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ORAL HISTORY TRANSCRIPT

LEONARD S. NICHOLSON
INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is July 18th, 2007. This oral history interview is being conducted with Leonard Nicholson in Houston, Texas, for the NASA Johnson Space Center Oral History Project. The interviewer is Rebecca Wright, assisted by Jennifer Ross-Nazzal.

Thank you again for coming in this morning and giving us your time for this project. We'd like to begin today by asking you at what point during the Apollo era when you were working for the space agency did you learn of the discussions and plans of the Space Transportation System?

NICHOLSON: Actually, I had moved over to what was called the Advanced Missions Office in the '69 time frame, and we actually were still in Phase A-B studies of the Space Station in the '69 time frame. Then the question became, and it had been around for some time, do we build a new vehicle first, or do we build the Space Station first? So there was a lot of discussions in the '69 to '70, '71 time frame about which to do first. Ultimately the decision was made to do the reusable spacecraft first, and so that then started on the early design activities and taking it forward for budget approval and that kind of stuff. So that was when I got involved in it, during those study trade activities.

WRIGHT: Can you share with us how that evolved? Was that a directive that was coming from [NASA] Headquarters [Washington, DC] on how to set up those study groups, or was this

something that came from the ranks on how best to utilize the current workforce to come up with the plans?

NICHOLSON: I don't recall there being a lot of discussion about how you use the current workforce. It was more a discussion of recognizing that we needed to figure out what we were going to do after Apollo. At the level I was at the time—of course, I wasn't interfacing with Headquarters or anything like that, so I can only assume that there were some discussions going on. But it appeared to me at least to be mainly driven here at JSC. Of course, Max [Maxime A.] Faget was pushing hard on the reusable vehicle, and other groups of people were pushing hard on "We need to get a Space Station."

The decision was ultimately made to do the trades, but I had the impression that the overwhelming consensus of the senior people, at least here at JSC, seemed to be building a reusable spacecraft first.

WRIGHT: How did you become involved in those plans? We know that after ASTP [Apollo-Soyuz Test Project] you moved into the payloads area. Was that part of your first duties? Or tell us how you transitioned in from that Apollo era into making the Shuttle a reality.

NICHOLSON: Well, when I was in that Advanced Missions Office, okay, I had participated in those trade studies for some time. Then I got asked to come over and work on Apollo-Soyuz, and basically went to work for who was then called the Apollo Program Manager, but really the focus was on the Apollo-Soyuz mission. So during that time frame I was focused on that as opposed to the early development of the Shuttle. So after the trade studies and the decision was

made, I got asked to go over and work on Apollo-Soyuz for Glynn [S.] Lunney. So I spent from then until after the ASTP mission in '75 working just totally dedicated on Apollo-Soyuz.

Then when that was over, the Shuttle Program was moving along, and they were starting to worry about putting payloads in the Shuttle, okay? So those of us that were coming off of the Apollo-Soyuz mission transitioned—some of us—transitioned over to start working on how you put payloads in the Space Shuttle and what kind of requirements do you have and that kind of stuff.

WRIGHT: Can you share with us how you started to lay that out?

NICHOLSON: Well, the only thing that was really, truly designed at that point in time was the size of the Shuttle. So we started with that and started doing trades and started doing studies about what kind of interfaces would be very easy for a payload to use and would be easy to integrate into the Shuttle. Of course, the way the Shuttle was designed, the loads from a payload had to come through certain structure, and so that pretty much dictated where the interfaces that a payload would have to meet would be and what they had to—and so we came up with concepts for how those ought to look and structural interfaces.

You had to take all the loads out through the longerons and through the keel, because the idea was to have several payloads stacked in the Shuttle, and you couldn't put the loads through the aft end of the Shuttle. So it had to go down the longeron and through the keel, so that dictated what the payloads would have to design to.

So we worked with the program at the time and defined what the loads would be on the payloads, so that they could design to be compatible with that. We also came up with concepts

for what kind of electrical interfaces did we need with the payloads that were flying Shuttle, and what kind of services would they need. So we did all that early study activity to define the things that a payload provider would have to have to design their hardware. We put those together in a whole series of books, which I still have a copy of, which is all the design books for the payload folks to use so that they could get their hardware consistent with Shuttle.

The other thing we did, too, was we had to define how we were going to get comfortable with the safety of these payloads in the Space Shuttle. There was a huge amount of discussion about how you do that, because we had never flown anything other than little, small payloads, like on Gemini I did some work on putting payloads in the aft end of the Gemini for the EVA [Extravehicular Activity] crews to come out and use. It was just pretty simple stuff; it wasn't complicated. It didn't have propulsion systems. It didn't have explosive potentials, etc., etc. Of course, the payloads we were talking about flying in the Shuttle were satellites and other things that had those kinds of hazards.

The program, the Apollo and all subsequent programs, and precursors, basically designed the hardware around just being sure they had a good, safe design. There wasn't a requirement called two-fault tolerant, which is the thing that's always used today. So we sat there and said okay, and the interesting part is the way the engineers got comfortable with the safety of a particular piece of hardware was being totally involved in its design and totally understanding how it's going to perform and what kind of margins they have to be sure it's going to be safe.

When somebody else is building a payload, like what we were trying to do is get ready to launch commercial satellites, etc., etc. You're not going to have the resources or the insight into their detailed design in order to get that kind of warm, cozy feeling. So we invented what we called two-fault tolerant. We said that would give us some margin. If it takes three failures to

have a catastrophe, and you're monitoring at least the first one or two, you can always take some action to get rid of them or do something if failures start occurring. So we put the two-fault tolerant philosophy in, in order to provide some margin over and above the amount of insight we would be able to have into the design of all these things from all over the world.

The funny thing is that that evolved to the point where that requirement was imposed on the Space Station payloads that flew in the Shuttle, and so the whole Space Station ended up being required to be two-fault tolerant. The reason why we generated that requirement to begin with I'm not sure has flowed totally down the system, but it was an interesting time, in terms of taking the transition from being hands-on and being totally involved in the design to taking some risk associated with putting somebody else's design in your vehicle.

WRIGHT: When you were first setting up the requirements, did you have input from these future providers?

NICHOLSON: At the time there wasn't a lot of that. We solicited it from time to time, but they were sort of still thinking through their own heads, and they were really asking us, you know, "What's the requirement?" So it was more something that we just had to come—in order to get comfortable that we could safely fly.

WRIGHT: Did you have an idea of who some of these payload providers would be, as far as on the commercial side?

NICHOLSON: At that time, not really. It was interesting; [there was a lot of discussion going on about putting the Intelsat satellites in the Shuttle.] [So,] the very first [payload] safety [requirements] document we built [was for the Intelsat satellite.] As a matter of fact, I still have that. It's the first safety requirements document for Shuttle that was for payloads. I've got it someplace. So we did build a little safety requirements thing and talk to the contractors that were providing the Intel sat and told them, you know, kind of what we thought the requirements might be, if that ever happened.

WRIGHT: Working with the Department of Defense, did you have a lot of suggestions from them on how they wanted things to be done as far as for their future payloads?

NICHOLSON: No, not really. We had a lot of interface with them in terms of getting the payloads they were designing compatible with flying in the Shuttle, but there wasn't a lot of discussion about the things they wanted the Shuttle to do. There was some, but the Shuttle basically is take you into orbit and throw you out, and then you go wherever you're going to go. So if you think about it, the only kinds of discussions we had—as a matter of fact, we did have some interesting ones on how do you get them out of the payload bay. [Laughs] We built some unique hardware to deploy a payload once.

WRIGHT: Are there any of those that you'd like to share with us?

NICHOLSON: I'm not sure I can. Those we all classified payloads.

WRIGHT: Okay. At what point do you feel that the commercial sector decided that going with the Shuttle to release their payloads was a good idea? Did you feel like you were getting lots of interest from them?

NICHOLSON: As a matter of fact, it's really interesting that a lot of the material we put together was associated with marketing the Shuttle, so we had an awful lot of interface and discussion with the whole community on how we could make it simple and easy for them to get integrated, etc., and put together a lot of brochures and briefing packages. We not only made them available to the commercial folks here but to the Europeans. We had a team that had all that information and data, and had briefings put together, plus the basic data they could provide, and we took trips around through Europe briefing different companies, etc., on the advantages and how to do it and that sort of thing. So there was a lot of that kind of activity that went on.

The commercial guys, of course, at the time the price was pretty good, and so they were anxious to do that. Then the little stages that were built—the PAMs [Payload Assist Modules], I think they were called—that were built to put the satellites into higher orbit after the Shuttle deployed them, and we got those integrated such that then the satellite provider really had a simple job. He didn't have to worry so much about it, because the basic interface with the Shuttle was with that first stage, and so he just attached to the stage. Then he had to meet all the environmental requirements associated with launch, etc. But it was an extremely dynamic, lot of fun time, in terms of dealing with the zillions of people all over the world and getting them ready to put things in the Shuttle.

WRIGHT: Did you encounter any unique payloads that someone had suggested that you just didn't feel like the Shuttle would be able to handle? Or were most pretty standard in what they were looking for?

NICHOLSON: No, there were some—I forget—was it Chandra [X-ray Observatory] and the Hubble Space Telescope. There were some of the scientific satellites that were big, long things that were unique in terms of putting them in the Shuttle. The commercial guys pretty much kept their stuff pretty straightforward. You know, they weren't trying to do science; they were trying to make money. So they pretty much stayed within a given envelope, and we made sure it would satisfy their basic needs.

WRIGHT: How were you able to test prior to launch that these items would work and do what was expected?

NICHOLSON: Well, the only thing we were focused on was safety. We didn't have any responsibility associated with whether they worked or not. That was their job. So we basically had them give us dynamic test results, where they tested their payloads, so that we could be sure that indeed the data was consistent with the environment that the payload was going to see. So they gave us models, and we would run it in an integrated sense to be sure everything was okay.

Then when the payloads got to Florida, of course, they went through the checkout, and we verified all the safety interfaces with theirs such that we could monitor the fault tolerance, that I mentioned earlier. So then when it got installed in the payload bay, you'd do a final check

of the interfaces just to make sure you could still get all of the data you needed and to be sure things were safe. So it was that kind of a interface and discussion.

WRIGHT: Did you work closely with the whole training in the procedures of deploying it, or where did your boundary stop once the payload was there?

NICHOLSON: Well, we had a big interface with the MOD [Mission Operations Directorate] and FCOD [Flight Crew Operations Directorate] folks, in terms of being sure we got to them from the payload folks the data they needed. The real deployment issues [were] associated with the [upper] stage that was put in the Shuttle, so you did [the procedures] one time [for it, and] then you used the same procedures over and over and over again, independent of what the satellite was on top of the upper stage.

So, yes, we had a lot of interfaces, and we had a team of folks. We had a Payload Integration Manager that was responsible for working that payload, and he'd have a team of folks from MOD and FCOD and Engineering, etc., that would interface and support, making sure all that data got into the system.

WRIGHT: When you joined that area—you had, of course, mentioned you'd just come out of working with ASTP and you went over. So you didn't necessarily become part of an operation except really -- what you did was help create this whole operation, and then you stayed with it a number of years. Can you tell us kind of how you formed your teams and how you brought the people in to work and set up your management structure to create this operation to get it ready for the first payload launch?

NICHOLSON: Well, Glynn started a lot of that, and then I followed up. Basically, when he started that whole organization, he had a group that would do the engineering piece of it, and had a group that did all the mission requirements, mission planning kind of piece

Then there was a group that was the group I led before I became the head of the office, which was the folks that did the actual interface with the customer, the Payload Integration Group. So we simply went out and looked for folks that were skilled at interfacing with people and collecting requirements and getting them all put together, because our basic job was to get all that information. We used the Engineering Group that was in that organization to help with the engineering interfaces, and we used the Ops [Operations] Planning guys to help with what the mission requirements were for this particular payload. But the group that I started out in was responsible for the direct interface with the customer that was providing the hardware, and getting all that put together so that the total system could proceed to plan and implement the mission.

WRIGHT: What do you feel that you brought from your Mercury-Gemini-Apollo experiences, that you were able to use in doing this part for this whole new way of doing space exploration?

NICHOLSON: Other than the thirst for human spaceflight [laughs], the discipline and rigor associated with the things that we picked up on while I was supporting the early programs. You know, you learned an awful lot as you went through those experiences. When things failed and didn't work, you create that "Don't ever do that again" or "Do that different." So it was really more just the knowledge you obtained from having done a lot of that stuff, to apply it to the next

thing that came along, and that's the way things evolved. I can't think of any big, show-stopping, bright thing that I brought with me.

WRIGHT: Day-to-day, on-the-job training.

NICHOLSON: Yes.

WRIGHT: Tell us about the first Shuttle mission and where you were, and then talk about the first payload that you saw go up.

NICHOLSON: Well, the early shuttle missions, of course, the very first Shuttle flights, I was intently focused on the payload part, okay, which wasn't to come yet, because we didn't put payloads on the first flight. There was a lot of instrumentation in the payload bay to measure what was going on, so we were pretty much in a mode of looking at the data and just keeping our fingers crossed. But we were really focused on getting the payloads ready for the subsequent missions, and so I was not heavily involved in the preparation and the operation of the first Shuttle flight.

WRIGHT: Well, tell us about the ones that you were, those first ones and the payloads and how it went, and then what did you learn from those first ones that helped you go on to the next one.

NICHOLSON: Hmm. Well, it was mainly getting the experience associated with actually flying something in the payload bay. You know, it was a pretty standard process, in terms of we would

change things based on what we learned on the first few flights, and do things a little differently because it didn't work quite so well and that sort of thing. But it was pretty much the standard thing you go through as you do something for the first time and then keep repeating it.

WRIGHT: Were there any of those that were more memorable than others?

NICHOLSON: Gosh, I'd have to go back almost and look at the manifest. [Laughs]

WRIGHT: There were a lot, weren't there? [Laughter]

NICHOLSON: There were a lot, yes. I'm sure I could come up with some "Wow," but not right off the top of my head.

WRIGHT: Well, maybe we could pursue that in a future time, because I know we've had some of the astronauts talk about the different payloads that they were responsible for and the new duties that they worked, because you were working now not just with the typical astronauts that you had in the Apollo days, but you were working with a whole different type of crew with the mission specialists that were responsible for those.

NICHOLSON: Right. Right.

WRIGHT: Is there anything you can share with us on interfacing with this new group of people?

NICHOLSON: It was just a great—I mean, you're talking about a totally dynamic, involved environment. It was just a team. Everybody pulled together, and it was just a constant [thrill,] you would come in every morning and you're [in a] "Wow" kind of environment. [Laughs] So the crews were all just totally cooperative and dedicated to figuring out how to make it work and making the customers happy. So it was just a unique time, I guess, but I can't think of any real showstoppers.

WRIGHT: It was an interesting time for you careerwise, because your position and responsibilities changed quite a bit during that '75 to '89 time period, where you moved a lot more into a higher level of management.

NICHOLSON: Yes.

WRIGHT: Now you were also responsible for more budgetary and personnel. How did that impact your day-to-day operations on what you had previously done and now you were being responsible for so much more?

NICHOLSON: Well, I'm a pretty laid-back person, and so I didn't really get all upset with a lot of the trauma that occurred from time to time because somebody didn't like what you did to them or whatever. So I just pretty much gravitated through that time period and did whatever they told me to do, and just pulled it into my job jar and did it, you know, and just pressed on. The least fun thing we ever did was budgets and dollars. [Laughs] But I even got to the point where I could handle that without getting all torn up.

WRIGHT: I know that, from some things that we've read, that there was a bit of tension through the space agency, because it was the end of Apollo, and Shuttle wasn't coming on line as fast as they had hoped. Were you having to deal with a lot of the issues of reduction in force?

NICHOLSON: No. No. Of course, yes, there was a lot of stuff going on, but I was pretty much isolated from it, because with the Apollo, Skylab, and then Apollo-Soyuz activity, and then as soon as it was over, going into the Shuttle payload world, I was totally immersed. So I was almost immune to the issues associated with "Where's my job going?" [Laughs]

WRIGHT: Shuttle era began and had a lot of expectations, and as it got up and running, at some point soon it was realized that it couldn't keep up with the mission schedule as aggressive as people had wanted. That certainly did affect the payload area, in the fact of having to change manifests or change teams and crews.

Then when [Space Shuttle] *Challenger* [STS 51-L accident] happened, there were other aspects of the Shuttle Program that changed, but it was kind of a demarcation, a big change in the program. If you could, talk a little bit about *Challenger* and where you were, and then how your role with the whole program changed after that, and talk about some of the changes.

NICHOLSON: Okay. Well, I was in the control center, and of course, I was responsible for the payload part of the mission. We had a room in the control center where we had the customers, and in this case, it was the TDRS [Tracking and Data Relay Satellite] and the IUS [Inertial Upper

Stage]. We had the IUS folks sitting there and the TDRS folks there, so that we could support the flight when we got on orbit. Of course, I was sitting in the control center when it happened.

It was the most devastating thing I have ever had happen to me. You almost couldn't believe it. You just sat there, and that whole thing went on, and your brain almost froze in terms of any peripheral senses. It took several hours to absorb that. I got a phone call from Arnie [Arnold D. Aldrich]; I'm pretty sure I was still in the control center, as a matter of fact.

This phone call woke me up. They were all in Florida, of course, and he asked me to take the lead on organizing the investigation activity and implementing all the stuff associated with securing the data and information until they could get back to town, etc. So I had to immediately transition from total shock to an action plan and gathering up people, key players, and starting hourly sessions on what do we need to do and freezing the data and make sure we had everything preserved so it would be there for the investigation activities.

So that was probably a little bit of a blessing, because I got so busy so fast that I couldn't sit and contemplate too much. But it was a traumatic time.

WRIGHT: Was there a plan already in place for you to follow, or did you create that plan as you were doing it?

NICHOLSON: Both; there were plans in place, but of course, we had never had one of those kinds of things before, and so it was a pretty top-level kind of a plan. So we pretty much pulled the plan out and made sure we were doing all those things, and then figuring out what else we needed to do. We had a good team of people working to make sure that we got everything, at least to be sure we kept the data that we thought we'd need.

WRIGHT: How long did you stay in this role of working with that investigation?

NICHOLSON: Oh, gosh, I don't recall exactly how long it was. I'd have to go back and look. It was probably, my guess would be, several weeks before they formed the formal board, etc., and we transitioned what we were doing to that formal investigation process. I can't remember how long. I'm sure it's on the record someplace, but I would guess it was at least several weeks and maybe a couple of months.

WRIGHT: Were you involved then with the formal board as well?

NICHOLSON: Only in an indirect sense, in support kind of things, because of my background, etc., but not directly. We did brief them some in what all we'd done, so I was indirectly involved [from that perspective].

WRIGHT: During that time period when the investigation was going on, were you keeping up with their findings and what the discussion was?

NICHOLSON: Sure. Yes.

WRIGHT: Did you have anything else during the time period for testimony or parts of what you did through offering more information?

NICHOLSON: I'm not sure what you mean.

WRIGHT: What was your involvement up until the time—I guess from the time that you turned that information over until actually the Shuttle went back to return to flight? What all were you doing during that time period?

NICHOLSON: Well, of course, we had a lot of activities associated with assuring that the payload wasn't a part of the problem, etc., etc., and responding to new requirements and being sure all that was integrated into the system. Let's see. Hmm. Gosh, let's see; what else would I say about that time period?

I think one of the most interesting lessons that came out of that from my point of view that's influenced me ever since was, you know, we had seen some leakage of gas across those seals on the solid rocket boosters; we'd seen it several times. I guess the thing I learned, that in this space business where you do so much work on designing this hardware and you do so much work on testing this hardware, that the probability of having this unanticipated catastrophe is actually pretty low. If you're careful and pay attention to listening to the hardware, it will tell you that something's not quite right before it blows everything up.

Now, you can't draw that as a firm conclusion; that may not always happen. But the probability associated with the hardware telling you something before a catastrophic event happens is extremely high because of the way we design and qualify the hardware. So those seals were talking to us, and the principle I've been applying ever since then is to be sure that the technical team is plotting and looking at all the occurrences of events and speculating what could the worst-case event be from that particular problem. I've had this problem twice; how could it

make a bad day? And do the analysis to be sure that you're paying attention and you know if it could potentially lead to a bad day, and take some kind of action.

So I've just insisted ever sine then that the technical teams listen to the hardware; plot the data. Don't just deal with an anomaly and get it taken care of and walk to the next subject. Watch that hardware every single time and see what it's telling you. See if it's deviating a little bit from normal, and pay attention.

WRIGHT: Good lesson.

NICHOLSON: Yes.

WRIGHT: There were a lot of changes made after the *Challenger* accident. How did these changes impact what you were doing in your areas and for the future flights? You know, of course, one being no more commercial payloads.

NICHOLSON: Oh yes. I didn't like that decision, but there was nothing I could do about it. When the Shuttle started flying again, of course, we were just as busy as could be, and there was a lot of other stuff going on.

The thing that's always concerned me is we put a lot of rigor in place, but I'm not sure that the listening-to-the-hardware thought process has migrated to the new guys that are on board.

But in terms of the total effect of that, everybody had an appreciation for the risks that are involved here, and the kinds of things you had to do to mitigate them. The nature of the program

definitely changed, because taking the commercial satellites off the plate and pretty much the DOD, also. Then it became more focused on the NASA payloads, and of course, then Space Station.

WRIGHT: Well, a big change for you soon after return to flight was that you became the Deputy Manager, and then not too long after that you became the Manager of the Shuttle Program. Talk about how that changed your ability to make some changes or put some different direction into the program.

NICHOLSON: Well, the guys that had been in front of me, Lunney and [Richard H.] Kohrs and Aldrich [and I] had been close all along, and so I was well mentored and I understood how to [do the job,] and like I was telling you, over my whole career there was always something else coming into the bucket, and I just got to the point where [I could] just assimilate it and press on. I enjoyed it.

I did more traveling than I wanted to once I got that job. [Laughs] I had to spend an awful lot of time on the road. But I thoroughly enjoyed that time period, in terms of dealing with the guys at Huntsville [Marshall Space Flight Center, Alabama]. I had, in my previous assignments, had some interface with those folks because of some of the payloads and stuff, but not to the extent that I did once I was running the Shuttle Program and dealing with the solid guys and the engine guys and the tank guys, and going to Michoud [Assembly Facility, Louisiana] where they build the tanks, and going to where they built the rockets and the engines in California. So I got a lot of education as a part of that. I had been focused on these little satellites and all this other stuff and more. It was interesting.

I enjoyed working with that team. Everybody was totally dedicated to their piece of the program. My job mainly was keeping things in balance and being sure we had our priorities agreed upon and we were all moving down the same train at any one time; and dealing with the budget issues and being sure we spread the money differently if we had to because of some problem or issue; and telling them payload guys to mind their own business. [Laughs]

WRIGHT: What was probably the biggest challenge of having to run the whole Shuttle operations from JSC, but yet having parts of the operation all spread out, as you just described?

NICHOLSON: Well, I was fortunate in that the system had been running for a long time. A lot of the hiccups associated with the early startups in terms of the integration of those things—you know, when the program first started up, the responsibilities for integrating the solids to the stack and the tank to the stacks and the engines, and getting all that interfaces squared away, was a huge problem. Fortunately, those interface issues and processes had been pretty much worked out by the time I was Program Manager, and so I found it to be a reasonably—you know, there were always topics and issues to work, but everybody was on mostly the same page in terms of trying to make it work out right.

WRIGHT: A couple of the issues that I know you tackled while you were in there was, one, with the hydrogen leak in the Shuttle fleet.

NICHOLSON: Yes. [Laughs]

WRIGHT: Tell us about that.

NICHOLSON: Oh, that drove us crazy. [Laughter]

WRIGHT: Well, tell us how you got that resolved and about the process, because the fleet was grounded for a while.

NICHOLSON: Yes. Well, we detected that leak, and we pulled together a team and tried to figure out where it was coming from, etc. Gosh, that's a long time ago. Couldn't find it and couldn't find it, and finally went back out to the pad, and sure enough, it was still there. Finally the team of guys—and I don't recall exactly who; I know Chet [Chester A.] Vaughan was on the team and some other folks—came up and found the source of the leak. It was fairly straightforward to fix it once we found it, but it was extremely and difficult and trying, I mean, to figure out where in the world that was coming from. Of course, it drove the whole team crazy for months.

WRIGHT: Was that your decision to ground the fleet until you could find it?

NICHOLSON: There wasn't any doubt in my mind that was the right thing to do. I'm sure we had a telecon [teleconference] with Washington [D.C.] [and] that I said, "Yes, we definitely think we need to fix this before we fly." Everybody agreed, so [we did get on with finding and fixing the leak].

WRIGHT: Another issue that, as you mentioned, that always cropped up here and there, of course, was cost and budgets. I understand that you initiated a planning effort called Shuttle Vision 2000 that would reduce the cost of the Shuttle operations. Could you share some details about that and why you initiated that whole plan?

NICHOLSON: Well, it was clear that if the Shuttle was going to really be the thing we all wanted it to be, we had to get the cost down, and if we wanted to do other things. [Laughs] So we just put together a Tiger Team and went off and started scrubbing through all the areas of the program and brainstorming the kinds of things we could do to reduce costs. So it wasn't any more sophisticated than that. It was just a matter of getting the whole team on the same page.

It was something that I'm not sure had really been done before, which was to sit back with a team of folks that had been doing all this work and brainstorm and start talking about how you could do things cheaper. We do that a lot nowadays, but back in those days we really hadn't done that very much, at least not that I was aware of. It was amazing. Guys would say, "Well, shoot, if you'd just give me this this way instead of that way, I wouldn't have to spend all this time to fix it." So it was a productive exercise, in terms of the team figuring out how they could do business more efficiently.

WRIGHT: So seemed to be a well-received effort through the ranks? Sometimes people get a little territorial about their budgets.

NICHOLSON: It's a pain for technical people to have to worry about that, but I didn't see a lot of protecting turf kind of reaction. Everybody pretty much got on the same page that we had to do this, and jumped in and tried to make it happen.

WRIGHT: During the nineties there was an upgrade of the Orbiters. How were you involved in setting that in place?

NICHOLSON: Well, there was a lot of discussion about upgrades, and really, it was just a topic of conversation pretty much while I was in the Shuttle Program Office. When I got to Engineering, it became a little more serious.

So we put together a team of folks to go look at each of the subsystems and to come back and talk about should we upgrade; if we should, why? And what were the penalties in not doing that, etc., etc. And went through each subsystem and talked about what are we going to have to do to fly this thing for another ten years, and what are the downsides associated with that for this particular piece of hardware. Put all that together and then took it to the Shuttle Program in terms of some ideas and concepts for what we might do to upgrade the vehicle to keep it flying efficiently.

WRIGHT: Okay. Well, I wanted to ask you, too, or mention that when you were still leading the Shuttle Program that you got to welcome a new Orbiter into the fleet when the *Endeavour* arrived.

NICHOLSON: Yes.

WRIGHT: That would be a nice memory for us to hear about. How were you involved through the design and development of that Orbiter during the manufacture of it? Were you part of the team that basically brought *Endeavour* online?

NICHOLSON: Well, of course, the design had all been done. It was a matter of getting the funding associated with building another unit, and I spent a lot of time out looking at the hardware and checking on how things were going and that sort of thing. But it was mainly Rockwell and guys doing their thing; I didn't find it to be a big deal other than happy times to get another vehicle in the fleet and just sort of keeping your eyeball on it to make sure it was staying on track. The guys did a great job.

WRIGHT: Well, the spacecraft was reported to be a 1.5 billion investment, but it's supposedly arrived for $50 million less than what it had been forecast. Was that a nice—

NICHOLSON: Fifty million out of 1.5 billion doesn't even [unclear]. [Laughs]

WRIGHT: Okay. [Laughter] Now I've been corrected. I'm understanding more about budgets now.

A second Shuttle Carrier Aircraft came into service right at the same time, so you were able to have two new pieces of equipment. Again being a part of Air Ops [Operations], was that part of your area, too, when the new SCA came on?

NICHOLSON: Well, the carrier was mainly handled by the MOD aircraft guys, okay? They really took care of that.

WRIGHT: During the early nineties NASA began the talks with the Russian Space Agency about putting an astronaut on the Mir. Then that evolved into the Shuttle going to the Mir as well. I know that you were back in the Engineering Directorate when a lot of that happened, but were you involved with those early talks?

NICHOLSON: No, they had a separate group of folks dealing with the Russians for the Mir thing. No, the basic Shuttle Program was really concentrating on flying Shuttles, and there was another group of guys off talking to the Russians about doing Mir. Then I moved to Engineering, so I had even less interface with it. So I didn't really have much involvement in Shuttle-Mir.

WRIGHT: Then the Station; I know the first module launched in '98, but as you mentioned, you had done payloads so much earlier, and then some of those aspects transferred over. Were you involved at all with the early days of preparing for the Station as far as the Shuttle was going to be impacted?

NICHOLSON: No, not really, because basically the interfaces were all established, pretty much. I mentioned to you I was involved in Space Station studies early on, but I was in Engineering during most of that time frame. I don't know if anybody has told you or not, but when the Space Station Program Office got first started, they basically instituted a mantra not to do anything the way Shuttle Program did it, because it was too expensive. So they really didn't want to have

Engineering heavily involved in the design of their hardware. They wanted to do it from the Program Office to the contractors, and so there was this big shift of emphasis.

So that started out when they had the Space Station Program Office in Washington, etc., and then that got all totally reformulated and brought back to JSC for the lead, etc. We gradually moved from the position where Engineering wasn't involved to where Engineering had Subsystem Managers again, just like we had done on all previous programs. So I was involved in making that happen to support the program and setting up the processes and the organization to get the right engineering people involved in the design of the hardware for Space Station. That was a big shift over, when they finally evolved to doing business a little more like what we had done in the past.

WRIGHT: Interesting. The Shuttle Program, you were pretty much involved for about twenty years. As you know, we mentioned to you when we first talked about you coming in and visiting with us, that there is a project that Dr. [Helen W.] Lane is working on, and one of the areas that she'd like for us to talk to you about is what you believe to be the most significant or unique accomplishments of the Shuttle Program as a whole. So if you could share with us what you think those might be, as far as scientific, engineering, security of the nation, or just overall, your impressions and your experiences that you feel like the Shuttle Program has helped shape.

NICHOLSON: Well, it changed the mentality a lot. Before the Shuttle Program, we were doing stuff for the first time. You know, Apollo and Gemini and Mercury were just all kinds of learning, and the experience factors associated with all the subsystems and the kinds of things you need to do to make them work, etc., just was invented from the floor up.

The Shuttle Program, from my knothole,…was really the first step of a group of experienced engineers at NASA who had been involved in spaceflight hardware that were now dong the next one. The guys who did the early ones came from aircraft industry to Houston and started trying to figure out what I want a spacecraft to look like.

So it was the case of transitioning from make it up to take the experience you've got and figure out how to make it better and do it more efficiently. So, to my mind, the Shuttle basically served as the vehicle that cemented the design capabilities for human spaceflight, and it serves now as [a source of] a cadre of people who have been involved in that kind of stuff that can now go make exploration happen far cheaper, in my opinion, because they're not having to invent it from the ground up. They know how to design subsystems. They know what they have to do. There's always a little new technology here and there to make it a little better, but it's not starting off from scratch anymore.

So from our knothole, that's what the Shuttle Program has really contributed. As a matter of fact, I've seen it when I was involved in the CEV [Crew Exploration] Vehicle. The team of guys we had put together could come up with what the systems had to look like, how much they weighed, etc., etc., etc., just rapidly, because they just pulled all the data they had up here in their thoughts, whereas the first group of guys didn't have any of that. They made it up. So that would be, I think, the most significant contribution that the Shuttle Program has made to our country and our space business, is providing that synergy for that core of knowledge that can move forward.

Now, other than that, you know, it's a spiffy machine. Gosh, designing something that can fly and fly again and fly again and fly again and fly again; the first time we've ever done that

in space. But the real core to my mind is the former, is that it served as the pillar for wherever we go.

WRIGHT: I want to ask you to talk just a second, too, on that same basis of the payload ability, what you learned or what you feel the Shuttle has taught us about being able to do the payloads for future space exploration as well.

NICHOLSON: Well, of course, for space exploration, it's a different ball game. The payloads will be pretty much associated with the kinds of things that you want to provide to the crew so that they can contribute to the scientific knowledge associated with whatever the mission is. The aspects that we, of course, learned in the Payload Office in Houston was more associated with—and the Shuttle—with the integration of all these things. So we learned a lot about how you take other people's hardware and put it into a system, but in terms of the payloads themselves, we didn't really get that involved in what they were doing and why they were doing it once they got to wherever they were going.

WRIGHT: But the operational aspect taught about how everything affects everything, and impacts, and the volume and the weight. All of that had a big bearing on what you did?

NICHOLSON: Yes. Yes.

WRIGHT: You have been in a unique position, because you worked so much in those areas for supporting the Shuttle system for NASA, but then when you left, you went on the commercial side and are still working in that operation.

NICHOLSON: Yes.

WRIGHT: Tell us how the two differ, working on the commercial side versus the government side, to meet the goals of the program.

NICHOLSON: The interesting thing to me is a lot of the similarities. [Laughs] The major difference, of course, is on the commercial side there's a certain amount of focus, attention, that has to be paid to making profit and keeping the business healthy. But in terms of the interface in a day-to-day basis, my experience has been that on the technical side the thought processes are very similar. The goals and objectives are very similar. There's not a lot of difference between what the technical guys worry about on the NASA side versus this technical team on the contractor's side.

Indeed, the other similarity that has been interesting to me is while on the government side you always worried about how much budget you've got; do you have enough money to do the program? On the contractor's side you're worried about I've got to get this done for what I told them I would do it for, because if I don't, I'm going to get hit. So the objectives there are fairly common, if you think about it, and if you create this communication and discussion path between the two, it's amazing to me how your goals and objectives fit. [Laughs] So I haven't found it to be like a day-night shift at all.

WRIGHT: Well, in your previous work with JSC, you certainly dealt with a lot of different type of contractors, and then now being on the other side, I guess that understanding and those dealings -- did that help you be able to understand NASA's expectations and the way they work?

NICHOLSON: Sure. Yes. Oh yes, sure. Yes. I have a good feeling for what's motivating the guys on the NASA side. No question about that, because I've been there. [Laughter]

WRIGHT: And helped create it. What do you think was the biggest challenge of all that you did when you were working as part of the Shuttle Program?

NICHOLSON: Gee whiz. Probably the biggest challenge was keeping some kind of a personal life alive, [laughs] because the programs can just totally eat you up, especially the big ones like what we had down here at JSC. They can just eat you up if you let them do that.

In terms of challenges within the program, probably the biggest one I found was keeping the organization—not the Shuttle organization itself, but all the supporting organizations—all aligned. In other words, like the Mission Ops guys, the Flight Crew Ops guys, the Engineering Directorate, keeping those guys all aligned from a management sense down as to what we're trying to do, and what our real goals and objectives are, and what are the important things we need to be worried about, because you had to carve out the time to go have those interfaces and discussions and be sure that everybody's working off the same page. I wouldn't say it was a huge challenge, but it's just one of the things you had to pay attention to.

WRIGHT: So are there any essential tips you'd like to share with us on what you did successfully to keep those aligned and keeping everybody pointed in the right direction?

NICHOLSON: Communications. Set up the process to talk. That's what it's all about. That's what it's all about.

WRIGHT: What do you think to be the most rewarding aspect of when you worked in the Shuttle Program?

NICHOLSON: Oh, there's no question—there's two things. One is seeing the vehicle fly and having a successful mission. Oh, what a great experience that is. The other most rewarding thing is watching the people grow. I just had a blast watching the folks that used to be reports to reports to reports within Engineering or within the Shuttle Program, how they've grown and matured and taken on new stuff. So it's a combination of watching the successes occur and watching the people grow.

WRIGHT: Are there any other thoughts? When you were thinking about coming in today, are there other aspects of the Shuttle Program or some of the experiences that you can think of that you would like to discuss with us?

NICHOLSON: Gosh, I can't think of anything off the top of my head that we haven't already talked about.

WRIGHT: I'm believe Jennifer has a couple of questions for you.

ROSS-NAZZAL: I have some questions about payloads and then just general questions for you about the Center. The Get Away Special canisters, is that something that your office had come up with, that design?

NICHOLSON: It came up while I was there, yes. I wouldn't take any credit for it, though. [Laughs]

ROSS-NAZZAL: All right. What sort of involvement did you have with the student experiments? Were you interfacing with the students or the schools as they were working those experiments that were going to be included on the Shuttle?

NICHOLSON: No. I was very supportive of it. That all happened when I was in more of a management role, and so I did not. We had people interfacing with all that, but I wasn't directly interfacing with it. I was just one of the people that said yes, let's make this happen.

ROSS-NAZZAL: You mentioned that you were doing some tours in Europe, trying to promote, basically, the Space Shuttle and its capability for payloads. Can you share with us some of those recollections that you had and some of the countries you might have visited?

NICHOLSON: Oh, gosh, we spent a lot of time in England and briefed the government and industry teams on how you could use the Shuttle. We spent a lot of time in France and Italy

doing the same thing, and Germany, also. So it was mainly through the major countries in Europe. The objective was to make them aware and try to convince them that flying their payloads on Shuttle could be made easy and doable, and get them interested in doing that.

ROSS-NAZZAL: Was there any competition in the late seventies and early eighties with the Space Shuttle, in terms of deploying payloads, that you felt you were competing against?

NICHOLSON: We didn't have the sense. Of course, the expendable launch vehicles were still around, and they were doing stuff at the time, so I'm sure they felt we were trying to inject ourselves on their turf. [Laughs] But we were mainly just interested in making the Shuttle Program do what it's supposed to do. Of course, we weren't in the business of making money, and so from that point of view we didn't sense the competitive environment, if that makes sense to you.

ROSS-NAZZAL: Oh, absolutely. Did you work with any of the other Centers, like Goddard [Space Flight Center, Greenbelt, Maryland] or Ames [Research Center, Moffett Field, California], on some of their payloads?

NICHOLSON: Sure. Sure. Sure.

ROSS-NAZZAL: Did you work with Ames, for instance, on the animal enclosure experiments, and how did that work?

NICHOLSON: Well, the biggest interface, of course, was with Goddard on the Hubble Space Telescope, and we had a lot of interfaces with Huntsville on some of the satellite hardware they were doing down there. My interface with the Ames folks was very small in terms of the payloads they were building, because they basically interfaced, as I recall, through the Life Sciences guys, mostly, and so they would bring the stuff to the Shuttle Program. So it was mainly Goddard and Marshall.

ROSS-NAZZAL: You mentioned the Hubble Space Telescope. What were you interfacing at that point? The space telescope it was supposed to launch, of course, in '86, but it didn't end up launching because of the *Challenger* accident. But what was your involvement with that?

NICHOLSON: Well, we were involved in the integrating it into the Shuttle, you know, and doing all of the coordination for what the loads would be, etc., etc., so that they could design the hardware properly.

ROSS-NAZZAL: Did you work at all with McDonnell Douglas on the Continuous Flow Electrophoresis experiments?

NICHOLSON: I remember the name, but no, I wasn't directly involved. [Laughter]

ROSS-NAZZAL: Did you work with the Saudis at all or Mexico with some of their payloads that were launched from the Space Shuttle?

NICHOLSON: Yes. When that was done, I was at a higher level, and so the direct interface was through the Payloads Integration Manager. So I did meet some of those folks and have a chance to talk to them and stuff like that, but I wasn't on the day-to-day interface with them.

ROSS-NAZZAL: You had mentioned the Payload Support Center in the control center. Can you tell us where that was located at the time?

NICHOLSON: Well, let's see. Gosh, I'd have to almost go over there. It was the main control center. It was around the corner on the second floor, and it was a fairly small room that was allocated for payloads on the—which side of the building would that be? Let's see; I'd have to almost get my map out, but it was located close to the control center, the main control room, but not adjacent to it. I mean, you had to come out of the Payload Control Center and go walk around the hall to get to the main control room.

ROSS-NAZZAL: How many people normally worked in that center?

NICHOLSON: It depended. It would depend on the mission, because on several missions, we would have multiple payloads on a given mission. So it would not be unusual to see fifteen or twenty folks in there, plus we had a little, small room for the non-involved people, like the managers from those different organizations had a little room they could sit in to watch what we were all doing down there in the Payload Control Room. I would bet it would hold ten or twelve folks, maybe. So it has that order of magnitude. We would have the guys from the PAM Project

and then the satellite that was riding on top of it would have folks in there. Then we'd have our people in there and so it would be of that order of magnitude.

ROSS-NAZZAL: Were you operating twenty-four hours a day, or were you just operating when the payload was ready to deploy and then after the deployment?

NICHOLSON: Primarily just as you stated it; it wasn't necessarily twenty-four hours a day, although you always had to have somebody available in case something happened. So there would be some people there twenty-four hours a day, but the main teams would be there when the operation was occurring.

ROSS-NAZZAL: You mentioned you provided support. What does that entail for the payload, with interacting with the Flight Controllers and the crew? What did that process entail for your folks?

NICHOLSON: Well, the Payload Control Officer who is in the main control room, we would have communications with them from the different consoles in the Payload Control Room, and so he could inquire to payload 1 or payload 2 or payload 3, or all of them if he needed to, and ask them for data or information or support or whatever. So I'm not sure that answered your question; but it was all through the Payload Officer who's in the main control room.

ROSS-NAZZAL: I was curious; I just have some general questions for you. What was it like when the female astronauts came on board in '78? Did you notice a change at all working at JSC with more professional women coming on board?

NICHOLSON: Not really. They were just normal, competent people, and so I didn't really observe a big change. We had a lot of female engineers at the time, so that environment was normal. I mean, it was just one of those things that was time to happen, and it happened and yea verily.

ROSS-NAZZAL: The reason I asked is Mr. [James R.] Jaax had told us he attended some sort of workshop about working with women, so I was just curious if that had a larger impact on the Center.

NICHOLSON: I don't remember ever attending that workshop. Jim needed a lot of training. [Laughter]

ROSS-NAZZAL: When you became the Shuttle Program Manger, can you talk to us about your work with Headquarters, working with the Office of Manned Space Flight, and the Administrator?

NICHOLSON: Yes, it was extremely interesting, because for a while when I was Shuttle Program Manager, I was a Headquarters employee. Then I was a JSC employee again. So there was a lot of interfacing and data that had to be done with Washington. I guess it was a constant challenge

to keep in line with where they were going, because they were dealing with the political environment. We're sitting down here dealing with the technical environment, and to be honest with you, ne'er the two shall ever meet. [Laughs] Or at least rarely.

We'd get an action item, and we're in the middle of getting something done that we thought was darn important, and so we'd have to stop and go get some people offline and start working on what data they needed in Washington next week or the next day or the next hour.

But I always found that the folks that I dealt with up there, they were under a lot of pressure because of their interfaces with the outside world, and in the end, if we had a real issue that we flat couldn't do that for two weeks because we've got to make this other thing happen, they would say, "Okay. Well, fine." So I never had a case where we just ended up totally out of bed with one another. Even though we were always out of bed, we would get synched up whenever we had to. [Laughs] They would always give us the room we needed when it was mandatory.

ROSS-NAZZAL: Did you primarily work under Admiral [Richard H.] Truly, or were you also in the office when Dan [Daniel S.] Goldin became Administrator?

NICHOLSON: That's a funny thing. Yes, it was interesting, because if you'll recall, there was this move to put the Shuttle Program in Florida, move the Shuttle Program to Florida, and that was while I was Program Manager.

So I bowed, and I said, "Okay, we'll do that." So I had got my team together and talked to them about, you know, "We're going to have to move the Shuttle Program to Florida, and some of us are going to have to move, and some of us can stay here, etc."

So I got a couple of folks spun up to go do that. One guy went down and actually put money down on a house. My wife and I had scheduled a trip to Florida to find us a place to live in Florida. So we were scheduled to leave. I got a phone call, and we were scheduled to leave the next day on a flight to Florida to go look for a place.

The phone call came in, and said, "Leonard."

I said, "Yes."

Said, "Mr. Goldin wants to talk to you." He had just come on board.

I said, "Okay, when does he want to talk?"

"Well, he wants to talk tomorrow afternoon."

I says, "Okay, I'm going to Florida, but I can go to Florida and then come to Washington and be there at such and such time."

They said, "Fine."

So they set it all up, so I took my wife to Florida and dropped her off at the hotel and then flew on to Washington, not knowing what the subject was, okay? So I got to Washington and found Mr. Goldin's office. I don't think I'd ever been in the Administrator's office before. I walked in, and he greeted me, and we introduced each other, and he says, "I have a question for you."

I said, "What?"

He said, "I hear you're moving the Shuttle Program to Florida."

I said, "Yes, sir, we were told to do that."

He said, "Do you think it's the right thing to do?"

I said, "No, sir."

He said, "Well, then don't do it."

I said, "Yes, sir." That was the end of the meeting. [Laughter] So I called my wife and I says, "Sweetheart, I'm coming to Florida to pick you up, and we're going home. We're not going to move."

That was hilarious. That was the funniest thing that had ever happened to me. [Laughs]

ROSS-NAZZAL: Think of all the influence you had over the Administrator. [Laughter]

NICHOLSON: He obviously had already made up his mind.

WRIGHT: Glad you agreed with him, huh?

NICHOLSON: Yes. [Laughs]

ROSS-NAZZAL: The only other question that I had that I thought of was I'm wondering if you could tell us what the mood was like at the Center following the *Challenger* accident until return to flight.

NICHOLSON: Well, I think I described a little bit what it was like after and then immediately after, and then my assessment was that within a fairly short period of time every single individual on that site was focused, got their brain and energy focused on getting us back to flight. So it was a huge unifying "Let's fix it and get going" kind of an environment. We all got impatient with how long it was taking because of the hardware changes we had to make, but everybody understood why we had to do that. The team was more focused, because everybody

just saw that [fixing the problem was] absolutely essential and threw in wherever they could to make sure we got it done and got it done safely.

ROSS-NAZZAL: Well, I think that's it.

WRIGHT: Well, before we close, although you weren't at NASA officially when [Space Shuttle] *Columbia* [STS-107] fell, how did that affect the operations that you were working on at the time? And then certainly personally, you had worked so long with that Shuttle Program and to watch *Columbia* be lost.

NICHOLSON: Oh, well, of course, I was working on the Space Station for Boeing. When I heard about that accident, I just couldn't believe it. Of course, it was devastating, also, in terms of knowing some of the people, etc.

It was a very traumatic time from the point of view of everybody understanding what we're going to do. I mean, there was so much chaos associated with are we going to abandon Space Station, are we not going to abandon Space Station, and a big percentage of the population around seemed to think that we were going to have to stop doing Space Station.

[The team was] determined that that wasn't the right answer and [concentrated on figuring] out how we could keep flying with just the Soyuz and Progress. So we spun up the whole team [to figure] out how to keep the thing alive, and what we'd have to do, and what kind of parts and spares, and how could we do work-arounds, etc., for issues and problems without having Shuttle to bring stuff up. So there was a huge amount of energy associated with coming up with all the plans to make that happen.

I think an interesting thing that occurred to me in that whole process was they had talked about that pod falling off, hitting the wing. Then they went back and looked, and [saw that the] pod [fell] off before. When I looked back at that data, it fell off one time while I was Shuttle Program Manager, and I never heard about it. So it reemphasized [the necessity] to listen to the hardware [and look at all the data. The amount of effort we put into qualifying the hardware almost ensures that it will tell us ahead of time that something is not right.]

A lot of that [is] there now, but it really taught me, you know, we didn't listen to [early warnings from] the O-rings; we didn't listen to the [earlier] pod falling. If we had listened to both of those, we possibly could have avoided both of those [incidents]. So it really reinforced the listen-to-the-hardware mentality. As a matter of fact, when that happened and as I realized that, I really put a lot of emphasis on our technical teams making sure they had gone back and looked at all the failures they'd had on their hardware, and were there any trends that they were missing as a result of that.

WRIGHT: That's a good thought to end with. We would like to stop today.

NICHOLSON: Okay.

[End of interview]