that was probably one of the bigger threats to our science.

JOHNSON: During the last interview you touched briefly on the landing and landing the Orbiter for the first time and how you were lower than you realized you were. Is there anything else about the landing that you'd like to mention?

O'CONNOR: Well, I just had a feeling of accomplishment after stopping on the runway when I realized—it really hit me that this is what I came here for, was to actually fly. I'm a test pilot. I did a lot of neat things for the last eleven years, but the real reason I came here was to fly the Space Shuttle, and they just now let me do it. [Laughter] Not to downplay the role that I had played on my previous flight, but I didn't get to land on that one. I was the copilot. This is the one where I got to actually do the landing. I've done two thousand landings in the simulator and two thousand more in the Shuttle Training Aircraft, all simulation. This was the real one here, and I just did it, and I feel good about it.

Now, of course, I felt funny later when I heard the data, and I had come in lower than I really knew I was. We'd talked to each other in the crew office about that. You know, there might be a perception issue on these longer missions, where when you get down there shortly before landing, where your cues tell you you're a little higher than you actually are, and we need to take that into account.

Of course, some people agreed and said, "I noticed that myself."

Others said, "Well, that didn't affect me. What affected me was some other thing," and so on.

So I don't know. I haven't really followed up on that particular one, but it was something I thought was worth passing on to everybody, that, "Hey, you guys. The data show I came in just a few feet above the threshold. I'm here to tell you I didn't notice that. Is it just me, or is it the displays or what? Let's talk about it."

It was when we were getting into the first longer missions. One of the things that we did after that for longer missions than mine, when we get up to fifteen-, sixteen-day missions, was gave the crew a laptop simulator, where they could watch the landing and actually fly through the landing on orbit. Give themselves a little practice. That may have helped with some of that. I don't know.

JOHNSON: Well, at the end of that flight, had you already planned to leave NASA at that point?

O'CONNOR: Yes. As I was coming up on the flight, I didn't really think a whole lot about it, but I thought that, "Once I've done this, then everything is on the table for my next moves. I'm

either going to stay here and maybe fly another Shuttle mission, maybe get into management, or go back and do my Marine job," and so on.

One of the things that happened while I was training for this mission was the first Gulf War. That happened before I flew that flight, and it was while I was in training. I noticed that they were calling up a lot of Marine Corps retirees and taking people from desk jobs and putting them into front-line positions; taking reservists and putting them in desk jobs to backfill for the people going overseas and so on.

The Marine Corps was a little bit stressed out at the time, and here I am, a Marine officer and a Marine pilot, although I'd been out of the Fleet Marine Force for many years, eleven years. More than that, actually, because I had come from four and half years in the [Naval Air] Systems Command, which is not a frontline unit. That's a support activity. So the last time I'd been in a real combat [-ready] job had been fourteen years prior. But I'm a Marine Colonel with wings on, and I felt like, "I'm missing out here."

Some people thought I was nuts. "How can you say you're missing out on something? You're training to go fly on a Space Shuttle mission."

Yet I had that feeling. I said, "Well, yeah, this is fun and so on, but I feel a little guilty." It's an incredibly important mission for the nation, to fly a Space shuttle, and yet I still had a little bit of that other feeling. It's probably screwed up, but maybe it's because I was a Marine Corps brat, also. I don't know.

The Marine genes came up and stood at attention and said, "What are you doing for your country?"

"I'm flying the Shuttle."

They came back and said, "Is that enough? Some of your people are going overseas here in harm's way."

I actually called a friend of mine who was a General in the Pentagon during that time, some months before my flight. I said, "I'm kind of tied up right here right now, but if this war is still going on when I get back from my Shuttle flight, sign me up. If you need somebody to sit at a desk in the Pentagon so you can go fly fighters over there, or somebody else, I know that people wouldn't consider me a candidate to go head up a squadron or a group or something," which is what my rank would have called for, "because I've been gone so long. But I can sure do a lot of other things for you guys that might free up somebody."

He just laughed. "You've got to be kidding me," [he said.] He kind of kidded with me and so on, and I'm sure part of his laughing was the thing I just mentioned, that, "You're already doing something important. Don't worry about that. We'll take care of this." But the other part might have been, '"You're so uncurrent. You haven't got a clue what's going on in the Marine Corps, having been gone this long. You'd be useless to us." My guess is there was a little of each of those things in [his response].

He said, "Don't worry about it. Just go do your thing. Then if you still want to come back into the Marines when you get back, my guess is this war will be long over by then anyway. But we'd certainly be glad to have you come back. There's some things you could do with us," and so on.

So I took him up on that, and after I landed—I didn't really think much about it, because I didn't want to distract myself with anything. I had enough distraction as it was with my oil and water [crew]. But after the mission was over, within a day or two of landing, I had that feeling that I had done what I had come to do, and I can do some more of it, or I can go back to my

normal job of being a test pilot, because the job they said would be open for me was at Patuxent River [Maryland], which is where I had come from, fundamentally, in the test community. They said, "We need somebody to be the Marine Aviation Detachment Commanding Officer down there."

I knew all about that job. It was a job where you're administratively in charge of about 110 Marines. About 40 of them were test pilots, and 60 really high quality maintenance people that come in there. Everybody there is hand selected, so it's a really elite group; and that the job itself didn't take up a whole lot of time, so you could do other things like do some test flying, do instructing at the test pilot school, or whatever. I thought, "Well, that's a great way to end up my career in the Marine Corps is go finish it up at Patuxent River."

I knew that would be my last tour in the Marines, because we had had a real frank discussion, a bunch of us Marines, in the Astronaut Office a couple of years prior to that, with the head of Marine Corps manpower, a guy named General Gray. We had asked him—and I remember Jack [R.] Lousma was the lead Marine Corps astronaut at the time, and there were several of us there. [We] said, "Well, what are our possibilities after we finish a few years here at NASA and then we come back? What kind of things can we expect? Can we expect to get back into line organization after a while and frontline units? Can we expect to be promoted beyond Colonel?" and so on.

He said, "Not a chance. No way. Forget about it. You're gone too long. They may do that kind of thing in the Air Force and the Navy, but we don't have enough billets for people like you to take the place of folks who have actually done the regular stair steps, done the schools, done the overseas deployments, done the training, done the war fighting kind of stuff, and then to say that some guy's going to come in out of nowhere and take those choice General jobs from

somebody who's done all that stuff. It's just not going to happen while I'm here or while anybody I know of is here." He was very frank with us. We appreciated that, by the way.

But it was kind of in my mind that, "Okay, this will be my last tour in the Marines, and I can't think of a better place to go than back to the test community." And that's what I did, and I did it exactly the forty-sixth day after landing. We owed [NASA] forty-five days after landing. You had to do your Flight Test Report, and they'd carved out forty-five days for that, and they wanted it due that day. So I handed in my Flight Test Report and left and went back to Patuxent River the next day.

JOHNSON: Well, I think that might be a good place to stop before we get into your next assignment.

O'CONNOR: Okay. All right.

[End of interview]