DONALD S. "DON" NOAH

August 4, 1998

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The interview begins with Don Noah speaking of his role with the Shuttle-Mir Program.

Noah: I'm not sure how fresh I am. It's been almost three years since I actively worked Shuttle-Mir. Greg Lange and I, Greg actually was [the first lead integrator]from this office [Cargo Integration Office], was the first guy that was the lead integrator for the first Shuttle-Mir mission, which was 71. At that time, that was the only mission we were going to have. So he was key in setting up a lot of the initial working groups and the way we were going to work.

Then after we got started on 71, then we started on the rest of the Phase One Program. It became rather than just one joint mission, it became a Phase One Program, which was going to help ISS [International Space Station]. There are a lot of folks that were skeptical as to how much benefit NASA was going to get from a Phase One Program. They didn't know how much we could learn from the Russians. But I'll tell you, from my perspective it was vital--if not vital, very important to NASA to do the Phase One Program, because we've not only learned how to integrate an orbiter vehicle to a space station, we also, and Frank [Culbertson] probably has already told you this, learned how to logistically support a space station, which, of course, is going to be important later. And we learned that we've got to do a lot of things quick, with a quick turnaround late in a mission flow.

I mean, in the Shuttle Program we were used to developing our requirements, developing our design for the payloads and all the hardware that integrates the payloads into the orbiter, and doing that months and years in advance. As you get down inside of twelve months, everything is more or less a template-type thing, where you progress on to a launch and you launch. There's very few major changes inside twelve months. At least, it used to be.

Well, Phase One taught us that you may have to decide to fly something two months before launch and figure out how to load it into the orbiter, whether it be in the space lab module or somewhere in the cargo bay, or even in the mid-deck, and build the integration hardware, test it out, go fly it.

So the Phase One Program, to me, was vitally important to the Space Station Program, not only from a station program, but also from the Shuttle program's prospective. We learned a lot, because a lot of the processes that we'd defined and developed in the Shuttle-Mir Program we're using today in the ISS Program, in our integration with ISS folks. So it was a very good experience, not only from a Shuttle Program, but from a personal standpoint it was by far the funnest thing I've done since I've been at NASA.

Talking about oral history, the HST, back in the early eighties, whenever we launched HST, they did an oral history, and I was the safety engineer for HST. I thought that was kind of neat. I think the

Smithsonian [Institution] did that. That was a fun project, but nothing I've done exceeds the self-rewarding experience that I've had with the Phase One. It's just a lot of fun.

Wright: Tell us how you got involved with it.

Noah: Well, I had the good fortune of working for Larry Bell, who, at that time, was the cargo integration. He assigned me to be the logistics manager for the first 71 flight. In other words, there was some small stuff that we wanted to fly on the Shuttle-Mir, on the first Shuttle-Mir Program, our mission to transfer to and from the Mir. So we had to write the requirements and develop some interface control documents between that hardware that the Russians wanted to fly on board the Shuttle, so that we could fit it inside the module or fit it inside the mid-deck to get ready to transfer over to Mir. So I got started doing that.

Then after 71 became just the first of nine missions, I got assigned as the lead for all Shuttle integration on the second Mir mission. The second Mir mission had another element added to it that was different from the first one. The first one we were taking a space lab module up, docking with the Mir, unloading some stuff out of the module and then taking some stuff off of Mir and bringing it back.

The biggest challenge on that mission was it was the first time that we had orbiter to a station stage that we had to integrate. So there was a lot of new ground to plow in doing that. On the second mission, we had to take up a Russian-built element, which was the Russian docking module. So not only did we have to integrate the orbiter to the stage, the station stage, which the Mir between 71 and 74 did change, they added another element, we also had to integrate a Russian-built piece of hardware into the Shuttle and then transfer it on orbit and leave it there. We had to do this inside of two years. For any major program within NASA, a major payload that flew on Shuttle, it was almost unheard of. Not only did we have just the technical challenge of doing that, even if it had been an American company, we had the language barrier and the design process that the Russian use in building their hardware and the understanding of our requirements. So it was a daunting challenge.

But when you got a group of engineers that the Russians have working on the Shuttle-Mir Program--and then, of course, it was easy to pull some of the better NASA folks, because a lot of folks at that time wanted to work on the Shuttle-Mir Program. I mean, we had exceptional support, both on U.S. and the Russian side. So it made what seemingly was an undaunting challenge something that was doable. The Russians, I mean, you can't underestimate the work that they did in that time frame. They designed, built, and tested the docking module in less than a year and a half and delivered it to KSC. We had, I don't know, two or three months of KSC processing time and we put some slack in there just because it was the first time and we didn't know what kind of problems we were going to have. We didn't know if we had to

go change hardware and take stuff over to our shop and remill it or what. But it turned out, we went through that process and we finished a month ahead of time. We were sitting there a month before we needed to ready to go fly. It was really a well-run program.

The Russians, you can usually tell the significance of a project based on who they assign. They assigned a guy that was a deputy design general to Mr. Semonov--something like that; I'm not pronouncing it right--to head up that project. Not only was the guy technically competent as a manager, but this guy came up through the design area and he was not only respected as a person, but as a designer by all the engineers that worked for him. So when he spoke and said, "I want to do this," it got done and it got done quick. So he had the horsepower from a management standpoint to get things done across different elements within RSC Energia, but he also had the respect and the leadership to lead the engineers that were actually doing all the work. I never heard anything but praise from any of those guys when they talked about him. He was, he was an exceptional guy. His name was Igor Efremov for the record.

Wright: The Russians engineers and the American engineers working together, were there any problems between the two?

Noah: No. I remember the first meeting we had, they were here for just a joint integration meeting for 71. During their visit here, NASA announced that we had a Phase One Program. They said on the second mission we want to fly another module. The reason for the other module was on 71--I don't have a picture.

[Referring to photographs] This right here is the Krystall module. On 71, they have an arm right here that moves the Krystall module from node to node. The Priroda and Spektr weren't there on 71. We had to move the Krystall to this axis in order to provide clearances for the orbiter to go to dock.

If you didn't have this docking module, which is this part, and this was the permanent location for the Krystall, and this arm, they didn't have confidence to keep moving this every time we came and flew, they didn't have confidence that they could move it from one place to the other, and if that arm failed in the transition, you've lost the module. So they wanted to get the module to its permanent location and leave it. So to provide us clearances with these solar arrays, we had to add this extension to the Krystall module that allowed us to do all the subsequent missions.

So if you didn't do 74 right, you couldn't do any of the rest of the missions because you were stuck. So that was the reason they said, "Well, we don't want to move the Krystall module every flight, so we need to add an extension to provide the orbiter with the clearances with all the solar arrays." Then they said, "Well, while we're doing that, we'd like to take two more solar arrays to replace." If you look on the two longest solar arrays on the very left side of the picture there, they wanted to replace those two with new

solar arrays. So we said, "Well, now we've got to integrate these two solar arrays in the cargo bay and how do we figure out how to transfer them out of the cargo bay onto the Mir?" Because we weren't planning an EVA to do that on that flight. I think one of the Rockwell engineers who was here in support of the meeting said, "Well, why don't we put them on top of the docking module." So that was how the idea of building that module--and then we carried, and you can't see it in that picture there--there's a box on the other side of that. It's sitting on top of the docking module where two solar arrays--I may have some photographs if you'd like to see those.

Wright: Please.

Noah: You can see it here. Let's see. See, here's the docking module with the orange thermal blankets. Here's one of the solar arrays and here's the other solar array. One of the solar arrays had U.S.-built solar panels that Lewis Research Center, I think, provided. Then the other one was an all-Russian array.

Now, they eventually deployed--here's a better picture that shows the docking module with both solar arrays. These black dots are not the measles; it was a new system that we were trying to use on Space Station. It's called Space Vision System that uses the orbiter's videocameras to give a relative position of this module and then there's some black dots on some other part of the orbiter. The software can take the video and calculate the relative position of one object to another object. Then in your berthing of one to another you can align things based on where these dots are.

Anyway, it was a test. It didn't really work on this mission. We had polka dots on orange and then these polka dots here. We had some problems on the 74 mission with not getting enough contrast in the photos, but hopefully they fixed that by now, because we are relying on that system on STS-88. Anyway, it was a big orange tube with solar arrays on both ends. Here's a picture of it sitting in the cargo bay.

Wright: Must have been a sight for all of you to see.

Noah: Here's a better picture. It was very satisfying once we got it all put together and stuck in the cargo bay. Like I say, a lot of folks that build things for a living, when they stand back at the end of the day and look at what they've done, you can see some tangible results of their labor. It's kind of the same feeling. You work for a year and a half and spent a lot of hours, twelve-hour days, six days a week, months over in Russia, it's very satisfying.

Wright: Where were you when you actually saw it work? Where you here?

Noah: I was here in mission control.

Wright: Would you explain to us the atmosphere or the environment that you were in?

Noah: Let's see. Well, once the designers actually build and deliver a piece of hardware and install it in an orbiter and we test it and check it out, we're pretty much done. The mission ops folks take the design and then they write all the procedures and we review the procedures and the flight rules that they write based on operating that hardware. They get all the data that they need into their console. So as long as everything's nominal, the mission ops folks take the hardware and they operate it. They have all the drawings and all the design parameters that they need. They don't really need our help. Now, if there's anything that in contingency that comes up, the engineering folks are usually in support rooms that if something comes up that's off-nominal, then we'll provide an assessment and say, "Here's what our recommendation is."

In the docking module's case, I was in the support room and we didn't have anything to do, which was good. That's the way I like it. So every system on the module worked without flaw. I mean, everything was nominal. It was very, very nice. All the pieces fit together. You worry about these things. You're looking at drawings and you're trying to keep all this stuff straight. If you'll notice on that drawing there, the orbiter's clocked about 25 degrees from the X axis of the Mir, which it runs the long axis there. That clocking was based on a lot of different parameters. We had KU-band coverage that the orbiter has to get. We had thermal constraints for both the Mir and the orbiter. We had waste-water dumps that we wanted to do. A lot of these things we had to go take into account and determine what was the optimal position of the orbiter relative to the Mir station, and it was something we were going to have to live with for eight missions.

In doing that 25-degree clocking, we had a lot of different docking aids between both the orbiter and the docking module, which would be used on subsequent missions, and then the orbiter with the docking module relative to the Mir. So you got two different docking planes that I'm trying to integrate here and I've got docking aids for each one of them. You go through your head and go through all the drawings a thousand times saying, "Yes, it's right," but then when you get on orbit you say, "Is it really right?" [Laughter]

Fortunately, when we went up and we docked with the Mir, I was looking at the camera that the crew was looking at, as video was available. I said, "Yes, that's lined up right." Then after we docked, there was a camera that was on the orbiter truss work for the ODS that pointed to another target that was on the docking module, in which we didn't use, because we didn't need to as a contingency. But I asked them to videotape that target, so if we ever had to use it on a subsequent mission, so I wanted to know how much misaligned was it.

The Russians built that target stand. We built the target, but they build the target stand-off, or

support, independent or just from our drawings that I said, "I want that target at this point, with these tolerances." So they went off and built it. Then our camera is built and attached to that truss to this point. When they showed the video, it was perfectly lined up. I mean, it was almost center. It was amazing. I couldn't believe it. [Laughter] Like I say, everything on there was nominal and fit almost perfectly. It was very satisfying. It was not necessarily totally my doing; it was a lot of different engineers that had different inputs into it.

This is a picture of when we were at KSC. We had just completed the integration of the solar arrays and put everything on top of a docking module. I was down at KSC and this is a ceremony where they were sort of officially saying we're complete. But I remember waking up in the middle of the night in a cold sweat and I'm thinking, "Did I give the Russians the right coordinates?" for a camera that was on the docking module relative to the mechanisms? So I'm thinking. I said, "I think I did." So I go up the next morning and I sketch me a photograph, a picture of the docking mechanism and where the camera should be relative to that mechanism. I get at one end of the docking module and I hold it up and I says, "Yes, that's about right." [Laughter] I said, "I guess I did give them the right coordinates." It was a good project.

Wright: How much of a challenge was it for you personally to work with such a team of international partners?

Noah: Well, when you start into it, you're kind of apprehensive because you don't really know. There were some new Russians that were coming in that I hadn't met. There's a thousand things that goes through your mind about, am I going to be able to work with them? What kind of relations are you going to have? What are the obstacles? I knew there were going to be technical obstacles that we'd face. Is there going to be an environment of joint work, or will be an adversary-type environment?

Luckily, it was totally a joint effort. Mr. Efremov and I, there never a problem that we couldn't, within a day, come up with a reasonable resolution that was satisfactory to both sides. He understood in my position there were a lot of things that I just couldn't do from my side in terms of solving a problem. Likewise, there were things that he couldn't do, that if I was able to help, that I certainly would. It was definitely a joint effort.

That was not only at our level, but it was also the same type environment both at each one of the technical working crews. For the docking module, we had like an avionics technical working group and we had a thermal and ECLSS [environmental control and life support system] working group and a structural working group. I would keep tabs on each one of those working groups and they would report to me if they

were having problems. The environment was totally a joint effort. I mean, we didn't have time to mess around with politics or who was doing what to who. I mean, we had a job to do and everybody focused on getting the job done, what was not necessarily my side versus your side; what's the right technical answer. And if it meant I had to something extra, then that's what we did.

It helped that I had backing from Mr. [Tommy] Holloway. I mean, I never went to him. Of course, I had to have good rationale if I wanted to do something, but the support that I got from him was extraordinary and it made my job a lot easier, too. As well as Frank [Culbertson]. Frank came in as Phase One program manager right about the time we were assembling the dock module. So most of the early effort was complete by the time Frank--but of course, Frank was Tommy's deputy for six months before that. So he was very supportive as well.

Wright: For you personally, how much time did you spend in Russia? Was there a lot of work done here or were you back and forth between the two?

Noah: Of course, we tried to do as much work here as we could, especially in the winter months. [Laughter] But, I don't know, I guess I must have made eight or nine trips over there. The longest trip that I had was a month long. We had what we called a design review. It was more of a verification design review, where we took our team of people over there and we went through their drawings and we went through our requirements documents and we matched what they designed, and in some cases already built, with what our requirements was, to make sure that they matched.

Then we had the KSC folks, we had a lot of ground processing problems--not problems, but open items that we needed to work through. That one even lasted a whole month. It was a series of meetings, but that was the longest time. Most of the time it was two-week stints over there.

Wright: Was that your first time there, was part of this project?

Noah: No, my first time there was in February of 1993 and that's when we were just working on 71. That was the first integration meeting that we had. Larry Bell, at that time, was the co-chair of the integration meeting. As I tell everybody--that was only for a week--I went to Russia in February. We got there at like twelve o'clock at night, Sunday night. Got to the motel about twelve. We got up at three o'clock in the morning. They drove us out to their TsUP, which is their mission control, and we watched--I can't remember what we watched. We watched a Soyuz docking, I believe.

We went back to the motel, ate breakfast, went to the conference facility that we were meeting at. Worked till seven o'clock--six o'clock at night. Go back to the hotel, we eat dinner. We work in the hotel

room till about eleven or twelve every night. This was every day from Monday through Friday.

Then we get up Saturday morning at five o'clock in the morning Saturday morning to come home.

I got asked, "Well, what'd you see of Russia?"

I said, "Well, I couldn't see anything out those fogged windows. I couldn't tell you anything about Russia. All I know is there's Russian people over there and they speak Russian." [Laughter] But that was about it. I mean, that was the first time I went over there.

I went over there a second time in the summer, which was much nicer, with the safety group. It was one of their first safety meetings that they had over there. The reason for that was when I was there in February, no one from the safety office had come along on that meeting and the Russians wanted to talk about the safety process and how they wanted to work that. So I had had some safety background, so I took on the challenge of talking to them about that. So I went back over with the safety group. After that meeting, they were off and running and certainly didn't need my help.

I'd have to say, Moscow in the summer is much nicer. Plus the days are about twenty hours long or something like that.

Wright: So you get more work in per day, right?

Noah: Yes, you can work for twenty hours. [Laughter] Or you can actually get off work and go see some of the city sites. The first few trips were long hours and not a whole lot of amenities in Moscow, as there were in the later trips. Moscow was getting more Westernized, there were a lot more restaurants to eat at, and a little more comfortable. Plus, we got a little smarter on scheduling our meetings at the right time of year. [Laughter]

Wright: So you got to notice the changes of the country, as well.

Noah: Yes. It was amazing, the difference between February of '93 and then I think my last trip was like June of last year. I went over for a support station meeting. The changes in advertisement, storefronts. In '93, I remember seeing all these apartment buildings and there was supposed to be stores on the bottom floors and in some cases there were, but there was no advertisement. Unless the interpreter, if he hadn't told me that there stores in there I never would have known it. He said usually each apartment building had their own grocery stores, some type store in the first floor of them. And they had all these little kiosks or whatever, lined up and down the street in '93. They were this big, from that wall there. They just sold anything from Cokes to liquor to cigarettes to candy bars and bottled water and stuff like that, as well as shoes and clothing and those type things. They were on the sidewalks of the major streets.

But by last year, a lot of those had disappeared and they were moved back into the buildings, into the main store. To me, I could see a drastic improvement. In '93, a lot of the buildings and things were in disrepair, whereas in '97, construction was everywhere. I mean, there was a lot of building and a lot of renovations and stuff like that. So they've got a lot of economic problems, but just from my perspective, at least in Moscow, I mean, it's drastically improving and continuously upgrading.

Wright: Were you able to get around in the city?

Noah: Believe it or not, by the time I got through going over there, I could navigate through the Metro by myself. The first couple of trips, we had the interpreter and he would say, "We've got to go this way," and I was just like a sheep following. [Laughter] But I got where I could read Russian to some degree and I knew some of the key words. I never had the time or inclination or aptitude to learn to speak Russian, which I regret, but I could at least read some of the Russian and I could get around town and order food at the restaurants.

Wright: All your work that was done on the docking module had to go through interpreters?

Noah: Yes. Each one of our working groups, when we'd have a meeting or whatever, each working group would have a separate splinter meeting. Then Efremov and I would have our own management meeting. But each one of these teams had an interpreter that we had to converse through.

I'll have to mention this one interpreter. She was incredible, the one that supported the avionics. Her name was Ella Grier. She's the only person that could--she could carry on a side conversation with me in English, interpret for these two guys, and type something totally different at the same time. She could put out the work of three people. It was just incredible. She was very good.

The key to the success on the electrical interface, all of our electrical, and they were extensive, between the docking module, both while it was sitting in the cargo bay, here we had electrical interface via electrical umbilical that retracted, and when we mounted on top of the orbiter ODS to go dock, we had extensive electrical interfaces. Not one of those we had any problem with. Although I had good engineers, experienced engineers on my side, and they had experience, if it hadn't been for her to put those two together, it never would have worked.

When we'd go to Moscow, she lives over here, and she supported all of our meetings here, of course, but even when we go to Moscow, I said, "I have to have her, because she has all the corporate knowledge for doing that interpreting." I count her as a key participant.

Wright: Part of that team.

Noah: Yes, she definitely was. And became a good friend.

Wright: What you've explained to us, is it the most adventurous payload that's ever been put in the cargo bay?

Noah: Probably not. From the element itself, it's fairly simple. I mean, it's a big tube that's pressurized. It has a fairly complex mechanism on each end. The challenge on this was not so much the complexity. I mean, NASA's flown payloads or integrated payloads that had more complex interfaces with the orbiter and interplay with the orbiter than this did. The challenge on this was doing it in no more than a short period of time. Even if it had been an American company, no matter how simple it was, doing something that large, and it was complex, it had a lot of interfaces, in the short time frame is a big challenge. But then doing it with another country with a totally different language and a totally different culture in how they design and build hardware was the biggest challenge. Like I say, a lot of people worked real hard to overcome those obstacles to make the hardware work as well as it did.

Wright: During that time period, was there one specific time or an area that seemed to be more challenging than the others, that maybe you thought, this wasn't all going to come together?

Noah: I don't recall ever thinking that it wouldn't come together, especially after the first couple of meetings with the Russians that I knew I had to deal with. I never really doubted we could do it, to be honest. It was very evident that the first time I met Mr. Efremov and they came over here, that he was the right guy for the job. Before he got here, I kind of researched on who he was in the organization, as best I could, and it was hard to get information. In talking to some of the engineers during the meeting, just side conversations, about his background, and once I met him and I knew what he was capable of, I didn't have any doubt that if it could be done, he was going to get it done. I knew he had some obstacles on his side. He had to get support from his organization. I knew if they did that, that the Russians would be able to provide it.

That's the thing. We've had a lot of problems with ISS and the Russians delivering modules, but it's only the modules that the Russians pay for. I mean, those guys go months without a paycheck. Not many people work much without a paycheck. But these guys are dedicated. The engineers are really dedicated over there to the space program and they love doing that type work, that they can't think of doing something else. So they stay with it, hoping that things will get better and they will start getting paid.

Eventually they do get paid.

But like the FGB is Boeing contracted RSC Energia to build, whoever, to build the FGB. The Russians built the FGB. Service module is Russia's contribution to the station, funded by the Russians. Or the Russians hadn't funded it. That's the biggest problem. But we were funding, NASA funded the docking module and at a significantly reduced price than what we would have paid an American company for. But knowing that NASA was paying for that and knowing the dedication of their engineers, like I said, I never really doubted, it never crossed my mind that we weren't going to make it.

Wright: You mentioned that as far as STS-71, a lot of new ground had to be plowed. Could you give us examples of some of that ground that you had to do?

Noah: Well, when you talk to Greg Lange he'll give you--because he was the one that helped put in the structure that we used for the rest of the missions, in terms of the sub teams and the staffs and what those were, the responsibilities for the sub teams and how we were operating. He'll give you probably a lot better explanation on how he did that than I can. I can tell you, and you've probably heard from George that we had technical working groups at each one of the disciplines and we had a joint working group document for each one of those groups, and each group was responsible for their document and they signed it. Once they signed it, then George and his Russian counterpart, as a management oversight, would sign it as well.

Wright: When you were over there for that meeting, you said you got see a Soyuz docking. That was the only time you got to do something other than work.

Noah: That first one, yes.

Wright: How was that to watch that?

Noah: Well, the video was not that good. Plus I was about half asleep, as I recall. [Laughter]

Wright: Or maybe the video was real good and you were just half asleep. [Laughter]

Noah: I think my looking through eyelids it was kind of blurry. I think I remember thinking I'd much rather be in my motel bed. [Laughter]

Before that, the furthest I'd flown is like to Alaska, and it was like a six-hour flight. I really wasn't prepared for the flight over. I can't remember, I think we left here at eight or nine in the morning, and then you get there at eleven o'clock at night. I remember the flight from Cincinnati, I think, we went through

Cincinnati, I think, to Frankfurt. It's just so long. I tried to sleep, which was a mistake that I found out later, that if you just get on the plane and just stay awake, don't even try to sleep, and then when you get to the motel, just crash then.

I wasn't even over the flight over there and we were sitting there trying to watch a Soyuz docking. I mean, it was exciting in one sense that here I was in the Russian Mission Control Center, which you read about and you hear about all your life coming up, if you follow the space program. And you're seeing the national operation in progress, and then at the same time you're about half dead, thinking about going back to bed. [Laughter] So it was exciting, but it could have been under better circumstances, perhaps. Anyway, like I say, it was fun.

This right here is a picture of the--this is their Buran Mission Control. Mr. Efremov does send me a new calendar every year.

Wright: That's nice.

Noah: And he sends one for my wife, too. She teaches fourth grade and so he always includes her in the package.

Wright: Were you able to bring your family over to Russia at any time?

Noah: I never did. I wished I could have. I really would have liked them to have gone over and at least experienced some of the culture differences.

Wright: Have they had a chance to meet your counterparts when they've been here?

Noah: They have. I've had some of them over to the house for dinner, feed them steak and baked potatoes and they don't know what to do with the baked potato. [Laughter] They say, "What do I do with this?"

"Well, you put a lot of butter in there and sour cream." So that's kind of fun.

We had one guy, Alexi Gavrilov. We had Rockwell hire him. He was sort of our facilitator over there and he helped us not only during our meetings, but when we were sending data and packages, drawings and stuff back and forth, he would handle the logistics for doing that. Plus, he spoke English real well. He was actually a good interpreter. He had an engineering degree, so he understood the subject matter. When he'd come, I'd always invite him. He was a lot of fun, a really very nice guy.

When they come over with these large groups, a lot of times they do things in groups, so it's hard to have thirty or forty Russians at your house. But if you break one or two of them apart and a lot of folks did that. Although we usually, in the early missions, we would have a beach party for them, where we were

joined with the operations. It was Operation Integration Working Group. So together we would plan and carry out, go by and get them in our own vehicles and ferry them all down to Galveston and barbecue and drink soft drinks and chips and dip and whatever. The Russians, I think, they enjoyed it. They acted like they did. We did, too. It was a lot of fun. Plus it builds camaraderie with your group, as well.

Once we got to know each other and we worked together, there were a lot of close relationships there. You're really amazed at how, even though someone 10,000 miles away in a totally different culture, how close you can get to some of those folks. You really get close to them. Good friendships.

Wright: I guess part of the common bond you had was to build a quality piece of equipment.

Noah: It's a lot of that. You're working on the same project and you've got the same goal in mind, and then when you realize each goal each step of the way, there's a lot of satisfaction, a mutual satisfaction, that you get out of that. Plus knowing that you've overcome some technical issues together and solved them together, it's quite rewarding. You build some solid friendships.

Wright: Did the docking module live on?

Noah: It's still there. It will reenter when the Mir reenters. Yes, it added some extra volume. I think the Russians used it for stowage for some items, which they were in dire need of. Yes, it's still there. We left it intact where if we had to go back, which I guess we don't anticipate now, we still could. We took a target up, a center-line target. One of those pictures shows one. Let's see. Yes, here it is. We left this target on board the Mir and then we had to replace it later with another target like that. But then we replaced it with a target that we're building for Space Station that uses a different coating for the back plate surface there.

So on 84 or 86, I can't recall, we replaced it with this new station target. Then on 91, talking to our materials people here, in their certification for long life of that decal staying on that surface, they said, "Well, we had to do really a shortened certification with our thermal vac and we had to extrapolate out over a ten-year mission," or whatever their mission life was.

I said, "Well, would it help you if you had six months of deep space, or space environment, for you to go analyze and see how well your adhesive adheres the decal?"

They said, "Yes, that'd be nice."

So 91 we brought that target back and gave it to our materials folks and they're now in the process of analyzing that and they'll give us a report and give station a report on how well their target will function throughout the life. But we replaced the target with another target, just in case. I said, "Well, we're not supposed to go back, but let's put another one up there just in case." So that's what we did.

Wright: Just one more benefit of Shuttle-Mir and how it's going to help ISS.

Noah: Exactly. We not only were able to go put the target on there and then go dock a couple of times with it. I can't remember if it was 84 or 86. I think it was 86. But we had 89 and 91 where we went and docked with that target. So we knew how the lighting affects it and the shadows affect it and we have floodlights that shine on it to make sure it doesn't balloon where it washes out the video. So we had that data from the two dockings. But then we also were able to bring it back on 91, so that we could verify that our certification for that adhesive and that decal, that it will last what we're advertising, or what engineering materials folks were advertising to the station folks. So, yes, that was definitely a benefit.

Wright: Are there others from your area that couldn't have happened or wouldn't be happening?

Noah: Yes, there's probably a lot of things. Most of the things from my area that we gained was the process. We set up a process, like I say, we're using today in ISS that's similar to what we used in the Mir Program, although it's a little bit different. But each program was different. The Mir was primarily built--we added a couple of modules since we were there, but we didn't take them up, whereas on the station flights we were not only integrating an orbiter to a station stage, but we're also carrying up the next piece in the cargo bay. So we have to protect that piece and get it out of the bay and stick it on to the station stage. So the ISS folks have a huge challenge ahead of them. I mean, more so than trying to operate. Once their assembly's complete, the workload should go down, but you never know.

Most of the things that we gained, from our perspective, was process and engineering and integration-type things. We did develop some analysis tools, like thermal analysis. We learned how to react on a very short time scale to attitude changes during the mission. We would settle on an attitude with Mir and the Shuttle, relative to the sun and the Earth, and we did all of our thermal analysis based on that attitude. Maybe something happens, they have a failure on the Mir that causes us to invalidate that analysis. So now we've got a new attitude we've got to do.

So these things were happening later and later as we were getting closer to each flight. So we had to figure out how to redo that thermal analysis on a fairly quick basis. We were a lot of times launching the vehicle, saying, "We think we're ready." [Laughter]

There was actually some on-orbit changes that we had to go react to during the mission, to go say, "Yes, that's okay. We can go do that." So, a lot of analysis tools in thermal. We had some analysis tools in the loads area that were developed, and then the whole process were the major benefits.

Now, like the SVS was not under my office, but the SVS is another benefit. There was lessons

learned out of the Shuttle-Mir Program. There were a lot of what they call RMEs that's station-funded to go run experiments on the Shuttle-Mir Program. I can't begin to name all those. But a lot of those, there was a lot of benefits that came out of that.

One example is there was a witness plate-type experiment where we attached to the docking module, I think on 76, they did an EVA and they deployed these witness panels that they collect contamination, among other things. Then they brought them back on a subsequent mission and analyzed them. We're in the process now of reevaluating the orbiter's capability to dump the waste-water from the orbiter while it's docked to the ISS because of the data they got off of that experiment. There's a lot of those type experiments that were part of the Phase One Program that were lessons learned that are going into the ISS.

Wright: From your standpoint, it doesn't sound like too many days were routine. They were routine, but at least they were never boring.

Noah: I'm not sure if they were routine either, but they were definitely not boring. When I was working this project, and after I got off the STS-74 mission, I moved into this position to a new job within the Shuttle Program which had responsibility for integration analysis for all the payloads that flew on the Shuttle, not just the Shuttle-Mir mission. So there was a lot of other responsibilities that I had to go and do. So I only kept track of the Shuttle-Mir Program in that people that worked in my office were still intimately involved in doing the process. But when I was working the docking module, nothing was routine and it was definitely not boring. It was a lot of fun. It was a lot of fun. You know, you get to do a lot of things that you wouldn't normally get to do. Then other folks you think about getting into the orbiter cargo bay and while they're putting this thing in there, or climbing inside this docking module while it's down at KSC, or climbing up the service tower at the launch pad when orbiters stacked out there. It's really impressive.

One of our interpreters--this is a good story. We were at one of our joint meetings at KSC, and this guy was an engineer by profession, from Russia, and had immigrated to the U.S. five or six years ago. The guys at KSC arranged a tour of the orbiter. It wasn't one of our orbiters for Shuttle-Mir, but it was another mission. It was sitting out on the launch pad and these guys were down there and says, "Well, let me arrange a tour for you guys to go out to the launch pad."

Of course, if you take Russians out to the launch pad, you've got to have an interpreter, so this guy, his wife was an interpreter and his daughter was an interpreter. They all three were excellent, excellent interpreters. But he had the decision to make who was going to go on the tour. So he decided,

"Well, I'll just go." [Laughter] So they took them on the tour and he comes back and his eyes are wide open and he's got a smile from ear to ear. He says, "I just had one of the most life-changing experiences in my life." He says, "As an engineer, you design things, but to go out on a launch pad and see the orbiter with the ET and the SRBs on the launch pad, it's just a sense of awe." He says, "I just couldn't believe it. You go through one or two of these changes in your life. I just had one." And it is, it's very impressive. If you've never done it, I highly recommend it.

While the Russians were down there that same trip, we saw the launch of that vehicle. We were down there for two weeks. In that time they toured it and then they got to see it launch, so it was a good trip.

Wright: I'm going to ask, Paul, do you have a question for Don?

Rollins: What kind of engineer are you? Mechanical engineer?

Noah: Doing this job you've got to be a little bit of everything. My degree is in electrical engineering. I'll argue that that's probably the best degree to get, not only because I got one. [Laughter] In school there was a lot of competition between the engineering colleges.

Rollins: Engineering rivalries.

Noah: In the job and working at NASA, you interface with a lot of different technical disciplines and you pick up a little bit. But then as you get into project management, then you have to become a little bit of an expert, but not totally because you still rely on the guys that are still in that technical discipline to do work. But you've got to at least understand the subject, so that you can make decisions when they bring you a problem. They say, "Well, you can do this or you can do that."

Rollins: There are a lot of engineers in the world, but I think there's only a handful who can put that particular task on their résumé. Did you ever think about that when you were doing it, how few people in the entire world had an opportunity to--

Noah: It did cross my mind. Greg and I, I remember sitting here late at night, most everybody's gone at 6:30 or 7:00 at night and maybe later. We said, "We've got to be two of the luckiest guys on Earth. This is a great job." And the Shuttle-Mir Program, from the very beginning, when we started 71, they assigned experienced people and then they let us do our job. We didn't get a lot of management oversight. I was given a responsibility for integrating this docking module and they said, "Sink or swim." [Laughter] Like I

say, it was a lot of fun. Yes, I did recognize that there's not a whole lot of folks that had the opportunity I had. I knew how fortunate I was. I get goosebumps thinking about it.

Wright: The other part is, nobody had done it before. But that meant you couldn't go back, you were doing your research and everything was real-time.

Noah: That's right. Yes, it was learn as you go in some cases. It was drawing on experience of doing other things that we had integrated into the orbiter, on the other hand. But, yes, we had to reinvent some things that we didn't used to do. But like I say, it was a lot of fun. I did recognize that I just happened to be in the right place at the right time to get the assignment. And working for the right people that had the confidence to allow me to go do the job, too, that's very important. I've been real fortunate at my career at NASA in that I've gotten good assignments and I've had good people to work for. For the most part, I mean, I can't say enough about NASA and the quality of people that are out here. They've really got some topnotch folks, both in engineering and in management.

Rollins: And definitely in Russia, too.

Noah: Definitely in Russia. They've got excellent technical people there, and in some cases they got excellent managers.

Wright: The engineers in Russia, were they electrical engineers?

Noah: Some of them were. Some of them were mechanical, structural, and thermal. Very similar-type degrees that we have here. A lot of things they were doing were very common and problems that they had, there was a mutual understanding of each other's problems. So they had faced and overcame the same obstacles that we had. There was immediate bonding in that we'd pretty much been through the same thing. I mean, they, of course, had their success stories in all of their space programs. Plus they had built a Buran, which did fly and came back, remote control. They understood a lot of the things with the Shuttle. Now, they learned a lot about the Shuttle and the orbiter, because they did several things differently on the Buran than we do on the Shuttle, although if you look at the Buran on the outside, it looks a lot like an orbiter. It's amazing how two countries so diverse in culture can come up with the same design.

Wright: I guess that wasn't one of your items of discussion?

Noah: No, we didn't discuss that. [Laughter]

Wright: Couldn't discuss everything.

Noah: Yes. Well, it wasn't required. Although we did see the Buran in Gorky Park. They were making some kind of ride. You could pay to get in. I'm not sure if it was a ride or what. We toured it. You could hear them banging around in there doing some renovations on the interior. But the Russians were very proud of the Buran Program. They were very disappointed when it got canceled and they didn't fly it. They were equally impressed and proud of the U.S. Shuttle program. I mean, a lot of people here I don't think appreciate the Shuttle program as much as some of those guys did. I mean, they really were impressed.

Rollins: It's the same all over the world.

Noah: Exactly.

Rollins: Doesn't matter what your politics are or what country you work for.

Noah: They really appreciated what we did on the Shuttle Program. They really admired it.

Wright: And what it's going to do in the future for all of us.

Noah: Yes.

Wright: Anything else you'd like to add? We certainly have learned a lot and really appreciate your time.

Noah: I think I covered most everything.

Rollins: Do you go to your wife's fourth-grade class and do your NASA pitch for them?

Noah: You know, I haven't done that. I'm from Mississippi, and I've gone back to my home state a couple of times and talked to the high schools there. I've found out, though, that you really need a selective audience. I've talked to different audiences. I've talked to math classes, I've talked to science classes, or technical classes. Then I've talked to like the senior class. You definitely want to stay with the technical or science class. [Laughter]

Rollins: The nerds. [Laughter]

Noah: That's right. Because you go to the senior class and most of them are in there sleeping or shooting

rubber bands. [Laughter]

Wright: Counting those days till graduation.

Noah: There's only one or two of them that's paying attention. I had some good stuff there, too, that was interesting. But, no, I haven't talked to my wife's class. Although Vladimir Solovyev was one of the first Russian guys on our Operations Integration Working Group. He was the co-chair. I guess he was all the way through, but he delegated to a couple of guys. He was an ex-cosmonaut, a national hero of the Soviet Union, all the medals and stuff. Wonderful guy, really a nice guy, sharp, one of the sharpest guys they had. I mean, he was certainly an asset to that program. He advised Mr. Ryumin, I think, extensively. But I was talking to him one time and he likes to do public speaking. I asked him would he be interested in speaking to a public school here. He said, "Sure." I almost had it set up. I had one interpreter who was going to volunteer his time to come over and do the interpreting, even though Mr. Solovyev could speak fairly good English. I mean, it was broken. If you hear him talk, he said, "I speak terrible English." But actually you could understand him.

Rollins: Better than our Russian.

Noah: A lot better than my Russian. [Laughter] I had it all set up, and then he had a conflict of something in the schedule, so he wasn't able to talk. But I did try to get some of those guys to come over and talk to the public-school kids.

To get back on education, one of the interpreters over in Russia, that lived in Russia, that we used over there, she had a daughter, I think, a daughter that was the same age as my son. So we exchanged addresses and all that. So her daughter's class did a lot of--each person did a lot of pictures and drawings and stuff of what they do. They took a picture of the class and they sent it over to my son's class. Then they exchanged stuff like that. So I tried to, as time allowed, do as much of that as I could. It's kind of important to exchange cultures. It's really interesting, learning the Russian culture and what their daily lives were like and what it was like during the Soviet times and what it's like now, what they feel about the U.S. and what they feel about the space program.

Since we mainly talked to the higher educated folks, because interpreters were usually degreed folks that had either engineering degrees or they were professional interpreters, they were, to use no other word, a different class than some of the other folks. But it was really interesting learning the differences. There wasn't a whole lot. They have a lot of the same problems we have, although during the Soviet times they had a lot worse problems than we had. It was amazing. I mean, you really can't appreciate the U.S.

until you go somewhere like that and you hear the stories that those folks tell. You really get a sense of appreciation for what we have over here. I was always glad to get home. Definitely. Even though I enjoyed my trips over there.

Wright: There's no place like home.

Noah: Definitely. It makes you appreciate it a lot more and what you've got.

Wright: So why don't we close by you telling us what would you tell that fourth-grade class. Would you talk to them about your adventures in Russia and how it is to work with people so many miles away? Or would you encourage them to go into what you've done? What would you say to them?

Noah: I would encourage them to advance their education as far as they practically can. Not being able to go to college for any excuses like, "I can't afford it," to me, is not an excuse. There's no substitute for education. There's no substitute for tolerance of other people and understanding of other people, even though they may have cultural differences. There's a lot they can learn from other people in different cultures. A lot.

Wright: It's a good lesson for all of us to remember.

Noah: Yes.

Wright: Thanks. I appreciate it.

Noah: Thank you.

[End of interview]