NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY TRANSCRIPT

DAVID W. WHITTLE
INTERVIEWED BY SANDRA JOHNSON
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JOHNSON: Today is February 21st, 2006. This oral history with Dave Whittle is being conducted for the Johnson Space Center Oral History Project in Houston, Texas. Sandra Johnson is the interviewer and is assisted by Jennifer Ross-Nazzal.

I want to thank you again for joining us today and continuing your interview. The last time we talked, you had returned to the Electrical Mechanical Environmental Systems Branch in Flight Control at the request of Gene [Eugene F.] Kranz, and for an advancement opportunity, you left the other area. Then you had the opportunity to work as the leader on one of the flight control teams monitoring the Skylab reentry. After Skylab reentered, where did you go from there and what were you working on?

WHITTLE: I was trying to remember that. [Laughter] It was one of two places. I went into the Comm [Communications] and Data Branch for a while, and then I got pulled out to do the Skylab stuff. Then when I came out, I went into Flight Techniques. I was working with Harold [M.] Draughon in Entry Flight Techniques in preparation for STS-1.

JOHNSON: What did that entail? What did Flight Techniques entail?

WHITTLE: There was a lot of unknowns. We'd never flown a Shuttle at that point in time, and so Flight Techniques was [the techniques and procedures for the first and subsequent flights.]

[Determining] that you had [safety and operations] margins [for the various flight phases.] Working technical issues; trying to resolve technical issues and coordination issues having to do with flying a flight and seeing if the systems had the extra [capabilities or margins of performance]. There was a lot of work done on reentry.

A good example, whenever you blast off out of Kennedy [Space Center, Cape Canaveral, Florida], there's some options that you have here about aborts, successful aborts that get you back to a landing site. Some of those aborts go into the ocean, and you hope they find you. But the decisions about when you call those aborts and what the boundaries are, when certain abort areas are available to you early and how long they're available to you, there's a lot of engineering and analytics and money and programs and things like that that are involved in doing that.

So Flight Techniques is where the experts come in and review with the management, "Here is how it's done," and sort of prove their theory, basically, is probably a good way to say it. [For example,] if I lifted off today and there's only a certain time period that's governed by velocity and position when I could do a transatlantic abort to Europe. So the logic and the mathematics and the energy computations, all the things that go [into the decision process] go into Flight Techniques [and has to be proven. Those decisions] feed back into procedures and things like that. That's just one example of many.

It might be how you manage other systems. It might be how you manage consumables. It might be how you manage ice. It might be how you do cross-wind landings, what are acceptable cross-wind landings, and proving that yes, this is okay. At that point in time there was a lot of discussion, and there was some work about doing little, small aerodynamic maneuvers to better understand the aircraft. This airplane had never flown in hypersonic flight,

and so everything was stuff that had been done on [test models] and computers; [with] a normal airplane, you'll take and you'll instrument it, and you'll take off and you'll fly in a very benign environment, and you'll slowly increase the environment and take measurements about the way the airplane behaves, and use that to determine its capabilities. And you start out slow and get fast.

Well, this airplane starts out fast. It starts out at Mach 20, it's kind of the reverse. So what you do is you build a lot of margin in it, and so you want to make sure you're not accidentally using up that margin, that it's going to fly correctly. Flight Techniques was kind of the forum where all of the experts came together to address those problems.

JOHNSON: Did you work with a variety of people, or how many were there?

WHITTLE: Yes, we worked with people from all over the Center. We worked with a lot of people from MPAD [Mission Planning and Analysis Division]. The astronauts were there, the Flight Control was there, Engineering was there. That was a gathering of all the people around the Center, and in fact, Flight Techniques is still in place today and does basically the same thing.

JOHNSON: Around that same time period you returned to school for a master's degree at the University of Houston-Clearlake [Houston, Texas; UHCL].

WHITTLE: I started that when I was out of Aircraft Ops [Operations], as a matter of fact, and I ended up—I got my degree in 1980. My wife and I graduated the same night, different places.

She got her nursing degree at College of the Mainland [Texas City, Texas] and I got my master's at UHCL.

JOHNSON: What interested you in going back to school at that time and getting this degree? Was it for career advancement, or was it through a program with NASA and UHCL?

WHITTLE: No. No. The fact is that getting degrees, getting advanced degrees, with NASA, it doesn't do much for your career enhancement. I don't know of anybody who went back and got advanced degrees, except, now, for people who have no degree at all and go back and get a degree, I think that it provides them with opportunities. But if you have a degree and you go get a master's or a Ph.D. I don't think it makes any difference at all.

It was kind of personal interest. One of the things that they don't do in engineering school is teach you about business type stuff and teach you about money and finance and that, and it was kind of interesting. I thought it would be fun to do. Matter of fact, I had a couple of friends that were doing it, also, and we were going part-time. The more I got into it, the more I liked it. It was a different way of thinking. I had an engineering degree, and the business degree is a lot different.

Has it helped me in a career? Maybe remotely. Whenever you're applying for a job, you can say, "Well, I've got an MBA [Masters of Business Administration] as well."

They'll say, "Well, at least when we're doing budgets and things like this, this person understands what we're doing."

JOHNSON: Well, STS-1 in 1981, were you still with the Flight Techniques group?

WHITTLE: Yes.

JOHNSON: Do you want to talk about that first flight and your memories of that?

WHITTLE: There's nothing remarkable about STS-1. I don't remember anything specific about it. I was not on console. I had been in Flight Techniques. I remember it; there was nothing that made it stand out in my mind one way or the other, that was close or an accident or anything like that.

JOHNSON: Was there any sense of relief that the ideas that you'd been working on, that everything worked?

WHITTLE: No. There is a—and maybe it's just me—it seems like we felt like, there was an attitude, that we had worked so hard and been so thorough that unless there was some type of a design issue that we were unaware of, that things were going to work. We had a lot of margin. If you're teaching your kid how to drive, you feel a lot better if you're in a ten-lane-wide highway, because you know they're not going to get off in the ditch. They've got a lot of margin for error. You don't do that on a little country road that you've got to be very careful on.

That's the way we did things; we made sure there was a lot of margin. A lot of that stuff had to do with entry, with turning on jets, with things like that, and with fuel management, and consumables management in general, how you would do that. We'd run simulations, and you'd

flown that thing so many times in simulations and tested it so many times that, in my mind, there was never a question that it wasn't going to work.

JOHNSON: You moved in [19]'81. You were assigned to the Guidance and Propulsion Systems Branch in Flight Control. Do you want to talk about that position?

WHITTLE: Flight Techniques was moved into the Flight Director Office, and I was not in the Flight Director Office, and so I had to find me another home. I went to work for Don [Donald J.] Bourque, who is in the GNC [Guidance and Navigation Control] area. Actually, you're right, Guidance and Propulsion. It had the GNC [system]. It had the attitude—what they call the prop [propulsion] section was in it, which was on the Orbiter—the attitude control engines, the engines on the Orbiter, and also had the booster section was in there as well, which had the big engines.

That was one of the neatest jobs I had, and it had to do with all of the guidance and navigation control equipment on board the Orbiter. It was very analytic. It involved a lot of computations. It involved the attitudes system. It involved the star trackers. It was a lot of engineering, and it was a very good section. The folks in there were all really good. They were competent. They were a very friendly section that did a lot of things socially and had a high esprit de corps. They were very smart. Things that we did had a direct effect on the vehicle. You were uplinking things to the vehicle that if they were wrong, the whole world would know. It was a fun place. I really liked that. I liked the systems we worked on and the people.

Don Bourque eventually moved on to someplace else, and I became the Section Head of that group. I became the leader of that group. I was a MOCR [Mission Operations Control

Room], front-room person in that, and I enjoyed that. I enjoyed the console time in that. That's some of the most fun I had was in that particular section.

JOHNSON: You mentioned you were a MOCR, front room person in that, and you said in your last interview that during Apollo, being in the back room, and you knew that you weren't going to be moving to the front room because of the situation. If you could just describe, for one thing, the differences between the Mission Control in MOCR during Apollo and then during the Shuttle era, and how the atmosphere changed, if it did, between the two.

WHITTLE: I don't think it changed a lot. You were sitting at the same consoles. The same structure and organization was there, pretty much. You were looking at the same displays. You were dealing with—you had some better tools. Computers were better. Our displays were better. You were starting to get some digital voice systems. The quality of the equipment that you were working with was getting better. We had computers. But as far as the hierarchy, as far as simulations, as far as interfaces, I don't think it's a heck of a lot different now.

Of course, the people there today, they don't remember Apollo, but from what little I know about the Control Center today, there's a lot of similarity still. And they're sitting in rooms over there. I don't think it's that much different.

JOHNSON: Do you have any memories of some of the simulations on those early flights or anything that stands out in your mind about those first few flights when you were on console?

WHITTLE: I know there was a lot of simulations. We trained and trained and trained and trained and trained and trained. I always enjoyed sims [simulations]. There is a feeling of this really happening; there really is. I don't remember the sims, or anything special about the sims. We talked about the sims the other day. They're meant to kind of test the boundaries. They kind of do two things. Number one, they test your capability, and it you're going to be certified to sit on a console position, you've got to have a certain number of problems in certain areas. It just so happened the GNC area always had a lot of problems in sims.

A sim might be targeted for testing a certain area. It might be targeted for doing things in the whole electrical systems area. They're going to do fuel cells and things like that. That's going to kind of be the theme of that [sim]. Or it might be some other area, but they throw in little things to you every now and then, little tidbits for you to work, little problems for you to work, so that you're not sitting there bored. But they give you things that don't kill the sim, because there's a purpose. A particular sim will have an object in mind.

They would come in, and if you were going to be certified, they had a checklist for everybody that said, okay, this person is going to have these types of problems, and you'd talk to the sim sup [supervisor] and make sure that those types of things would happen. Not all in one sim, but over a course of several sims, and then people could be certified.

JOHNSON: Early on they had high hopes of flying the Shuttle as many as twelve times a year, and I believe in 1985 there were nine flights. During that time, do you have any memories or thoughts about those early hopes of being able to fly that often?

WHITTLE: Everybody thought that was bogus. That was for political PR [Public Relations]. It became immediately obvious you were not going to fly twelve times a year, and you were not going to fly that thing a hundred times. Although, at our level, other than making us work real hard, that was not a big player. But nobody really believed that, that you were going to do that.

The other bogus thing that they said is that "The Shuttle is operational." That was the real push before [Space Shuttle] *Challenger* [STS 51-L accident]. "We need to quit doing all this—treating this thing like it's an experimental vehicle. The Shuttle is operational. We need to fly it like it's a 747." That's kind of a buzzword for you don't need to pay as much attention to it, and so, boom, it crashes. Just before [Space Shuttle] *Columbia* [accident, STS-107], you start hearing the same rhetoric, primarily out of [NASA] Headquarters [Washington, D.C.], primarily out of the people that the Administrator had brought in from the military that were now running the program. [Major] General [Michael C.] Kostelnik was a perfect example. He was really on a tear that the Shuttle was now operational and we needed to quit being so careful.

Boom, *Columbia* happens. It's a different mindset. Of course, when we do that, everybody says, "Well, you know, we know it shouldn't be operational. This is an experimental vehicle. You need to pay a lot of attention to it." It kind of resets everybody's clock. But I don't think we ever believed we were going to fly twelve times a year. I don't think that the Control Center could support that. Given the amount of sims and preparation and people and things like that, it just—that was for congressional purposes.

JOHNSON: Okay. How long were you in the MOCR and how many missions did you work in the MOCR?

WHITTLE: Gosh, I haven't the foggiest idea. I did not count those things up. Now, when I was flying on the airplanes, you logged all that stuff, and they kept a record of it. I may even still have it. I can tell you every flight we ever made, how many hours it was, where we went, and everything. But those records were kept by somebody else, and I just didn't pay a heck of a lot of attention to that. It was several. It was several.

I got transferred to the Comm and Data section. The Division Chief—there was an opening. The Section Head for the Communications Branch, Ed [Edward I.] Fendell, retired, and the Division Chief came in and asked me if I would move over to that section, because he knew I'd been in communications before. I told him that I really enjoyed communications, but I was really in a great section, and that I really wasn't terribly interested in moving.

He said, "Well, I can understand what you're talking about." He said, "You know, you are really doing a great job in this section." And he said, "In my mind, you will probably be a great Section Head for a long time in the GNC Section. Or you can move to the Comm and Data Section, and there may be promotions for you in the future."

So I made up my mind. I moved. And, in fact, I did become the Branch Chief over there eventually. I don't think I was the Comm Section Head for all that long. I think it was a year or less, and the branch came open, and I became the Branch Chief for that.

JOHNSON: And you were in that position at the time of the *Challenger*?

WHITTLE: I as in the Comm and Data Section during *Challenger*. It was one of those things where we just flew so much that I didn't go watch all the launches. We were relaxing that morning, and I was in my office. One of the guys in the section came around and got me and

said, "The vehicle just blew up." We ran around to the Building 4 lobby where they had a television, and we sat there and watched the replays. The interesting thing was that even in the replays, whenever you saw the big cloud form, you kept waiting to see the vehicle fly out of the cloud. You're just sitting there waiting, and you just knew any second the vehicle was going to come flying out of that cloud. Of course, it didn't.

JOHNSON: What were your duties immediately following the accident, if you can describe those first few days and what you moved into?

WHITTLE: In what we were in, I had very little to do with the accident. I was an observer. At that point in time I wasn't in the Mishap Investigation Team [MIT]. As a matter of fact, NASA received a really black eye over that for not being very well prepared to react to that. What we ended up doing—of course, we got affected by that, because we went into endless simulations.

Probably the biggest impact to us is everybody went back to square one in reviewing the failure mode and effects analysis of all your equipment, kind of going back to the first square in identifying hazards and problems of your area that could result in catastrophic events. We were involved. They redid all the what they call CILs, critical item lists, and they did all the failure mode and effects analysis, and we had a lot of people involved in that. It was just hours and hours and hours of that. Probably another way to say that, we reevaluated the risk of everything that we owned at that point in time, starting at square one. A lot of work. We did a lot of sims, as we were just trying to keep a little bit of proficiency there and keep people busy.

JOHNSON: And prepare for a return to flight in [19]'88?

WHITTLE: Yes. Yes. You basically go back to the beginning and review or redo everything. Are your procedures right, or is this right? You kind of start with a clean slate.

JOHNSON: How did you move into the Chief of the Safety Division?

WHITTLE: Charlie [Charles S.] Harlan was the Directorate Chief, and called me one day and asked me if I would be interested in moving over there as the Division Chief. I thought about that a while. Of course, this was after *Challenger*. Safety, in general, the Safety Group, in general, had a very low respect from basically everybody on the Center. The Safety Group was where you put the nonperformers and the people you didn't want to have to deal with. They just were not very well accepted anywhere across the Center.

After *Challenger* they decided that they were going to change that, and they put Charlie Harlan over there, who came out of Mission Ops. They wanted him to change the way that that group was viewed and their attitudes. They brought a bunch of people in from Engineering that had real competence. For a while Charlie [Charles F.] Bolden was over—as a matter of fact, Charlie Bolden was the Division Chief that I basically took his place. Actually, I didn't take it; it was Charlie Bolden and Jay [H.] Greene, and then I was the person after Jay Greene. It was a way that Charlie was trying to do to involve a lot of MOD [Mission Operation Directorate] type attitude into the organization.

Well, I looked around, and looking at promotion opportunities, and how many Division Chiefs or whatever were going to be available in MOD, and it didn't appear to be that there was going to be much. So I took the job.

JOHNSON: Were you concerned at all, since that area had the low respect.

WHITTLE: Well, it went through my mind, but the thing about it is that I also know Charlie Harlan very well, too. As a matter of fact, his daughter had worked for me over there. She was a summer hire. She came in for the summer. She was going to college and came in and had worked for me, and so he and I had kind of renewed old acquaintances over that. A Division Chief is a Division Chief. If you look at my career, I tended to move someplace about every seven or eight years. I don't think that's bad. It just seems that me personally, after about seven or eight years, I get restless. I don't know if I've done everything I wanted to do, or if I'm just restless. It's just time to do something a little bit different. It was about that time period, and that was an opportunity, and I said, "Well, you know, it's not every day you get an opportunity to be a Division Chief," and I took it.

His Deputy was Gary [W.] Johnson, who was also a good friend of mine, who had been my Branch Chief in the Guidance Propulsion Systems Branch. I'd known Gary since Apollo. So, a lot of going to work has to do with who your bosses are going to be, and I liked them.

JOHNSON: How long were you in that position?

WHITTLE: I went there in '89, and I left in about '96. Yes, about seven years.

JOHNSON: In the research that we did, one of the things, while you were still in that, I believe, in that area, in the spring of '96 you were selected as one of the members of the Tethered Satellite

System Mission Failure Investigation Board. Can you share your memories about that experience?

WHITTLE: One of the things that you get to do, that I enjoyed doing, is being on boards for [incidents] like that. That group, that investigation group, was run by the Center Director at Dryden [Flight Research Center, Edwards, California], whose name I will think of before we quit today. We went to Marshall [Space Flight Center, Huntsville, Alabama]. Actually, we first went to KSC [Kennedy Space Center], because the carrier for the satellite was back there, and we wanted to look at that, and we wanted to look at the ends of the cable that had come loose.

That was just—it was a standard, run-of-the-mill investigation of an anomaly. I've been on several of those. We had a group of, gosh, maybe seven or eight people. Ken was the guy's name, Ken [Kenneth J.] Szalai was, I think, his name. And it was very interesting. There was a lot of forensics type stuff that we did, having to do with looking at that cable and looking at the data that came down from that thing and how it happened. We had a couple of guys from Italy that were involved with the science of all that, that participated on it. They were scientists. They weren't engineers; they were scientists.

That type of a thing, it usually runs a long time. It's usually not more than eight hours a day. We cut like twenty or thirty foot of cable on the side that had burnt and had come loose. We had took a whole bunch of that stuff back to Marshall and ran whole bunch of tests on it. There was a box inside the unit that we took and brought back. There was a box about a foot and a half long by maybe a foot square that the cable runs through before it goes out, out of the Orbiter and connects to the spacecraft. Inside that box are some wheels and some measurement devices and some tensioning devices that measure how much cable you have out and do some

stuff like that. We took that thing back and took it apart. Obviously, we didn't take it apart, but we had it taken apart. Then we inspected it. We had pictures taken. We did some analytics. We had some video made that showed events, physical events, as they related to the data, to the electronic data, showing what was happening. Made a video, really nice video that kind of gave an idea of how things were happening and what happened.

It was a case where we learned a lesson again. Some of it was they did not expect that satellite to generate that much electricity. The way a generator makes electricity is it moves a wire through a magnetic field, and that magnetic field will cause electricity, will cause a current to flow in the wire. Well, the Earth has magnetic fields around it, too, and you've got this wire that's a mile or two or three or four long—I forget how much wire was out, but a bunch of it—and you're going around the Earth, and it's intersecting all these magnetic lines of force. That thing was generating about 3,000 volts of electricity, a lot of electricity.

One of the things that we found—actually, we found out during Apollo—was that the little, tiny, small [closed] areas tend to not go to a perfect vacuum, even in orbit. Even though these areas are not closed in—they may just have holes, little holes where the wires come out and wires go in, things like that—they're not meant to be a closed, encapsulated container, but they're a container. So what happens is that inside these little, small containers, you'll have a few little ions, a few little atoms of atmosphere, and it might come from things just outgassing inside that. But if you take something that has pressure in it, and you pop the top on it, you hear everything going out, but there's still stuff in there.

In an orbit what happens is you'll have a few of these [air molecules] in there, and it kind of becomes a ping-pong ball type thing, where these things just bounce around and they may or may not find the hole. The result is you have a very, very low atmospheric pressure in there, and

there's a range in there, in that low atmospheric pressure, where you have a tendency, if you have a high voltage, you'll have a corona. It will have a discharge. It's not a discharge like lightning. It's a discharge like there is some glowing; it has some current flow. And basically, that's what happened. The wire had a flaw in it. It had a little, tiny, tiny flaw in it. If you hadn't gone through that box, it probably wouldn't have been a big deal.

I got a piece of that wire. I should have brought it in and showed you. I didn't know you were going to ask the question. That wire was a multipiece wire. It had a copper core in it, because they were actually taking electricity out of the satellite and measuring electricity. Then around the outside of that was a Teflon protector like, sort of like this wire right here. This is rubber, but this was Teflon. Then outside of that was a Kevlar layer that gave it strength. Kevlar is sort of like a bulletproof vest, but it provides strength. But Kevlar is not very abrasion-resistant, and so it had a Nomax layer on top of that to provide a—Nomax is fireproof, plus it provides the abrasion resistance. So we learned all kinds of stuff about wires.

We took all that wire, and we looked at it, and we found all kinds of places where, in the making of all that, where little pieces of trash had gotten in there, tiny, tiny pieces, little microscopic stuff. That little microscopic stuff shows up, and some of it was metal. There was obviously a piece of—of course, now you're in the hypothesis mode, because you don't have the piece that burnt up; you have the end of it that burned up—but it became very obvious that there was obviously either a flaw in the Teflon or a piece of metal that went through there and touched the wire.

When it got into that little box that had the atmosphere in it, now all of a sudden you've got this ionization, and it became very, very hot. In fact, you could see it on the rollers. The rollers had a little hot spot, a little burnt spot, where that piece went across these three rollers

inside. You could take you a piece of the tether. You could mark it, and you could roll it through there, and it would be a perfect match. Then that kind of got things started, and then as the thing went out into the atmosphere—that compromised the strength of it, and as it got out, it just pulled it in two. Physics.

It was fun. I enjoyed that. We went out to Dryden and did our report out there. Spent two weeks out at Dryden. I'd been at Dryden many, many times with the airplanes, so I was very familiar with Dryden, but went out to Dryden. Got to see the [Lockheed] SR-71 [Blackbird] fly.

JOHNSON: Oh, wow. What was that like?

WHITTLE: It was great. We went out on the ramp and stood right underneath that thing and then watched them fire up the engines. Then we jumped in a car, a van, and we went out to the center taxiway on the runway, and it took off right in front of us. We were within probably thirty, forty foot of it as it came by us.

JOHNSON: An amazing experience.

WHITTLE: Oh, it was, yes. Of course, I like airplanes, anyway, and, of course, that was—at that point in time, the SR-71s were out of the black world. The Air Force had divested themselves of them and given NASA two of them. So I got to see the SR-71 up close and personal.

JOHNSON: How exciting. Were there other boards that you worked on during that time that you have any memories of that you'd like to share?

WHITTLE: I was involved in the [Russian Space Station] Mir collision, the Progress [unmanned supply vehicle] collision with the Mir. The Air Force had a Titan [IVA-20] launch at the Cape that blew up seventeen seconds off the pad. I got to go participate in that as kind of an Air Force/NASA type agreement that I went over there. They were trying to get me some experience, a little bit of experience in MIT stuff. There was the Wake Shield Facility. That cost me my Christmas.

Wake Shield was a device that the University of Houston [Houston, Texas] was involved in, and its purpose in life was to generate very, very ultrapure silicon. It was actually built over in League City [Texas]. They had flown it on one flight, and they'd stuck it out and were going to turn it loose with the arm, and it just never could get its head.

So then they flew it again, and the way that—the philosophy behind this was that this was a twelve-foot-diameter disk, and on the back of it was some very high temperature oven type devices that would make this silicon. The device would fly through the atmosphere so that the velocity vector was into the front of it, and behind it the Wake Shield means it was shielding the wake of the thing, and so the stuff done behind would be ultrapure, because this big disk is shielding it. They flew it the second time, and they would put it out, it would go several miles away from the Shuttle, and then it would do its work, and then it would come back, and they would put it back in the payload bay.

Well, it got away this time. The second time it did get out. They were able to turn it loose, but it got out there, and it kind of lost its head and started doing flips and things like that,

and they had attitude control problems. Well, George [W. S.] Abbey was very unhappy with it, being the second time, but at the same time since it was kind of a—Max [Maxime A.] Faget was involved in it, so they were trying to give it a—Space Industries [Incorporated] was the name of the company, I believe, and Max was an advisor over there, so they were trying to give it every extra opportunity.

It was right around Christmas, and they asked me to pull together a team. We had about four or five people, and visited Space Industries. Then we went up to Ithaca, New York, when the snow was taller than my car up there. As a matter of fact, it wasn't obvious that we were even going to be able to get into the airport; there was so much ice and snow.

We visited with the folks up there that built the computer and suggested a bunch of changes, and flew again, and it was successful. Again, it goes back to details in science, engineering. That was a case where you have a bunch of young engineers who are very, very good, but do not have any space experience. So things that people who have been around in the space industry a little bit would say, "Hey, you don't do that," it just wasn't on their calendar. They just didn't understand that.

They didn't realize that whenever you're flying something around the world, that there's a lot of people in the world that are interested in that, and they paint it with radar, particularly when you have two devices that are together and then they separate. I know exactly the size of both of those devices. I know everything about them. It's common knowledge. So I can take my radar and paint those things and then look at my radar data, and I can tell you—I can see what my resolution is so I can discern between two objects as they get further and nearer. I've got two known objects that are separating and coming together. If I can measure that with my radar on the ground, well, that gives me a lot of information about my radar.

Well, there was almost enough radiation up there, you could cook an egg, when we got to doing a little bit of research, and a lot of those areas, we don't have control over. You can tell the U.S. military not to be painting the vehicle and get away with it, but you can't tell a lot of other places that. That was something that they just hadn't thought about.

They'd had a previous problem on—this was the second investigation group. They'd had a problem before that, and it had to do with—it was thermal type stuff. It wasn't just thermal; it was also wire routing, where they had routed some wires right next to each other that should not have been routed next to each other. Again, pretty basic stuff that wires cross talk with certain signals on them. So they were very receptive. They didn't perceive us as being on a witch hunt, and the third time we flew it was successful. I like to think that we had a little bit of part in that, of making that successful. They did a great job of responding to what we had.

That was one of those cases where this little company in Ithaca, New York, built a lot of stuff for unmanned type stuff, satellites, having to do with attitude control and computers and things like that. It was run by some professors that were associated with the university up there, and it was almost a mom-and-pop group, but maybe a little bit more than that, but not much. They built one digital computer in their whole existence, and this was the one. After they built one, they decided they didn't want to build any more, and so they went back to analog computers. Their programmer, the person who had done all the code and the programming, had gone on. They had zero records. We were able to call this guy up and talk, and he would say, "Well, you know, I think I did this, and I think I did that." It just was very unspacelike, where you document it and you have multiple copies of everything. They didn't have any backup. This computer was the only one ever from them. So that made us feel real good.

JOHNSON: Confident, anyway. [Laughs]

WHITTLE: Oh yes, because we were looking for ways—you know, there's a lot of ways to respond to bad information. One of those things is something that's called a Kalman filter. If I start giving you some information, and I say, "The Coke machine is over there. The Coke machine is over there. The Coke machine is over there." And all of a sudden, I say, "The Coke machine is over *there*," [points in a different direction] you're going to say, "That's bad information." A Kalman filter would take care of that. Now, if I say, "The Coke machine is over there," enough times, then it's going to believe me. But if I'm giving you some information and it's within a certain band, then the computer will accept it. If all of a sudden I give you something that is way out of the norm, it says, "I don't believe that," and it throws it out. That's the technique that is used on the Shuttle as well, for the guidance.

So we were trying to put a Kalman filter in this thing. We were pretty confident we knew what the problem was. We had them do a bunch of changes to improve tolerance against radiation. We had them do some cable changes and some things that insulate it or protect it against RF [radio frequency], although it's very hard to do. Then as a second effort, we wanted to put this Kalman filter in there, and we were trying to do that in the computer. Well, it became obvious that we didn't want to mess with that code, because there wasn't anybody there who had the foggiest idea what was going on. So we ended up building a box. They built a box that would filter that information. It was kind of a Kalman filter in a box, as opposed to the computer.

I liked the technical, the stuff like that, the engineering, where you're problem solving. You're kind of like a sleuth, trying to figure out what went wrong. That's fun.

JOHNSON: You mentioned Progress collision with Mir. In that board or investigation, did you have any dealings with the Russians directly?

WHITTLE: Not directly. The Russians didn't provide us a lot of information on that, partly because they didn't like us investigating their stuff, you know. The attitude that we had was, "Well, you know, we've got a person on board that, and we'd kind of like to know what happened." So we had some people that were knowledgeable about the Progress. There was a certain amount of sharing about all that, but there was no Russian involved on our side. We were able to request a little bit of information, but not a great deal. We had an opportunity a little bit to interview—or some people did—interview the person that was on board that belonged to us.

But it was kind of a touchy situation, because we think that the guy screwed up, the Russian screwed up, and, of course, now you're pointing fingers at your international partners, and there's a certain amount of politics involved in that.

That could have turned out much, much worse. They were doing something that they didn't really have to do. The Progress, there's two ways to dock it. One of them is there's an automatic system. There's two systems, manual [TORU, teleoperated rendezvous control system] and automatic [KURS, automated rendezvous and docking system]. Anyway, in the automatic system, it communicates with the Mir, and it basically takes the vehicle right up very, very close. Well, Russia was breaking up, and all these little countries were breaking off and becoming the independent countries. Well, the country that manufactured that device was one of them that broke off, and so either the Moscow folks, the main Mother Russia folks, either they didn't want to do business or these people were trying to ask for too much money, or there was

some—there was a situation happening that it wasn't obvious that they were going to be able to get this automatic docking system. So they were willing to practice their manual ways.

The manual way is kind of like a video game. There was a camera on the Progress that looked at the Station, and then transmits this information back to this guy that's got some control sticks. He's looking at a display that has some grids on it, and depending on how much grid, how big an area the view of the Station is, he gives commands. It's not an obvious situation.

If I want to go out that door, I just get up and go straight to that door. When you're in orbit, orbital dynamics come into play, and if I see something out there, I don't go straight to it. Orbital dynamics just don't let you do that, and so what you're doing is that—really what's happening is you're both in orbits. You're both orbiting the Earth, but you're in a different orbit. So what you're trying to do is either increase or decrease your orbit to the point that you meet.

So it's a more complicated situation, and this guy just kind of let it get out of hand, and he just wasn't patient enough, and then all of a sudden he realized that things were all going bad, and he started responding in a way of trying to move the [Progress] away, and what he was doing was actually making it worse. But he was seeing it coming in, so he was trying to [avoid a hit]. He was trying to avoid it with some commands that were not necessarily the right commands, partly because of the laws of physics and partly because of the way the jets on the Progress work. It could have been very, very bad.

Now, as it turned out, our guy on board, whose name I forget at this moment—

JOHNSON: [C. Michael] Mike Foale?

WHITTLE: Yes. He went by him. He went by him, or looked over his shoulder, brushed him or something like that, and the Russian ended up blaming it on him, saying that if he hadn't come by and bumped him, it would have been okay. But generally that doesn't happen on a—a brush doesn't—this is a long-term situation.

JOHNSON: Were you involved in the investigation after the fire on Mir?

WHITTLE: No. No, I was not.

JOHNSON: At one point you mentioned that some of the investigations that you were involved with was to get you training for the Mishap Investigation Team. At what point did you become a part of the Mishap Investigation Team?

WHITTLE: Can we stop and let me take a break here?

JOHNSON: Sure, sure. Not a problem.

[pause]

JOHNSON: Okay. When we stopped, we were going to talk about your involvement in the Mishap Investigation Team and how that started.

WHITTLE: NASA received a lot of criticism over the *Challenger*, not being prepared. The mishap investigation function had been at Headquarters in Code Q, SR&QA [Safety, Reliability, and Quality Assurance]. In Don [Donald R.] McMonagle, ex-astronaut, who was the Deputy Program Manager for Launch Operations down at KSC, was sort of responsible for it and was concerned about the fact that there wasn't a lot of attention in being prepared. So he was able to get the function moved out of Code Q to the Shuttle Program, and asked me if I would like to do that, if I'd like to be the MIT chair. And I said yes. That happened just about the time I moved from SR&QA over to the Shuttle Program. About [19]'96 is when that really happened.

I spent probably the first six months writing all the procedures and writing the MIT plan, just basically going from scratch and writing all that. Then the trick was to try to get some experience. Now, I'd been on a lot of accident investigations while I was in SR&QA, so I had a little bit of experience in problem solving, but not being an MIT type person, not an aircraft type thing. So there is an aircraft accident investigation course that's taught at JSC [Johnson Space Center] occasionally. I made some contacts in NTSB [National Transportation Safety Board].

Then I started looking around the country about where people got trained to do stuff like that, and I found out that one of the primary places is USC, University of Southern California [Los Angeles, California]. They have a school that they give in accident investigation, aircraft accident investigation, that once you complete it, you get a certificate, and at that point in time the courts recognize you as an expert witness. So at least the courts recognize you as an expert. So I started taking those courses, which involved going out to L.A. [Los Angeles] for a couple of weeks at a time several times.

At that time Don McMonagle was still in KSC, and so when the Titan A20 blew up, he said, "Hey, that's a good opportunity to get some real experience," and, in fact, I did. Later on—

that was probably a month or so down at KSC, and I went up to Denver [Colorado] for a while, trying to work out the problem with that launch—then through our contracts at the NTSB, I was able to participate in the American Airlines [flight 587] crash that went into Long Island [New York] about a year after 9/11 [September 11, 2001, terrorist attacks on the World Trade Center in New York City and the Pentagon building in Arlington, Virginia], the one that crashed in Belle Harbor. I got to go participate in that. Then the next real activity that came along was *Columbia.*

I spent probably a week up in Long Island, a little over a week in Long Island with that and working NTSB. I learned a lot from that. The thing I learned about that was how the lead investigator handled being the orchestra leader. In fact, that guy, that particular guy, came down and was with me up at Barksdale [Air Force Base, Louisiana] during *Columbia*. I was talking to him, and I said, "Well, you know, this is my first big one."

He says, "You know," he says, "you're writing the book on this. We've never done anything this big."

So we got a lot of help from them, and they did a lot of stuff. They have a lot of capabilities that most people don't know about, particularly handling radar and stuff like that, radar tracks, because we were trying to look for a bunch of stuff out in Utah, Nevada, New Mexico area, and trying to find radar tracks that would imply where things were located that might have fallen and hit the ground.

JOHNSON: The Mishap Investigation Team set up here at JSC. How many team members besides yourself, and how were those team members chosen?

WHITTLE: There was ten of us, and they were chosen as representatives from various areas. One was a photographer. One was from the crew. We had a person that represented the Orbiter. Had a person that represented main engines. Had a person that represented payloads. We had somebody from Flight Medicine, had a doctor with us. Basically the main areas. We had a guy from KSC that was an expert in how the various remote sites operated, because we really figured that there was a good possibility that—if you had asked me what I thought that I would end up going to, it would have been a TAL [Transatlantic Abort Landing] site or something like that. Actually, I even visited a TAL site for one of the launches just to meet the people and understand how they worked at the TAL sites and understand their functions. Had another guy from KSC that was kind of the administrative assistant type person. It was just one little Indian from each area, basically, and that provided kind of the core to get you out and get started.

If I had guessed, I'd have thought that we would have done some type of a TAL abort; I would have ended up in Spain or Morocco with the Orbiter laying flat on its belly on the runway or something like that, as opposed to what we ended up with.

JOHNSON: These team members, did they have to train the same way you did, or was this just something that they were on call, or did you meet occasionally?

WHITTLE: They had to have minimal training. Basically what they took, they took the JSC course of aircraft accident investigation, which is a three-and-a-half-, four-day course of basic overview. Here's what it all looks like, and here's an example of a few things. So I had the lion's share of that.

The role that the MIT has is different than the role of an NTSB investigator. An NTSB investigator goes out to an aircraft site, and their purpose in life is to determine what happened. The MIT does not do that. Whenever a Shuttle crashes, it's a big political event, obviously, and there is a prenamed board of about five people, Mishap Investigation Board, that's prenamed. It's documented at this very moment. What happens is that whenever there's a crash, this board gets activated. This board is combined of people from the Air Force and from academia and generally high-ranking folks, but who will have experience in this type of stuff. But they are not the people who go to the field, and so the MIT is the quick reaction folks.

So the way I viewed my job is my job was to go out and collect and preserve and protect the evidence for the board to look at. So that was our role. Our role was not to determine what happened. Now, I'll be honest with you. As the pieces were coming into the hangar there at Barksdale, I was over there walking through there, looking at the pieces, saying, "What does that tell me? What does this mean?" and trying to see if I could see a pattern to what we were seeing. But that's not my purpose in life. My purpose in life was to keep the integrity of what we were collecting and to document it.

When we went out on that, my goal was if you saw a piece of debris in the hangar, that I would have a picture of that piece of debris where they picked it up, and I would have the GPS [Global Positioning System] coordinate system of where it was located. Frequently the picture of what happens comes out from the locations of things. So everybody that was picking up stuff, they had GPSs, and we were trying to document where everything fell.

JOHNSON: Previously you've provided two interviews about the *Columbia* accident and more details about that. But since time has passed since that accident and maybe you've had some

time to reflect on some of the issues or some of the things that you dealt with, is there anything that comes to mind that you'd like to mention about your time in East Texas and the time afterwards with collecting the debris here at JSC? Then, of course, it moved to KSC.

WHITTLE: I think in many things when you look in hindsight, there's many small things that you might do differently or you might reconsider a little bit, and there's probably some of that stuff. I question why did I do this, why did I do that. I don't think there was any stark differences. NASA, if it hadn't been for FEMA [Federal Emergency Management Agency], we'd have been in a heap of hurt. FEMA provided huge resources to us, and they were our arms and legs. It turns out that the FEMA guy and I struck it off and had a very good working relationship. I said in a previous interview that we had 130 state, federal, and local agencies and never, ever had a tiff. Matter of fact, the Congressional Committee on Homeland Security sent some people down to interview us to figure out how we did that, because that was not the experience of 9/11. They wanted to know what we did to make things work. So I was proud of that.

NASA, in my own mind, they didn't follow their plan as much. When it happened, all of a sudden the Administrator named other people to get in and involved in it, as opposed to saying, "We have an MIT plan, and we're going to follow that." I think it was politically inspired. "Well, we need to have a Center director down there," and this, that, and the other. Fortunately, they kind of realized what the situation was and just kind of played a remote role and let things happen. They let the MIT do its work, basically. They didn't really interfere. But it could have been the other way. If you'd had the right personality down there, they could have really screwed things up.

NASA today, I don't think, is prepared for another one of those things. They still have the MIT, but if FEMA doesn't come into play, they don't have the plan in place to provide the things that FEMA has provided. Now, we talked about that afterwards. The program reviewed the lessons learned and what have you, to how they might do it. But they have not stepped up to, well, if FEMA doesn't get involved, what are we going to do? Do we need to go ahead and have some type of in-place agreements? Do we need to prepare all this ground ahead of time? Accommodations for the people; all the computer systems. FEMA came in and set up cell towers. FEMA came in and provided us desks and computers and 5,000 people that were marching out every day, that were living in tents. These types of things, NASA, they haven't done anything to say, "Well, you know, if FEMA is not around next time, how do we handle this?" That planning has not taken place.

There is a thought process, and I agree with it, that there's a trade-off in spending money for accidents or for prevention. I can spend all my money for getting ready for accidents, or I can spend half my money for that and half my money for preventing accidents. Well, there's a trade-off in there where that line lies. So some people will say, "Well, I'm not going to do a lot of this stuff, because I'm going to put my money into being more safe, and therefore I don't have to do that stuff." Your guess is as good as mine as to where that right line is.

But we got a lot of praise for being very well prepared for *Columbia*. The Accident Investigations Committee, they came up and stayed with me for about a week up in Barksdale, and then we communicated routinely. I came down and briefed them several times. Overall, I'm proud of what we did, of our piece of that. We got over twice as much as what the experts said we would get. They said we would get between 15 and 20 percent; we got 39 [percent]. I felt real good about, overall, the way that thing went.

JOHNSON: You mentioned that you and the other agencies were interviewed on why you thought the relationship worked better than it did at 9/11. Why do you think those relationships worked better?

WHITTLE: I think it was the personalities of the guy, the other person, and myself. Matter of fact, he and I, we still talk. He's been heavily involved in Katrina and all this stuff, and other things, since then. He lives up in Denton, Texas. We periodically chat. We just—we hit it off. If there had been two A-type personalities there, two people who didn't want to cooperate, if each of us had said we're in charge, no matter what, there would have been a big fight. But right off the bat, he and I just—maybe it's because we're both bald. We just hit it off. We would talk, and we would negotiate, come up with solutions. I realized where his expertise was, and he realized where mine was, and it just worked.

JOHNSON: You were the Chairman for the Space Shuttle Systems Safety Review Panel. Was that after *Columbia*?

WHITTLE: No, that came with my job. When I moved into SR&QA in [19]'89, a part of that was being that.

JOHNSON: Well, is there anything else about *Columbia* and that time period or in that position that we haven't talked about that you'd like to mention? One other thing, in my notes I'm seeing

the Space Shuttle Probability Risk Assessment [PRA] Project. Do you have any specific memories about that?

WHITTLE: Oh yes. [Laughs]

JOHNSON: Would you like to share them with us?

WHITTLE: We were in the middle of the PRA work when *Columbia* crashed. Everybody hates PRA except the people that do it. The reason is that it tells them information they don't want to hear. If you look at the Shuttle itself, and people will question the analytics of how you determine the probability of it being successful launches. There are analytical techniques that are used. They were primarily developed for nuclear power plants. For instance, there's a probability that that door is going to fall off the hinges. It never has fallen off the hinges, but there is a probability of that and so there is analytical ways to analyze that and come up with that probability, even though you've never had the event.

In a lot of cases, we don't have events, or maybe we have just near events. If we take the APUs [Auxiliary Power Units], which provide hydraulic power to the Orbiter when it's on ascent and entry, they're kind of dangerous devices, in that they use hydrazine, which is a bad stuff. Hydrazine goes in, it hits a catalyst bed, and it causes hot gases, cause fire and things like that. The hot gases turn a turbine which turns about 100,000 rpm [revolutions per minute], really fast, and it can come apart and go to shrapnel and do bad things. And although you've never had one of those things blow up, you've had some events where little pieces of it didn't work right and

things like that. So you can take that data and turn it into probabilities that you're going to have a problem with it. A lot of people have difficulty with probabilities.

The other thing they have a difficulty with is being told that their vehicle has a one in seventy chance of making each launch. Part of that aggravation is political. I am putting somebody on this thing that has a one in seventy chance of blowing up and killing everybody, or of having to abort, or whatever. So they question that data. The Nuclear Regulatory Commission and the folks in power plants, they like that data. They think it's important, and they use it. But NASA has always not liked that.

Now, there is in Headquarters, in SR&QA, Code Q—or what was Code Q, and now they call it something else because it's not considered politically right to refer to it as Code Q anymore—they have put some people in there that are real PRA experts and are trying to promote PRA risk assessment. The program, at that time Ron [Ronald D.] Dittemore was kind of coming around and, in fact, there was a lot of pressure from Headquarters and from Congress—from Congress, primarily—to try to come up with some analytical analysis of the vehicle. Now, the numbers were coming out in the one-in-a-hundred ballpark, so maybe a little bit less than a hundred.

It was a cooperative effort. It was an effort that involved Marshall and KSC, because they all get involved in the launches. We had probably forty people, thirty, forty people working on that. We were close to coming in with some pretty good answers. We were going to have it validated by some real-world experts, the Ph.D.-type people that teach this at universities, third parties. We just didn't want to examine ourselves and give out a doctor's report without a third party and people who could validate our technique and our results, and we were going to do that. [*Columbia*] kind of put that on hold a little bit.

We were a few months, three or four months away from coming up with something when *Columbia* happened. When I came back, it kind of took a left turn when we got back, partly because we had a new Program Manager. One of the ways you do that is when you're about to get data that you don't want to hear, you try not to get the data, and so they, in my mind, threw a lot of roadblocks in the way to make sure that that information didn't come in. They're going to study it forever and not come up with results is what it looks like to me.

Dittemore was very much in favor of that, and he was aware that he was about to get information that was not going to be what he wanted to hear. I knew Ron very well and talked to him, and you tried to give the Program Manager a heads-up about what he's about to hear, and we were telling him, "We're looking at the somewhere one-in-seventy, one-in-a-hundred ballpark here." But that's fine. That information is not absolute, and what that information does is there's an error band around that. It's not one in seventy; it's between this and this. It depends on how accurate your measuring device is as to how accurate your measure is, and, of course, not having a lot of events in these cases, there is a certain unknown.

What it does do, the important thing about that, is not that one in seventy number, although that's what Congress concentrates on; that's what the press concentrates on. The important thing about that is it tells you the areas that are driving your risk, and so now I can be selective about where I spend my money. Now, maybe one in seventy is wrong. Maybe it's one in two hundred. But even if it's one in two hundred, you'd like it to be one in four hundred. You can say, "Okay, the thing that's driving it is this item right here," and now you go work on that item right there and drive it up. You don't spend your money on things that are not big leverage, big players in that.

Unfortunately, people tend to grab that one data point number, and run with it and say, "The sky is falling. The sky is falling," play Chicken Little. It's hard to get people to back off of that and realize that what it is, is it's a tool to show you where to work. Now, if you go to the Project Managers over at Marshall, pretty much all the Project Managers were not terribly in favor of that, because they were afraid it would make their project look bad. It would make them look like they weren't doing their work. To a person, they would tell you, "I don't need you to come over here and tell me what needs work." Says, "I know. I work with this stuff every day. I know where our problem areas are."

There is a certain amount of truth to that, but the thing about it is that if you take two different projects and each has problem areas, and only have a dollar to spend, which one of these two do I spend my dollar on? Well, if I have this way to compare risk across projects, now I can compare the risk over here to the risk over there. That's fine, except now the Project Managers view that as a threat to their funding. So if you spend your dollar over here, I didn't get that dollar.

JOHNSON: Well, in the probability of risk as far as the landing was concerned, you mentioned that you thought, as part of the MIT, that you would be going to an abort site or something like that if you ever had to go anywhere. In what happened with *Columbia* because of the foam, what was decided, how big a probability of risk was that before this accident? Was that identified as something that was significantly dangerous?

WHITTLE: No, it was not. If I were to put myself in those places, if I were to put myself in the shoes of the decision makers at that point in time—I went to KSC all the time. I was at KSC for

all the launches, and I've been in with OPF [Orbiter Processing Facility] and the Orbiter. If I gave you a piece of a foam—matter of fact, I have some. I'll bring it in and show it to you. If I gave you a piece of foam, you would pick it up and you'd say, "There is absolutely no way." If I were to show you the leading edge, if I took you out and showed you the leading edge of the wing and let you [knocks on table] knock on it a little bit, you'd say, "That is tough stuff. That is really hard." Then if I saw this other stuff, which I have a piece of foam about like that, you know, a little small—and you can hardly feel it in your hand.

So I think there was a mindset that, "Yeah, you know, there's some stuff coming off, but it's not going to do any big damage." They had their Crater program that historically had been very conservative. They were saying it was no problem. As it turned out, the Crater program really wasn't meant to do this, and nobody checked on that. To my mind, SR&QA failed miserably in that whole thing, as they did in *Challenger*.

The other piece of that puzzle, there was a lot of people asking questions about that, and a lot of people were wanting pictures. If I were to guess what happened—capitol G on guess—when you call up to agencies in [Washington] D.C. that do spy satellites and things like that, they have a very good capability of taking pictures. That was at a time that the war in Iraq was really heating up, and let me propose a scenario that I think would—I do not know if this happened or not, but I think it fits the picture.

They tell a Program Manager, "We will be glad to do that. We will be more than happy to do that, if you want to. Right now all of our resources are concentrated on Iraq. People in Iraq may very well die because we're using this resource to take pictures of your vehicle. Now would you like us to do that?"

So the Program Manager is sitting there thinking, "Hey, I've got this program I've got a lot of confidence in that is not going to—no problem is going to happen. I've held this stuff. It is so light. It's fluffy. You could throw it at me, and it wouldn't hurt me. And I've got this material it hits that we know [knocks on table] is very hard. Do I want to risk our soldiers' lives on that? No."

Now, subsequent to that I was at a conference up in D.C just before I retired, January of last year, where some researchers out of Glenn [Research Center, Cleveland, Ohio] were doing testing down in San Antonio [Texas] where they were shooting pieces of foam at leading edge, and it was making holes identical to what we think we had.

What is disgusting about all that is that if you were to take a piece of foam about that size, and you go back and do the arithmetic. You do the calculations. It becomes pretty darn obvious that at 700 foot per second, that it would. It was about three pounds of foam—maybe even less; it might have been two pounds of foam—that came off, and the foam is such that it doesn't have a lot of inertia. So when it separates, it slows down quick, because there's no inertia to keep it moving. So the vehicle, in essence, just flew right into it. Whenever you do the calculations on it, it's pretty darn obvious. Why they didn't do that at the time, I don't know. In some cases, the program is very detailed and they dig into the smallest nets. In other cases, they don't want to hear it.

It's a case where if you're the world's expert, if you're the engineering expert, and you tell me everything is okay; when SR&QA comes in and says everything is okay, I think they don't know what they're talking about, and SR&QA doesn't necessarily have the tools to prove what they're saying. All they can do is hand-wring. I personally agree with Ron Dittemore's Deputy [Linda Hamm]. I know her very well. I've known her for years.

She kind of came out a villain in all of this for being very decision oriented. I think she was dead on. The program cannot [listen to] everybody who walks in and wrings their hands, you can't go chase that rabbit. Her attitude was, "Hey, you bring me data, and I will listen. Don't come in and tell me, 'Well, I've got some concerns. Well, I've got some concerns.'" Everybody has some concerns, and maybe there was enough people saying that that she should have said, "Well, let's go pursue it a little bit." But maybe not. It was probably in the the gray area a little bit, but that's the way the program works. The program works is, "Don't come tell me your concern. Come give me some data, and then if your data is good, we'll do it." And SR&QA, and Safety, in general, was a nonplayer in all of that. They failed miserably.

JOHNSON: You mentioned that before *Challenger* and then before *Columbia*, that same kind of feeling that it was more routine. Do you feel that maybe there was a feeling of complacency, because the foam had never caused a problem before that they could identify, a significant problem, that it wasn't going to cause it in this instance?

WHITTLE: Maybe. I'm not sure that I would define it as complacency. I think there was an attitude it wasn't going to cause a problem. [STS] 112 before that had had a pretty significant piece come off, and so there's a number of factors in there. Number one is that early on they had cameras and they made a lot of effort to take pictures of the tank to see what was happening on it. Although there were still some cameras down in the umbilical area, they weren't working real hard to get pictures. They weren't doing attitude maneuvers. They weren't doing things that would give them a little more visibility into the tank. There was an effort to put a camera on to look down. That camera was for PR purposes, not for inspection of foam. Our Administrator

had seen that camera on an ELV [Expendable Launch Vehicle] launch and had decreed that we will have one of those because it looks so neat. So that was not used for that. There wasn't a place for that. Program didn't want it. It was something that was "oh, gee whiz" type stuff.

They didn't treat foam loss with the same degree of importance as if we'd had another problem, if we had a tire problem or something like that. I'm guessing. I just believe that they thought that, "Well, we're getting a few little dings here and there. It's repairable stuff." If you looked at the data, the amount of foam coming off was increasing.

Now, the original design of [the foam], the original plan, was that none was supposed to come off, and this was a pretty good-sized chunk. There's a certain amount of that being dispositioned at the project level as opposed to coming into the program and showing them what's happening. If the Project Manager had brought that in and shown the program, "Hey, we lost this PAL [Protuberance Air Load] ramp area," I think that it would have maybe received more attention, but then again, then the Project Manager gets a black mark for having something wrong with their thing. There's that aspect of it, too.

So it was dispositioned with the project. It wasn't kept secret at the project, but it was, "Well, we had this, and it came off. It didn't cause any damage, and everything is going to be okay, and we'll work on making it better," that type of thing.

JOHNSON: In your position that you were in at that time, did you have anything to do with preparations for the return to flight?

WHITTLE: Not really. Well, yes, I did. Yes, I did. Every accepted risk hazard had to be reviewed, and a lot of cells. I was still the Chairman of the System Safety Review Panel, so I

was having to look at all of those things. I was heavily involved in the stuff with that tank. I went down to Michoud [Assembly Facility, New Orleans, Louisiana] several times to review the things that they were getting ready and as they were rewriting their risk documentation. We were trying to help—help them is probably not the word. We weren't doing the engineering, but we were identifying the risk areas that we thought were important that they were going to ask questions about so that they could anticipate those and take care of those ahead of time, and not wait till they brought the stuff forward and then have to go back to the drawing board. So we were kind of working with them a little bit. It was a lot of work. Typically, the System Safety Review Panel is meeting maybe once a week or maybe every other week. We were meeting five days a week and long hours.

JOHNSON: What led to your decision to retire from NASA in 2005?

WHITTLE: Several factors. Number one is the program was reorganizing, and our function was being moved back to SR&QA. I've got thirty-seven years and ten months. Just, you know, it was time. After you put in thirty-seven years, it's about time to try something else.

JOHNSON: Looking back over your entire career, what would you say was your most challenging time?

WHITTLE: Probably the biggest single challenge was *Columbia*. That was three months of twelve to fourteen hours a day, seven days a week. It was amazing how fast that went. Usually, if you work twelve, fourteen hours a day, after about a week or two, you kind of get tired of it. I

mean, every day was zoom. Matter of fact, you would leave that day wishing you could stay another hour or two to do a few more things. So that was probably the biggest challenge to me. In general, I'm proud of what we did. It was a job that it was fun doing all the preparation and doing all that stuff and going to the launches, but it was a job where I hoped I'd never have to go to work.

I'm just a person who tends to think that things are supposed to go right, and if they do, then I really don't think that was a challenge. When I came into work in Apollo, I expected things to go right. I expected us to land. I expected us to be successful. That's just part of me.

Probably the funnest part was in Aircraft Ops and the things that we did there. There was a certain amount of challenge in Return to Flight after *Columbia*. That was a lot of work.

JOHNSON: Is there anything in particular that you're most proud of?

WHITTLE: I'm probably most proud of my part in landing on the Moon. We literally made history, and not many people get that opportunity. I was just in the right place at the right time. I was sitting there two years and one month after I'd gone to NASA, I was in the main Control Center, landing on the Moon. I said, "Wow! Where do I go from here?" I would say that's the part that really sticks with me.

The Apollo folks, the folks in the LM [Lunar Module] systems area, and now, just in the flight control area for landing on the Moon, still get together every so often. We still have a party every—we were doing it every five years. Actually, we have a reception in the Gilruth Center once a year on July the twentieth, plus or minus a day or so, where a lot of the folks come

back. Then about every five years we have a picnic where people come in from all over the country. Problem is that a bunch of us are dying now.

JOHNSON: But it's a select group of people that were there to make history at the same time you were.

WHITTLE: Yes, it really was. Yes. NASA has been very good to me. I've got to do a lot of things I would have never got to do. I've been a lot of places that I wouldn't have been before. It goes back to reminding yourself, in spite of problems and politics and things like that, most people would take your place. If you go out into the other world, they have the very same things, maybe even worse. So it's not like NASA is unique in that respect. You'd still have politics to deal with, and you'd still have personalities to deal with, and you just—"Welcome to the real world," is what I always tell my kids, which they hated, but now they say to their kids.

JOHNSON: Is there anything we haven't talked about that you wanted to mention before we close today?

WHITTLE: Nope. I think we've covered it from A to Z.

JOHNSON: Okay. Well, I appreciate you coming. Thank you.

[End of interview]

David Whittle provided a number of photographs that you can view from the following link.

Visit a photo gallery provided by David W. Whittle