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EDITED ORAL HISTORY TRANSCRIPT

RICHARD W. NYGREN
INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is March 16th, 2006. This oral history is being conducted with Richard Nygren in Houston, Texas, for the NASA Johnson Space Center Oral History Project. Interviewer is Rebecca Wright, assisted by Sandra Johnson. This interview will conclude the oral history session for Mr. Nygren, which includes two sessions earlier this year, one on January 12th and the other on March the 9th.

We ended the last session briefly talking with you about your involvement with Shuttle-*Mir*. Many of the aspects of your involvement with this program were addressed in the interview for the Shuttle-*Mir* Oral History Project on July 23rd, 1998. But before we move on, there were a couple of other areas we'd like for you to talk about with the Shuttle-*Mir*, if you would.

One of them is, when you began with the Shuttle-*Mir*, it really wasn't Shuttle-*Mir*, you were just working on the original mission with Norm [Norman E.] Thagard to fly to the *Mir*, which was going to be a one-time venture between NASA and Russia. But in the meantime, talks turned to negotiations, and a $400-million contract was established, and now you were going to be working on increments and we were going to be in long-duration flight with the Russians.

Share with us how you were able to adapt what you started on for the first mission and how it evolved, and how those preparations for the long-duration missions began.

NYGREN: Okay. I did the NASA-*Mir* Oral History and, interestingly enough, had lunch with three of my cohorts today from that program, so we had a chance to talk about it even more over lunch.

When we first started off working at the NASA-*Mir* Program, it was Norm Thagard's flight up to the *Mir* Space Station, and it was essentially a long-duration flight and then a return back to Earth. Because of the limited progress and Soyuz launch capability, we had very little science that we felt we could get accomplished, but we wanted to get as much as possible. So the Life Science folks went with medical kits and medical draw for blood and the saliva. There were a number of experiments from Shuttle flights we felt we could expand to support for *Mir* and Norm would have some meaningful science and we could get some good data from long-duration experience.

We started off with that, and then, as you say, shortly after that, we extended it into a number of flights with U.S. astronauts planning to go to *Mir*, and two things were key to that. One was that the Russians, as part of the expanded scope of the program, were going to launch their *Spektr* Module and later their *Priroda* Module. Then just as important, if not more so, the fact that we were going to start docking the Shuttle to the *Mir* gave us a tremendous upload and download capability for our research. So we had a tremendous amount of opportunity to get some real meaningful science and get some science hardware up into the *Mir*.

The downside to it—we didn't have a whole lot of money and we didn't have a whole lot of time, and we had even fewer people to get it done, so it was a challenge in that context. But as is fairly common with a lot of the NASA programs, if you're small enough, you don't get a lot of visibility, and by not having a lot of visibility, you don't get constrained by a lot of the management and political overhead that is associated with a big program. So we were pretty

much given a license that said, put as much scientific equipment on the *Priroda* and on the *Spektr* as you possibly can. We were given a fairly good allocation on the Shuttles up and down for hardware that we could fly up and utilize on the *Mir* Space Station.

So we started off to do that. We built essentially from scratch thermo-electric freezers, thermo-electric refrigerators, centrifuges, and those kinds of items that would allow us to do the research on orbit. We flew microscopes and stuff for animal experiments. The Russians had a number of their own experiment facilities in the way of furnaces that they allowed us to use, and it really opened up a fairly good opportunity for us to get some good science done.

We had a science working group that originally was chaired—I think the chain actually went from John [A.] Rummel to Peggy [A.] Whitson and then to John [J.] Uri with Carolyn [L.] Huntoon pretty much leading the Life Sciences research activity at the beginning. That working group, coordinated with the Life Sciences guys and the Biological Sciences folks, the fluids and combustions community, the micro-gravity community, and put together a very good science plan. To make sure we were working well with the Russians, we took the entire science plan and translated it into Russian. It was a two-inch thick document, but it really helped our negotiations with the Russians because it was in Russian, but it also allowed them, I think, to share that document with some of their researchers. We got into an environment where we could actually start collaborating on some of the science, and where we wanted to use some of their facilities, particularly the furnace equipment.

The Russians got really interested in what we were doing, and as long as we were willing to share the data with them, they were willing to let us use the hardware. And then when they realized that the Shuttle was going to be there and that they could get some of their stuff down,

they got more interested in getting some of their own scientific hardware up on Progress flights because they could get some samples down via the Shuttle that they couldn't by the Soyuz.

Tommy [W.] Holloway was heading up the program, and he decided he would prefer a working group structure, realizing that this was a program but it did have a short life. He preferred this rather than establishing what I would call a typical NASA program with a formal program office and a program control organization and SE&I [Systems Engineering and Integration] functions, and the different elements. Rather than paying a price for establishing the overhead of a program office and trying to establish all of the boards and the charters for the boards, etc., he went into a working group structure and pretty much allowed the working groups to interface with their Russian counterparts and negotiate what needed to be done to get their scope of work completed.

I had two that I was overseeing, and a third one, which I was actually managing. The two I was overseeing was the Science Working Group and then the Medical Operations Working Group. And the one I was actually managing was the *Mir* Operations and Integration Working Group, which is the one where we were responsible for getting all of the hardware we were building certified to launch and be installed on the *Mir*.

And that presented a lot of issues for us, some of which I'm sure I covered in my other oral interview. But the Russian launch environment on a Progress is significantly differently than a Shuttle, so all of our certification had to be reassessed. And where we didn't meet their Russian requirements or their environment, we had to go back and certify the hardware to that environment, which was an additional task that we hadn't really envisioned.

The Russians had a set of documents called a Series 100 documents that when we first started working with them were somewhat of a baffle to us, because it seemed like each one of

them asked for exactly the same thing, but we couldn't figure out why they needed it so many times. In our world, you'd give it to them on a disk and say, "Here it is. Share it." But over a period of time, we began to understanding how their departments worked and what each department needed, you could see where it was at and how it was being used, and it made sense. But we still continued to try and convince them to let us automate it for them so that we could fill it in one time and use the computers to spread it into the different documents. We never got there. Eventually, we may have convinced them, but we didn't while we were there.

It went fairly well in that arena. We had a number of issues in trying to get our hardware to Russia. They did an Acceptance Test I and Acceptance Test II on the hardware. Acceptance Test I was essentially what we would consider a pre-ship test in the U.S., if we were sending hardware from JSC [NASA Johnson Space Center, Houston, Texas] down to KSC [NASA Kennedy Space Center, Florida], but it's an acceptance test. The Russians came over and witnessed all of this, and they would buy off on the fact that we run the tests according to their documentation and it was ready to fly.

Then they did an Acceptance Test II in Russia, which was generally done in Moscow at their facilities. Actually in Korolev in Moscow; Korolev is a suburb. That was a post-ship get-ready-to-go, and then they would ship the hardware to Baikonur [Republic of Kazakhstan] and install it.

Some of the interesting things that we ran into was that although we understood, or thought we understood, how the Russian electrical system was supposed to work. Their facility power which we thought was like the European one, ended up having what was equivalent to a floating ground. We burned up an awful lot of our Ground Support Equipment, and our

computers trying to figure out how to get power supplies that would actually work with their ground. So that was a challenge to us.

And the fact that most of their buildings aren't very well conditioned over there, we froze our hardware on occasions, and on one occasion they actually froze one of their own pipes and it ruptured. Then when it thawed, it sprayed water all over our hardware, so we had to clean it all up and go retest it. Some of it we had to take apart and clean.

But overall, it was a very cooperative environment. The Russians wanted us to get as much of the hardware up there as possible, so they really didn't put any impediments in our way. It was a learning curve. The way we do business and the way they do is business is significantly different, but I can't say that one's better than the other, just different. So we had to come to common ground.

The *Spektr* Module, we got the refrigerators and freezers and other hardware installed and got it launched. One of the interesting stories on that was that when we were trying to mount our freezer in the *Spektr*, we were looking for what's called an Interface Control Drawing [ICD] that shows , "Here's our bolt pattern, here's the Russian's bolt pattern," so that they do, in fact, line up. The Russians didn't have ICDs, and we couldn't figure out for the life of us how we were going to actually get the hardware mounted. We finally shipped it to Baikonur along with our engineer. They got down there and the Russians actually just took it in and put it where they wanted to mount it and marked where they were going to drill the holes and drilled to match our bolt pattern in the secondary structure. We couldn't believe it. We thought that was pretty phenomenal that in a spacecraft they had enough margin that they could just drill their structure out and put our stuff in it and it would not weaken their structure and the vehicle would take the loads that we were putting into it. Then on the *Priroda*, one of the interesting stories was

because we were actually connecting up to their electrical system, we needed the mating half of an electrical connector to wire up to our cables. We kept asking them to send us the connector so we could wire it up. We knew they had them. We just couldn't figure out why they wouldn't send them to us, but they would never send them to us. Finally, it got down to the point that if we were going to make the launch, we had to send our cables over there and put the wires together over there with the connectors on them, which we did. Then we needed to send the cable back over here so we could test it. We kept asking them why they couldn't have sent us the connectors, "Why was that?"

Well, it turned out that it was an interesting story that the pins in the connector were gold-coated and gold being a precious metal can't be sent out of the country. The gold by part number was traceable to that connector, so therefore it couldn't be shipped out of the country. Once we put the connector on our cable and we shipped under the part number of the cable, the Russian guys didn't have any idea that the gold was on there, so it went out without any kind of a problem.

But you get into those kinds of issues and you multiply it times two or three hundred pieces of equipment. It keeps you busy for a long time trying to figure out how to make it work. But, we all got together, we got it done. It was a great time. We ended up pretty much all staying in a hotel over there called the [Olympic] Penta Hotel [now named the Renaissance Moscow Hotel], which is a German-built hotel right next to the Moscow Olympic Complex, very nice hotel, enjoyed staying there.

I know when our guys would come over, some of them would like to just get on the subways and ride around on the subways because every subway stop was a different architectural design, and they were very, very intricate. They'd have mosaic tiles, bronze statues, models.

Just riding on the subway was an interesting thing. When you stopped someplace you'd never been before, you always had to dillydally around long enough to look and see what it is that was unique about this particular subway stop.

I haven't ridden a lot of subways in my lifetime, but of the ones I've ridden, theirs was the best one I've ever seen for punctuality. Their trains came on time and they came frequently, where sometimes I go to [Washington] DC and after about ten o'clock, trying to find a subway in DC gets difficult. You knew where theirs were. They have little clocks that tell you when it's going to come, and it comes exactly when it says it is.

But overall, that program was a lot of fun, and the oral history I gave on the Shuttle-*Mir* has a lot more detail than what I covered here.

WRIGHT: I know you put an article together with John Uri and Jeff [Jeffrey A.] Cardenas about the lessons learned from *Mir*. After a five-year presence with the International Space Station [ISS], do you feel like some of those lessons learned have been applied to what we're doing now? How have the lessons been learned and have they been applied to what we're currently doing in space travel?

NYGREN: Well, my observation of how NASA does its lessons learned is that they don't do a very good job at it. There are several reasons for it, some of which are valid, and some of which I don't think are valid. But we, as our part of the NASA-*Mir* Program, went to extensive lengths to record our lessons and what we had learned in that activity, we worked with the Russians to make sure we had it right, worked internally with all of the players to make sure that we captured everything we could possibly capture. Then we worked with the [International Space] Station

Program to try and transfer those lessons learned and that experience base to the Space Station Program.

Some of the lessons that we had learned, they had already learned or were far enough along in their program that they weren't applicable any more. Some of them were more operational and the Station wasn't that far along yet and they weren't ready to deal with them at that point in time. Some of them, the people, in my opinion, wrote off as, "Well, Phase I is not like Phase II, so they're really not applicable to what we're doing." So from a process prospective of writing up lessons learned and providing them to a follow-on program and having the program give them due diligence and incorporate them, I don't think we did a good a job as we possibly could have in that environment.

On the other hand, I think that a large number of the people that worked the NASA-*Mir* Program migrated over into ISS and were, in a lot of cases, put in positions where they could influence how things were done. They used their own experiences, which was where we developed the lessons learned, so I think a lot of it was captured in that context. But from a formal process and writing the lessons down and passing them on and incorporating them through a formal process, I don't think we did as good a job as we could have. Taking and putting the people in key positions so you could gain from their experience, I think they did a pretty good job of that so, overall, it probably worked out okay.

WRIGHT: You were phasing out of Phase I while Phase I was closing down, and you became Acting Deputy Director of Space and Life Sciences. Tell us how you moved into that and what you were doing there before you moved into the International Space Station.

NYGREN: Well, that was a fill-in position to some degree, because the Director of Space and Life Sciences had left, and John Rummel, who was the Deputy Director for Space and Life Sciences, became the Acting Director. He needed a Deputy, so they reached out and they grabbed a hold of me and said, "You're going to be the guy that's going to be the Acting Deputy." So I was for about six to nine months in that position. But they didn't backfill what I was doing in the Flight Activities area for Flight Operations for Space and Life Sciences, so most of my involvement continued to be the stuff I had been doing in the past, which was working on the Shuttle experiments that we were flying for Life Sciences.

We were, in fact, working on the development of the Human Research Facility, the two-rack complement that we were going to put in the International Space Station. Those racks, well HRF-1 [Human Research Facility Flight Rack 1] anyways, was scheduled to be the first payload rack to go to the International Space Station, so it was the frontrunner. I ended up interfacing in that role to a fair degree with the Space Station Program and, to some degree, with the Shuttle Program.

As far as the Deputy job was concerned, I took on more a role of interfacing with [NASA] Headquarters [Washington, DC] and working the budget, working some of the policy areas that were going on at that point in time with doing international flights and medical standards for international environment, joint selection standards. I'll have to admit in six to nine months, I can't say that I was—I've got this list of things that I started in with I was going to get done and I check off and I was 80 percent successful or not. I would say that I went in and I managed to continue to do what I had done before, and they didn't fire me for what I was trying to do as the Deputy, so it probably worked out okay.

But it was strictly a case of when Rummel moved up to be Acting Director, he needed some help and he asked me to do it. It was a nice event for me because I had some additional responsibilities and met some new people and got to do a couple of new things that I hadn't been doing before.

WRIGHT: Then you transitioned to the ISS payloads area?

NYGREN: Yes. That was an interesting thing because I worked NASA-*Mir* when Tommy Holloway was the Program Manager, and then Tommy went on to be the Program Manager for the International Space Station, and I got to interface with him again as the Space and Life Sciences flight hardware interface person. So Tommy ended up with a vacancy in the Payloads Office, and because of my experience and rapport with him, he asked me if I would come over and take on running the International Space Station Payloads Office.

So I went back to Space and Life Sciences and said, "I'd like to go do this," and did they have any problems with it? They didn't, so I moved over and started working in the Space Station.

WRIGHT: Tell us how you developed the protocols and agreements and everything else to do your job with the payloads; you're now working with international partners as well.

NYGREN: Most of the policies and the agreements, at least at the MOU [Memorandum of Understanding] and the program level, had already been established at the beginning of the program, at the very onset. So at that point in time, it was more of a case of implementing the

agreements than it was establishing them. And we had generally biannual reviews with our international partners. One was in the U.S., and then they'd invite us to Europe, and one in the United States, and we'd go Japan. We would sit down and look at the schedules and what we were doing and at the hardware that was being developed and how the agreements were actually evolving.

There's an intricate amount of detail that was negotiated in the original agreements where they were talking about common ops [operations] costs and what was going to be provided and what was negotiated hardware. What I mean by that is, as an example, the U.S. got 50 percent of the resources in *Columbus* [Laboratory, European Space Agency (ESA), ISS module]. So where they had eight payload racks, the U.S. had four of those that they could use for their use. We had to identify which of our four racks, we wanted to put in their module, and then we had to negotiate with them how those particular payload racks would eventually get installed, checked out, how to make sure that our certification and verification, documentation met *Columbus'* needs along those lines.

We had to make sure that our ops concept for those racks was compatible with the *Columbus*' concept of operations also because if we had our big power users and they had their own racks that were big power users, they could put constraints on how much we could actually do in their module. We needed to make sure that the racks that we were putting in there and the racks that they were building themselves were somewhat compatible. As it turned out, we planned on putting our racks in there and then the ones we picked were complimentary to the ones that they were actually building themselves so that we intended to do all of the Life Sciences in the *Columbus*. We were going to move our two Human Research Facility racks in there. They had a bioastronautics rack of their own that they were putting in there, and there was

another rack called a MARES [Muscle Atrophy Research and Exercise System] that was also related to Life Sciences and that suite was going to be in *Columbus*.

It got to a point where it was a complimentary environment that we were working on. I mentioned the MARES rack. The MARES rack is one that was part of a bartered deal where it was a European-built rack, but it was eventually built to meet our science requirements as a piece of bartered hardware. It was being built for us, and when it was done, it becomes a piece of U.S. hardware.

And a similar involvement in dealing with the Japanese. However, in the case of the Japanese, they had a larger share in the common ops cost, and therefore we had more bartered hardware with Japan than we actually did with the Europeans. That included the centrifuge in the centrifuge accommodation module. Essentially, they were building a complete module for us, and we worked with them on the implementation of that, and the centrifuge was essentially built for plant and animal centrifugal experiments. It required them to build a number of racks to go in the centrifuge accommodation module, but also to build the centrifuge itself.

In the tenure that I was there, we got into the real CDR [Critical Design Review] portion of the centrifuge design, and it became obvious that there were some real technology challenges that it was going to be very difficult for the Japanese to overcome. Even if they could overcome them, it was going to be very expensive for them to pay for that. The estimated costs when they were trying to do the balance of trade, so to speak—it was pretty obvious that they were going to put a lot more money and effort into building the centrifuge in the centrifuge accommodation module than anybody really envisioned in the original concept that wasn't accounted for in the original MOU.

They were concerned that they were continuing to work on this and that it was going to cost them an awful lot of money. So they came back, as any program office would, and said, "Can you release some of your requirements, give us a little bit more flexibility so we have an easier way to meet your overall requirements?" Then we got into discussions with them about which requirements we could relieve on them, and we'd have to go back to our science community and find out whether, in fact, we could really do that or not, and they could still meet the science objectives that they wanted.

That was always a trade, and in this particular case, the office became more of a referee than anything else. The science guys didn't want to give up any of their requirements, and the Japanese were saying, "I can't meet these requirements. They're just too stringent, and we don't have a way to do that." We continued to work with them, and eventually we got to a set of requirements that everybody was relatively happy with, and we'd go to the next design stage. It was an iterative process as all the technology is; you end up making trades as you go along to get the best product you can. In certain cases, you can't meet all of the requirements that you started out to, so we kept making those kinds of trades.

The Europeans, I think, because of what they had done in the Spacelab [microgravity laboratory flown on the Shuttle] arena, were more attuned, I would say, to NASA's way of doing business, so their processes from Spacelab rolled over into what was going on in the Station. It was pretty easy to work with the Europeans with what they were doing and negotiated agreements. The Japanese, again, I would say this is more cultural than anything—I say more difficult, but difficult sounds negative, and it wasn't done in a negative context. But in just dealing with them, it was more difficult because they were reluctant to make real-time decisions.

If you get in a meeting with them, they would sort of nod their head, and nodding their head meant, yes, they understood what you were saying, but not necessarily agreement.

When I first started working with them, I didn't pick up on that, and I thought I had some agreements, and a few weeks after I got back, I got all of these questions about things that I thought we already had agreements on. So it took a while for me to get accustomed to dealing with the Japanese, which I think any organization would. They probably are sitting over there saying, "We don't understand how these Americans do business." So, it's not pointing the finger at them, it's just a different way of doing business.

Again, everybody had a common goal and they wanted to try and make things work as much as they could, and we established a really nice rapport with the Japanese. They recognized some of the shortcomings, I think, that they had in how they would deal with the NASA community. I think they created an organization called JAMS America, which has some Japanese JAXA [Japan Aerospace Exploration Agency] people involved. It also has some retired NASA people that they have brought into their company to try and foster a better understanding of how NASA people do business and to help make sure that when things are said they are interpreted properly. I think that's worked out fairly well for them to help them get a better grip on what's going on and how to deal with the Americans. I've talked with them in the past, because I knew the ones that went over there, and said, "Help me understand what's going on here."

Where, on the other hand, the Europeans didn't have to do that, but on-site there was a European Space Agency Resident Office and there's a JAXA Resident Office. Where the European Resident Office dealt directly with the guys in ESTEC [European Space Research and Technology Centre] and different places in Europe, the JAXA Resident Office, I think, relied

heavily on the JAMS American people to go to meetings and help them understand what was being said and why it was being done the way it was and how they could make their documentation compatible with it.

So I would say that dealing with the Russians and the Japanese was similar in that it was culturally different and processes were different. Dealing with the Europeans was easier in that they had worked with us on Spacelab in the past and they knew our processes pretty well, so they made it pretty easy.

Now going back a little bit along that line, some of the Europeans had also worked with Russia for a long period of time. When they found out about us flying U.S. crewmen onboard, they offered to share with us a lot of their experiences. We sent some folks over there that they briefed on how they did business and why they did business the way they did. When they flew EUROMIR 95 [second ESA mission on board the *Mir*], they invited us to their debriefings to hear what was going on. We actually, as part of when they weren't flying their crewmen over there, we set up a training session for their crewmen on the hardware and experiments that we were going to be running while their crewmen were on *Mir*. They did a reciprocal so that our crewmen could go to Europe and take a look at the hardware that they were actually planning to use and be familiar with it just so that when the hardware gets on orbit, and people start setting it up, you're not surprised. It's just a familiarization, a courtesy to do that.

So we established a really good rapport with the Europeans along that line. We had the opportunity to help them actually bring down some of their samples from when they flew the European crewmen. I think that helped us and it certainly helped me when I went from Space and Life Sciences over to the Payloads Office in ISS. I had been working with most of the European payload guys through NASA-*Mir*, at least at the management level. Not at the

principle investigator level, but at the management level, they were the same people that I had worked with previously, so that worked out pretty well for me.

WRIGHT: Did you find some familiarity that you're working on a program that yet was to be launched? You were working in the Payloads Office before we actually had Space Station up and going, as it took us a while to get there.

NYGREN: Well, yes, it did take us a while to get there, and we had a lot of changes along the way. It wasn't so much being in front of it. In fact, that's where you want to be, because then you can get your requirements in early, as opposed to when you come late, people don't want to deal with you.

But it was an ever-evolving exercise in that originally we envisioned that we were going to get twenty-seven payload racks on orbit that we could do a lot of science with, and we were going to have six- and seven-man crews and ninety-day increments. It's a different Space Station than the one we currently have today, and certainly different than the one that's even envisioned in the future, because when we finally get back to a six-man crew in the 2009 timeframe, we're going to be retiring the Shuttle, and the Shuttle is our up and down mass for the U.S. side. I know that they're working diligently to try and get up-mass capability and, with the HTVs [H-II Transfer Vehicle] and the ATVs [Automated Transfer Vehicle] that Japan and Europe are providing and with the Progresses that the Russians are using, there's, I believe, certainly adequate up-mass capability.

But down mass is a premium, and without the Shuttle, there's certainly limited down-mass capabilities.

It's going to impact the research that we're going to be able to do on the Space Station. In fact, it's what we envisioned as a world-class laboratory is not there, and we're essentially down to studying the human and the human's adaptation to space, which is extremely important if you're planning on going to the Moon and staying there for any time or taking trips to Mars. You've got to make sure you understand how the human body adapts to fractional gravity of 1/6 to 1/3 G and you have to know how the body and the supporting elements adapt for long periods of space flight going to Mars and coming back. Those are long trips and short trips, and the body reacts differently. We need to make sure we understand how it reacts and why it reacts that way, and if we need to mitigate it, how to mitigate it.

Some things, you'd say, "Well, okay, it does that and it's okay." But other things, you've got to find a way to mitigate it, things like bone loss which can cause you to increase your probability of having fracture, if you're going to be able on the lunar surface for a long period of time or en route to Mars. And then working on the Martian surface, you don't want to be in a situation where you have a high probability of breaking a bone.

If you look at the videos from when we were on the Moon before, there were a number of times when the crew guys actually lost their balance and fell down. They had their backpacks on and their CGs [center of gravity] way up high. Well, when you go up there for three or four days and you're on the lunar surface, your bone structure's pretty much the same. But if you've been in space for a year and you've lost a lot of your bone mass, falling down like that could be bad.

So you want to try to mitigate that as much as you can. That's the focus of the research that's left on the International Space Station at this point in time, and it's important. But it's unfortunate the other disciplines in microgravity and fluids and combustion and biology and

animal research aren't going to get a real opportunity to use the Space Station the way that it was intended.

WRIGHT: In 2002, you opted to retire from NASA. Can you tell us what led to that decision?

NYGREN: The long answer or the short answer?

WRIGHT: It's your answer.

NYGREN: The short answer is money. [laughs] And that's really what it boils down to, in my perspective. But the Payloads Office was an outstanding job, and I certainly didn't leave it because I didn't like the job or I didn't like the people. I was having a great time and really enjoying it. In my personal life, it was a case of just having had three kids in college and there was no money left in the bank account and the savings account. And when you've worked for the government since when I did, [and] in the CSRS [Civil Service Retirement System] retirement system, I had thirty-five years plus of service, so it meant I was working for 30 percent of my salary. That meant if I could go out and find a job that paid me exactly what I was making, I made a 70-percent raise. So I essentially left for the money, and that was really the only reason I left.

WRIGHT: What type of work were you doing after you left?

NYGREN: Well, it's interesting, because I looked around at a bunch of different things. It took me seven months to figure out—well, it probably didn't take me seven months, it probably took me about four months to figure out what I wanted to do, and it took me three or four months to figure out how to get it done.

But when I left, I interviewed with a number of the aerospace companies in the area, but in that same timeframe it turned out that the European Space Agency, one of the managers that I had worked with from the ESA side of the house, asked if I would come onboard as a consultant to support them. He described the job, which was pretty much helping them with the negotiations for the hardware that they had already bartered. They had some additional hardware that they wanted to barter on, which in the bigger piece of that is what's called the *Columbus* external payload adaptor. This is what allows the Europeans to mount their payloads onto the external platforms on the backend of the *Columbus*. And the standard adaptors, which fit the NASA platforms, were designed to go up on the Shuttle and then fit on the U.S. side, and they needed some of those same adaptors so they could fit onto the *Columbus* module.

And the question was, how were they going to go about getting those? Were they going to barter for them? Were they going to buy them directly from the manufacturer? Were they going to have one of their contractors buy them? So I got into some discussions with the Europeans and the Americans on those kinds of endeavors.

One of the things that came back that was interesting was that when the ESA guys actually came forward with how they wanted to do the contract, they said they wanted me to be a consultant. But they wanted me to work as a consultant for a company called Astrium North America, which was a wholly-owned subsidiary of Astrium in Europe, which was a consortium of a number of the European companies that had combined over the years, similar to how Boeing

[Company] and McDonnell Douglas [Corporation] came together, and Lockheed Martin [Corporation] came together.

Well, most of the aerospace companies in Europe had done the same thing. Astrium in Europe was subsequently then called and renamed EADS, European Aerospace and Defense Systems Company, but Astrium North America kept the Astrium name. They came forward with this proposal and said, "We'd like you to do this consulting work for us." And they had this consulting group ESA, and they listed what that they wanted me to do for ESA, which was negotiate contracts and do specifications on hardware, write statements of work for contracts.

Then I read the stuff for the B part, which was what Astrium wanted me to do on their behalf and for Astrium in Europe, and it was to work with the ESA on contracts, and I said, "I can't do that. That's a complete conflict of interest. You could go to jail for doing that kind of stuff."

So they said, "No, no, no, no, not to worry, that would be okay."

And I'm going, "This, no, no, no. This is stuff you go to jail for."

"Oh, no, we don't prosecute people like that."

So I'm sitting there going, "Holy smokes, this is not going to work."

Finally I ended up getting a lawyer and asked a friend of mine, who has a lawyer for a wife, and she recommended a lawyer that I should contact. And interestingly enough, the guy specialized in German contracts, and I don't know what I would have done without him. He managed to manipulate the language and he finally said, "Well, you can sign this thing and you probably won't have to go to jail. You might have to do a lot of talking, but you probably won't go to jail."

So I signed it, and it turned out that it did work out really well, and they used me in ways that in the U.S—the way the U.S. companies do business with the federal government wouldn't have been allowed over here, conflict of interest and stuff. With them, it worked pretty well. For ESA, I negotiated with NASA and with the Boeing guys on how to best work out certain barter agreements, and how to make trades without having to go back and fix MOUs.

For the Astrium guys, they wanted to bid on things like the mission contract and the cargo mission contract, which are ISS contracts, that they wanted to get work on. So I helped write the statements of work on like the *Columbus* external payload adapter, how we were going to potentially get that, and whether Astrium might be a venue for actually buying it from Boeing. I worked those kinds of negotiations, so it turned out to be a very interesting job in that you get involved in a lot of different activities.

They do things differently than we do in the U.S. There's no doubt about that. I had a difficult time adapting to the environment, and still do, I'm afraid, of being a consultant after having been a manager for so long. Being a consultant, you look at what they're doing and you tell them what you think works for them, and then you're supposed to be able to forget about it and walk off and go have a beer. I've got too much manager in me that I want to make it happen; I want to go do it. [laughs] So I continue to struggle with that. I give people my ideas, and then they go off and go do something different. And I keep going, "I could do this, why don't they let me do this?" But I gave that opportunity up when I quit, so I have to get over it.

I guess the other highlight, from a personal perspective, is that as part of that I got to go over to Europe for three or four trips a year and got to take my wife over there. We were over there for two months one time on business trips, got to go down to Spain for a week and over to Germany to Bremen for a week, and we spent the rest of the time touring on our own. I was

working at ESTEC [European Space Research and Technology Centre] in the Netherlands, so from a personal perspective with the kids gone and the wife can travel, working for a company that's international is not bad.

WRIGHT: How long did you stay with them?

NYGREN: Two years. Two years.

WRIGHT: And then what did you do?

NYGREN: Well, depending on how much I want to kick myself, the first thing I did was I told them, no, I wouldn't take a two-year extension and continue to work for them. I had been talking to some of the guys at Space and Life Sciences that I had worked with when I came over originally and started working NASA-*Mir*. They were working what was called the Bioastronautics Exploration Research and Technology activities here at JSC, which was a subset of a Headquarters' activity called Humans Systems Research and Technology, which was the remnants of the old Code U, Office of Biological and Physical Research. They had a major effort under the Bioastronautics Exploration Research and Technology going on here at JSC, but they didn't have the project management and program control expertise in the directorate to do that kind of work. They had more of the science background.

They had a lot of scientists, and good scientists, and people that had been doing it before, but they didn't have people that had actually been program managers, program control managers, and actually gone through and followed all of the processes that are associated with it and made

sure you had integrated linked schedules and program control configuration management, budgets and ways to track your budget. So I came in as a consultant to try and help them get some of those processes and activities established within their Bioastronautics Exploration Research and Technology efforts. Originally, I was going to try and come back as an IPA, an intergovernmental personnel assignment, but that didn't work out. I actually came in through the National Space Biomedical Research Institute as a contractor.

And the last year and a half, it's been a year and a half since I did that, has been a whirlwind of change. I'm not sure I've ever been associated with anything that changed quite as much or quite as fast as this did. But they had abolished Code U, the Office of Biological and Physical Research, and created the Human Systems Research and Technology [HSRT] Office within the Explorations Systems Mission Directorate at Headquarters. I was coming onboard when they actually cancelled the Human Systems Research and Technology effort and through the ESAS [Exploration Systems Architecture Study] activities, basically, eliminated all except the Human Life Science initiative. They moved the Human Life Science activities to JSC and put it under a program called the Human Research Program.

So I was trying to get in front of the train when they were eliminating the HSRT and standing up the Human Research Program and helping Space and Life Sciences as much as I could in that environment. In September, they finalized that the program was going to be at JSC, and Space Life Sciences started standing up the program. Then I started doing for the Human Research Program what I had initially been onboard to do for the Bioastronautics Exploration and Research and Technology effort.

I started working with them at Program Control, and I've been working out of the Program Integration Office portion of the Human Research Program on program plans,

integrated schedules, project plans, budgets, monthly reports, quarterly reviews, all of the kinds of things that you do when you're trying to set up a program and do program control.

WRIGHT: So back home again.

NYGREN: Yes, and back in Space and Life Sciences, too. And unfortunately, or fortunately, always depends on how things play out, but the two guys that came to me and said, "We really could use your help in this," in the midst of all of these changes, both of them have gone on, and I have new people that I'm working with. To some degree that's good, and in other cases it's not as good. I don't have the same rapport with them that I had with the other folks, but these guys are willing to listen and trying to get the program going in the right direction, so I don't think that my efforts are wasted either, so it's working out fairly well.

WRIGHT: You've worked with so many different types of programs within NASA, and then, of course, you were just talking about the ones of working as a consultant. Can you share with us what the differences were or the similarities as you moved from program to program? For instance, when you started out at Apollo, and how was that different, maybe even the environment that you were working in or budgets, compared to when you were working from Shuttle, and then Shuttle to Station, and especially with Shuttle and Station how those two programs that were dependent on each other, how they worked well together but maybe sometimes not as well together. Share with us how programs work and what they were like as you moved through the system and how they changed significantly.

NYGREN: In a lot of cases, it's difficult to try and relate one program to another because they are, in fact, different by intent in what their mission really is. So in certain cases, it's difficult. And also, added to that is as the Agency matured, it got to be more bureaucratic, and it also got more involved, got more oversight, I guess I would say, by other government entities, which make things, most people would say, more difficult, but not necessarily, not for a good reason.

But examples would be in the beginning in the Apollo days, money wasn't a problem, and we would hire two or three contractors to go build something and down select from what they were building and their prototypes. Therefore, we were pretty well assured of getting the best product for what we wanted to do, because we could afford to down select very late in the program, because we had the money to fund different concepts to a very mature state.

From Apollo, we went into the Skylab. Skylab was a Space Station as opposed to a spacecraft that gets you someplace. From my perspective, a large difference is the fact that the [NASA] Marshall Space Flight Center [Huntsville, Alabama] was actually the lead Center for the program, and Marshall had never built a manned spacecraft before. So there was a lot of discussion, and to some degree I would say political infighting, to whose standards were going to be used. Marshall had their standards, which were basically driven from building boosters and rockets. They had their own material standards and their materials acceptability processes and their safety processes. JSC had their own associated on manned space flight for how they would do it, so there was a lot of discussion back and forth of whose standard was going to be used in which particular application.

Their board structure and their program structure was different than what JSC was accustomed to, so there was a learning process that wasn't there before of how to work together at the manned spacecraft interface. Where in the past, in the Apollo, Mercury, Gemini,

environment, the interface was at the heat shield, so to speak, and the Marshall guys built the stuff that had all the liquids and power, and JSC built the front end of it. Where the role was somewhat reversed in the manned spacecraft part of this, so there was a lot of involvement in that.

Then ASTP [Apollo Soyuz Test Project], there was another Apollo for all practical purposes, the same processes were pretty much in place. Nothing more than trying to deal with the Russians building the docking module so we'd have a common docking system and we could get a common system, but a tube that we could then each dock to it and meet in the middle. So it was nothing unique there.

The Shuttle, I think that the Shuttle was probably certainly the most challenging endeavor that NASA had taken on for a long period of time. It was also coming on at the point in time that money was tight and therefore you couldn't use the same approaches we had used previously. We had to come up with different ways of getting to the same solution and getting the ones that we wanted, and that basically meant we had to spend more time analyzing our requirements and making sure our requirements were good requirements.

We had to down select the vendors much earlier, so we had to do a lot more analytical modeling than what we would actually do when previously we'd say, "Go build us three prototypes and breadboard this thing." Now you had to do the engineering work upfront and down select and hope that you could actually make it work, as opposed to having two or three that were tested and pick the best of the two or three that were out there.

The budget problems got us into schedule problems, the technology got us into schedule problems, which got us into more budget problems. So it was a chain of events trying to get the Shuttle ready to go fly. The practices and how we set the program up and how we tried to run

the program was very similar to what we used in the Apollo days. Then when we started into the International Space Station and Space Station Freedom—I think that we—right in that timeframe, and I can't tell you which came first, but we ended up with the four work packages for the Space Station Freedom and an integration contractor.

In trying to integrate all of those guys into a common way of doing business was extremely difficult, because each one of the work package Centers had their own way of doing business. They had their own processes. They had their own tools. They may have a different CAD [Computer Aided Design] drawing system than somebody else. They may have a different way of tracking their action items, and if they issued alerts or something, they'd issue them one way, and another Center may not have the same tools and capabilities. So it became obvious pretty quick that this was going to be a real integration nightmare. And to a large degree, the integration part of it is why they finally ended up giving it up. They just couldn't get everybody on the same page at the same time.

At the Headquarters and the Agency level, I think it was a little bit of an awakening that says, "If we're going to have these big programs that involve all of these different people, we're going to have to create standard ways of doing business, and we're going to have to develop policies that push down from the Headquarters level to the different Centers for implementation." And that's the genesis of a lot of our standards, how we do it, what's required, how you're going to do things, trying to do standardization of software tools, whether you're going to use Microsoft Project for your scheduling tools, for your databases, whether you use something like an Oracle or Windchill.

The Agency evolved to the point that they realized that the programs we were getting were so big that they were going to have to be done by multiple Centers and that we needed

common tools that the Centers could use in implementing those programs. But at the same time, there's a huge culture and history and, in certain cases, a lot of investment in the tools that those organizations had.

It's been an evolutionary process of Headquarters developing the documentation and then pushing it down and seeing which programs in which Centers pushed back in which areas and trying to adapt to that. That's where we're at now, and now as we're trying to get into the exploration environment, hopefully some of that effort will pay off in that Constellation [Systems] is going have the launch vehicles out of Marshall and the Crew Exploration Vehicle [CEV] and the cargo and crew program offices here at JSC. The lunar surface access module is probably going to be out of [NASA] Glenn [Research Center at Lewis Field, Cleveland, Ohio]. It may have already been decided where it's going to be. The lunar habitat's probably going to be a different Center.

And you have to make sure that all of these people are working to the same set of standards, the same requirements, using the same tools, so that we can be as efficient as we possibly can.

In fact, one of the things that, as an example, we're trying to deal with is radiation. Radiation in deep space is a significant problem. Then you have to say, "Well, we're building a Crew Exploration Vehicle that is going to go to the Moon and back, and we've done that so you don't need much radiation protection." Well, that's the same thing that you're going to use to supposedly carry the crew to Mars, and you've got to figure out how much radiation protection you can build in now or what shielding you can put on later to protect from those kinds of things.

You look at the lunar habitat and say, "Okay, I've got to have some shielding for radiation up there," and it's got to be consistent so that when you look overall at the dose when

they're in habitat, when they're in the lunar access module, and when they're in the CEV that their total compliment of radiation doesn't exceed their allowable. Well, you have to talk to each one of those programs and do an allocation. For your piece you've got to protect for this and for this and for this, so there's a large integration effort involved in that in trying to look far enough downstream at a lunar habitat and figure out what the requirements are actually going to be then and apply it to a CEV that's going through SRR, Systems Requirements Review, now. It's a challenge. It's going to be a challenge to those guys.

Another one is lunar dust. How do you deal with the dust? How much dust can you actually handle and how much can you get rid of? Because dust is, to a certain level, a toxic material. Lunar dust, we know that it's not good for you and then you've got to figure out, well, how much can you have on your suit when you bring your suit into the airlock. You have to have some way to clean it off outside, clean it in the airlock, scrub it in the airlock, scrub it in the habitat module. You don't want to get it into the CEV, so you got to figure out ways to filter it out.

There's a lot of technology kinds of things that we're trying to look at now and make sure we consider them in the early parts of the exploration program so that we don't have to redo them or reinvent them ten, fifteen years from now when we actually get ready to put a habitat on the lunar surface.

WRIGHT: Well, it sounds like you'll be busy for a while if you continue your consulting work.

NYGREN: There's plenty of work out there. Now, whether they like the way I consult and what I can bring to the table, we'll have to see whether there's any takers out there.

But I've also thought about actually going to work for a company just because, as I said, being a consultant and being a director where you can actually be a program manager or make the decisions and see whether you can get them implemented or not hasn't appealed to me. The consulting has never actually been satisfying.

WRIGHT: It's interesting that you're bring up about the different cultures and the common tools. When you were working with Shuttle and Shuttle-*Mir* and Station, did you find that that culture had to be nurtured some to make sure that all three of those programs were working with common tools and common language and a common platform? Here within the Center?

NYGREN: Shuttle and Station, I don't think, put in what I would consider much in the way of tools. They put in some processes where they had joint meetings and joint responsibility. They talked about shared responsibility, who's going to lead. Through more mechanical processes, they have managed to run each of their programs separately where necessary but through what I would consider a more manual process. Where they've needed to work together, they've been able to do that.

There are certain cases where there's been some friction in the onset and then they've come to some kind of a resolution about who was driving the ship. In the earlier stages of Space Station and Shuttle, and you look at the Space Station and said, "This is going to take all these Shuttle flights to get us up there," so obviously, the reason we got Shuttle is to build a Space Station. So Station took the upper hand and said, "Well, we're in charge of this thing," and Shuttle on the other hand said, "Well, we're your truck, and the only way you're going to get in

space is by us, so we're the upper hand," and this kind of thing. It was interesting to watch the meetings with the two program managers together as to who was actually in charge of this.

I think that over time they have gotten to where they know where they need to shake hands and where they don't need to shake hands, and where they do, they have joint meetings and they have the right people under them that have been working collaboratively to get to the right answers. I would also say that's how it was when we first started out. Station would say, "Well, this is what we need to fly," and Shuttle said, "Well, we're going to pull in this stuff of our own, so you can only have this much," and it went back and forth in that arena.

The fact that the Exploration Program Office is now at JSC and the IT [Information Technology] environment has changed so much from when Shuttle and Station first came onboard that the exploration guys are bringing a lot of electronic tools and capabilities with them that they are baselining within their program. It will be interesting to see how the other programs evolve to actually pick up and use some of those tools. There's all kinds of dynamics in what exploration is doing but it has relatively little impact on the International Space Station. CEV is supposed to fly to ISS and help carry crews, so you've got to dock to it. Other than that, not a lot of impact.

Constellation is standing up now and trying to get its arms around its program and all of its tools in place. Shuttle is going to be gone in 2010, so how much effort do you want to put into common tools if you've got such a short term to put them to use. You've got to do a cost-benefit trade that says, "Yeah, I see what you're doing and if we were going to be here for fifteen years, yeah, that's the right way to do it. But since we're not, we're going to do it manually." That means that the exploration guys won't be able to use some of their tools, so they won't be

quite as efficient as they thought they were going to be able to be when they were dealing with the Shuttle.

There are some growing pains that are going to have to come out of that, but I sat in on a telecomm today that the Exploration guys were talking about some of the efforts that they were trying to work with the Shuttle guys, and some of it was working really good and some of it was we seemed to have been left out here. We haven't gotten on the train yet. They haven't given us a ticket, so there's going to be some growing pains to get those organizations working together, but they're trying to do that.

And it's particularly important with the Exploration guys and the Shuttle guys, because of the amount of Shuttle derived capability Exploration wants to use where they want to use the solid rocket boosters and they want to use a lot of KSC facilities. They're going to have to figure out how they're going to work together. They'll have to figure out what they're going to do, like draw out a plan, what they're going to sit down and write down on a piece of paper, and file it.

WRIGHT: Well, before we go too much into the future, I want to ask you to go back and answer a couple other questions that we had [about] earlier in your career, and I'll stay on the Shuttle era right now. How challenging was it for you with the different payloads for the different missions? For instance, you had a culture with DoD [Department of Defense], and you had one with Spacelab, you had one with satellites working with commercial people. Tell us how you were able to do the protocols, do the implementation. How were you able to work with all those different, different groups and with the Shuttle schedule the way that it was?

NYGREN: One of the neat things was—the Shuttle was going to launch, you had to be onboard, so having the Shuttle schedule forced you to get your act together to some degree. But you bring up a good point, because particularly in the early part of the program, just about every flight brought a new environment to you even early on with [STS-4], with [Thomas K. "T.K."] Mattingly [II] and [Henry W.] Hartsfield [Jr.] flew a DoD flight. NASA was not at all accustomed to dealing with classified documents, material, information, different concepts, and there was a lot of stuff, a lot of it that I didn't have to deal with, but a lot of it I was on the periphery of in that the vehicle integration team was responsible for interfacing with the crew.

When we started talking about the payload, they'd say, "Well, you don't have a need to know, so we can't tell you about what this military payload is."

And we'd tell them, "Well, here are the things in our documents that say that this is what we need to do to each one of the payloads to make sure that the crews are safe. We have to do an EVA [Extravehicular Activity]. We're going to go do all these things, and so we have a need to know." And then you get into what's the military's definition of "need to know," and what our definition of "need to know" was, and they weren't always exactly the same. So there was a lot of stuff where we ended up, I guess I would say, training and briefing the military guys on what it is that we were doing and got comfortable with where they could go off and do a particular inspection or a particular verification that we would normally do, and they'd come back and say, "Yeah, we've done that, and it's okay."

Or in certain cases, they would come back, and they'd show us some pictures of what it was that we were talking about that the picture was of exactly what you wanted. You could see that bolt head, but you couldn't see anything else. [laughs] "That's a smooth bolt head. We can show you. It's right here in this picture."

WRIGHT: Little cutouts.

NYGREN: Yes, it was all blacked out. I really didn't see any of those. But it was that difficult of an environment, and then there were certain things where we needed to know how that particular payload interfaced with our software and avionic system. They recognized upfront that there wasn't any way they could get smart enough about our avionic system and simulate it.

They'd give us enough information about the payload and the data stream and the bit rates and the data we would see for error checking that you could make sure that, it was working in those arenas. The flight data file, a lot of the documentation became classified, so you had to protect it, and somebody would bring me a document and say, "Here's the flight data file, here's the ascent checklist, and it's classified. You've got to lock it up when you go." I don't have a place to lock it up. So all of a sudden, we had to start getting all kinds of safes that were classified to hold confidential or secrets documents and I had to start remembering combinations.

We had to protect a lot of data that we had never protected before. We weren't familiar with that. The military came forward with this idea that they were going to command to their payload in the Shuttle, and instead we were going to send the commands through the Control Center like we have always done forever and ever. That's different. That's our spacecraft, our Shuttle up there. We should be commanding to it.

And the military guys are saying, "We've got hundreds of satellites flying around up there. We command to them all the time." So there was a period of trying to get comfortable with how that was going to evolve. The military sent guys to sit in our Control Center to see how we operated, and we sent people out to what is called the Blue Cube [Onizuka Air Force

Station] out in California to sit in their environment to understand how they did their stuff, to get a comfort level of which Center was going to be able to do what commanding and see what data.

The DoD guys brought a new perspective, new environment, even from a facilities perspective. They ended up making vaults in rooms where people could work, and then we had to have encrypted telephones in certain areas so we could do telephone conversations. They brought in a different environment than we hadn't dealt with in the past.

Spacelab came along. Spacelab, again, that program was managed out of Marshall, so even though it was a manned spacecraft environment, Marshall was the lead Center for managing the contract. The European Space Agency was actually the builder of it, and again, it was one of these kinds of barter deals that they built it and for a certain amount of the use of it and the fact that we launched it and brought it back, they got a certain percentage of the utilization rights of it.

It was, again, interesting in trying to get from our perspective, the flight crew involved in participating in the development of the Spacelab module. We had to work with the Marshall guys, and it was a different set of guys than it was at Skylab, so we had to do some reeducation in this particular area about why the crew guys participated, what we were trying to get out of it. Then they had to negotiate that with the Europeans, because the crew guys actually went to Europe to see the module a few times when it was over there.

That's really when we first started getting into dealing with the Europeans and the European culture, and because they were actually launching the Spacelab as a payload in the Shuttle they had to become accustomed to the Shuttle requirements, which are relevant because the *Columbus* module was going to launch in the Shuttle. That's where the linkage comes.

Spacelab, they learned how to work as a payload in the Shuttle cargo bay, and they learned the Shuttle processes in systems requirements.

When they went to their contractor to build the *Columbus* module, they had all of this experience, and they could pass it along through the contractual mechanisms to say this is how you're going to have to build it, how you're going to verify what you have to build it to. Some of the documentation was taken verbatim. Some of it they created themselves, and we just had to do a traceability matrix to make sure it was the same. The intent was there, and in most of the cases it was very easy. They didn't use it exactly to do a traceability matrix, because they used it as a model. They just didn't take it verbatim. That was an interesting exercise.

Then, as you say, we started launching commercial satellites. Hughes [Network Systems] and TRW [Incorporated] were both big in launching their satellites, and they had what we would consider corporate sensitive, their equivalent of classified information. They again wanted to make sure that the people that they were giving access to that information weren't going to share it with other folks.

In that timeframe, you had to do a lot of protection through nondisclosure agreements, because you go to the Cape [Canaveral, Florida] and the Shuttle processor was Boeing to begin with and Lockheed later, and in the payload process, it was Lockheed and McDonnell Douglas, all of which are to some degree competitors with Hughes and TRW. So you got into the arena of what information your contractors could see and nondisclosure agreements.

In our area where we had McDonnell Douglas and Lockheed people working with us that we sent out to other contractors, we had to work those agreements upfront. That also presented some interesting challenges for how do you deal with the industrial world. We flew some commercial payload specialists with their commercial payloads in the crew module, and they

also had corporate sensitive information that we needed to deal with. Then we had to deal with how do you integrate them into the crew and what pieces of the Shuttle hardware can you actually allow them to use. Obviously, they've got to eat, they've got to go to the bathroom, but do you want them using the [remote] manipulator arm? There were some early negotiations on what payload specialists would be allowed to do, what they would be trained on, what they wouldn't be trained on, emergency egress, the suit that they're wearing.

It was evolving, and at the beginning of the program, it seemed like every flight brought you some kind of a new challenge. I will have to admit that fifteen flights into it, it started becoming a little bit routine. You hoped you'd covered enough of the little different idiosyncrasies that nobody could spring something new on you, but they always seemed to be able to find one or two things. It was pretty routine probably fifteen flights into it, from our perspective. We had dealt with the commercial side, we'd dealt with the military side, the NASA payloads, Marshall was coming onboard, we'd flown Spacelab enough times that we had a pretty good rapport with those guys.

One of the neat things that was always good was that the Kennedy guys were always supportive of getting the crew guys involved and making sure they knew how the hardware was working and got their hands on the flight hardware. It was always a pleasure to work with the Cape, KSC guys. They really tried to work with us.

WRIGHT: In the early days of STS 3, you had a Shuttle that landed at White Sands Test Facility [New Mexico]. How did that impact your group?

NYGREN: It was quite an impact. Early on, part of the team, the way the team was broken up with the lead and then we had the guys working the payloads, the guys working the orbiter and guys working the landing well, for the early flights, we staffed up both at the primary and secondary landing sites. So we had somebody at Edwards [Air Force Base; NASA Dryden Flight Research Center, Edwards, California] and we had somebody at White Sands for the flight. We actually had a presence there upfront, but I'm not sure that anybody thought we'd ever go there.

When they decided that Edwards was wet and when KSC wasn't an option, and we were going to go to White Sands, we all packed our bags and headed out there. It was interesting because I know George [W. S.] Abbey was directing all of the operational aspects for what we were doing with the flight crew guys, and he wanted to make sure that he had a senior person out there managing all of the activities. So he sent Rick [Frederick H.] Hauck out there and called him the Airdrome Commander.

I was out there doing all the landing recovery stuff for the flight crew and working with the convoys and the logistics and the families and all of the other stuff we were supposed to be trying to deal with. Rick [Richard J.] Hieb also came out there, and I can't remember exactly what Rick's role was. But, it was interesting because we had the small center of operations that we were working out of and with Rick Hauck and Rick Hieb and Rick Nygren all in that office. And the telephone would ring and the secretary would holler, "Hey, Rick, it's for you," and we'd all drop what we were doing and go get the phone. And then they go, "No, it's for Nygren," or "No, it's for Hauck," so we needed to come up with some abbreviation for all the Ricks.

But the White Sands Test Facility guys did a great job of pulling their entire facility together to provide us with the equipment that we needed. We had staged a partial convoy out

there, but there was equipment that was at Edwards that we needed transported and had to get it trucked over there so we'd have it available.

I remember a couple of times when we were attempting to land the weather wasn't compatible and you'd be standing in the Ops Center there looking out the window, and the dust was just—it was just a whiteout in the dust. When we were sending the convoy out to the runway, you could see the very tops of the snorkel truck and the purge truck. They looked like tall dinosaurs creeping across the lakebed, because that's all you could see was the very tops of them. You couldn't see the trucks at all, and the convoy was probably twenty vehicles. You could see these two little snakeheads going across at the top of the dust.

You'd get out there, and after your day you'd get in your car to leave, and your car would have a sixteenth of an inch of dust on the inside of it. It wasn't like grains of sand, it was just a powder, and it got into everything, into everything.

The White Sands guys did an outstanding job, and we got the Orbiter down. We mated it to the SCA and got out of there just as fast as we could. At KSC when they started doing the inspections, they found a lot of alkali in the throats of the RCS [Reaction Control System] jets, so there was a lot of cleanup. I think it was somewhat of an awakening that says we really don't want to ever go back there again. If you really had to, you probably would, but it's not someplace you want the Orbiter to be.

But it was fun to go do it. It was a challenge when we got out there, because it was something different, and any time you do something different, you can look back at it afterwards and say, "We pulled that off. It was tough. We had to work hard, but it was something we really got accomplished." It was nice to get the Orbiter down and the crew safe and get the Orbiter back to Kennedy.

WRIGHT: Speaking of something different, on STS-7 we launched a female for the first time. Tell us about that flight and how it impacted your team. What was different about it other than it was Sally [K.] Ride?

NYGREN: Let me start off with that Sally was really great to work with. You talk about a really nice lady, cool. She didn't require anything different just because it was Sally. She melded right into the crew and did a super job.

As for the team overall, I would say there was very little impact associated with Sally. From my perspective as the lead, Sally brought media attention that wasn't there with just launching the "guys." She was the first female. She drew a lot of media attention, and the public affairs organizations tried to accommodate as much of that as they could, and Sally, she tried to balance that as much as possible. I know she wasn't interested in the publicity, publicizing Sally Ride, but she also recognized, I think, that she was the first female and it was something that NASA was doing and NASA needed to be recognized that they were doing this.

My involvement was more with the Public Affairs and the media in that there were more photographers that wanted to take pictures and be at different particular locations where the crew was going to be training, or when they went out and flew their T-38s, they wanted to be on the flight line to take pictures. There were more artists that wanted to be in particular areas, and I had to try and balance it out so somebody didn't get shown what would be perceived as preferential treatment by being able to go someplace that somebody else didn't go.

It presented some media public relations activities that were different and certainly more time-consuming than what I'd had to deal with previously, but I think overall it came out really

well, I think more to Sally's benefit and from her efforts than necessarily from mine. She had a way to make that stuff balance out really well, and she gave me some guidelines of what she wanted to do, and it worked out pretty well in that respect.

But it wasn't the same. It wasn't the same number of people standing around with cameras or artists that wanted to come in and do things. It was they knew Sally was flying, and they wanted to be part of it and document it, too, so they were there in force.

WRIGHT: Share with us your experiences of launching the crew with Admiral Truly on STS-8, in a lightning storm and with a night landing.

NYGREN: The launch, it was one of the ones where we got to go out to the pad and come back a number of times. We were having a hard time getting it launched, and Dick and his crew—well, just to set the stage a little bit, the way that the system worked is that the crew guys got suited up. The crew quarters are in the O&C [Operations and Checkout] Building at KSC, and the crew guys get suited there. Then there's an astronaut transport van that takes the crew from the O&C out to the launch pad, and the route out to the launch pad goes by the Launch Control Center. And while the crew guys are in transport, the Kennedy guys shut down all of the movement of vehicles around there so that there are no accidents and no incidents t.

Well, in the job that I have, I needed to be able to get from the O&C building out to the Launch Control Center where all of my team actually worked, and we had our operations center set up out there. So I always rode in the astronaut transport van out to the Launch Control Center, and then they'd stop and I'd get out and walk into the LCC and then they'd take off and continue on out to the pad.

We'd made a few trips out to the launch pad and back, and on this particular night, as we were driving up Kennedy Parkway, the lightning is just all over, just bang, bang, thunder and lightning. The lightning is hitting fairly close to the van as we are driving, nothing that actually hit the van, but it was quite a lightning show. I remember Dick making comments about the fact that, "I don't know why we're going through all of this. We know we're going to be coming back in a couple hours," because the rain is coming down, the thunder and lightning all over the place.

We keep counting down and there's thunder and lightning and we keep counting down, and we go, "Well, we're actually going to go launch this son-of-a-gun." And right smack in the middle of what appeared to be a really severe lightning storm, we actually launched him. I just keep thinking back about how he was talking and we were all joking about the weather, "This is just another drive out to the launch pad and back, we'll be back in a little while. I don't know why we're going through the exercise. We could have just stayed at the crew quarters and watched TV or had a few more cookies."

I It was another one of those incidental things on each one of the flights that you think about and you appreciate it, working with the crew guys and what they were thinking about just before going out to the launch pad. You're trying to make it as comfortable and casual and upbeat as you can, talking to them, because, in the early days when we were doing it, there was a fair amount of stress and uncertainty in how things were going to go. But you tried to just make it a real positive environment and help them. And these guys are just going out to the launch pad and they are all joking about, "Why? Why are we doing this? This doesn't seem like the right night to be going out to the launch pad."

No, it was good. I had a really good rapport with Dick and his guys and I worked with Dick all the way back into the Skylab days. I really enjoyed working with Dick, too, and now he's retired too. He left NASA and went to a number of different positions, but he worked at the National Renewable Energy Laboratory in Colorado for a number of years, and I was always envious of being able to live in that country.

WRIGHT: Any other thoughts or memories of the Shuttle era that you want to share with us?

NYGREN: No. I think we've been talking for six or seven hours, I've hit on most of the high points, I think. If I sat down and wrote some notes, there are probably lots of little nuances and little stories to tell, some of which people probably wouldn't want me to talk about. But from a highlights perspective, I think we've hit most of it. I think it was all pretty good, it's been a great time for me.

WRIGHT: I've got just a couple more if you would provide a few more details for us on the Health Stabilization Process. You brought that up in one of the sessions, but if you could share some details about what that is and what is its importance.

NYGREN: The Health Stabilization Program was a fallout of the Apollo days. Basically, it's a program that they've instituted that isolates the crew guys to a certain degree from the general public and the general populace, the employees, and staff, within seven days of launch to try and keep them from getting a cold or the flu or contracting some kind of an illness before the launch. Essentially, what they do under the Health Stabilization Program is, there are certain people that

they know are going to have to deal with the crew, other astronauts, flight directors, flight surgeons, other people that work on airplanes and T-38s out at Ellington Field [Houston, Texas] where they do their flying.

They get a list of all of the people that the crew is going to have to interface with, and then they essentially screen those people with medicals, give them a medical exam and make sure they're healthy. And then they have established a set of—nothing really intricate, but just common sense rules that people who are working under the Health Stabilization Program are supposed to abide by. Essentially, if you're not feeling well, don't go to work because you're going to be working around the crew. We don't want you there. If you've got a sick family member, then you shouldn't be around the crew, or make sure that you get the doctor to diagnose what the family member has so you know what you're dealing with. It's that kind of thing, kind of a common sense.

There are a number of people and you get a special little badge that has Health Stabilization Program on it. And generally, where the crew guys are working in the simulator buildings, there are security guards at the simulator buildings. When they fly down to Kennedy three days before the launch where they're in the crew quarters, there are security people around there. The security people will only allow people with a Health Stabilization badge inside the cordoned off areas where the crew guys are actually going to be. It's a program that's put in place to help maintain and ensure the crew's health prior to a mission in hopes that you won't have to delay a mission if somebody contracts something in the last week before a particular launch.

It's one of those things that's important to do. It's difficult to enforce. It takes a lot of due diligence by the people who are doing the program to be honest about it. If you really aren't

feeling well, don't come to work. If you don't have a badge, don't try and get access to the crew. As an example, for a launch, the crew is at the Cape and they've got a close family member, a brother, a sister, mother or dad or someone who lives someplace else and they flew down to the launch and they want to see them. For this you have to schedule those people for physicals and blood draws and check them out to see that they are, in fact, healthy before you let them go in and see the crew.

You have to try and work ahead of time to get a list and an idea from the crew of who's going to be coming, who they want to see, so you can schedule the physicals with the docs [doctors]. And it is a program that's designed to maintain the health of the crew and help ensure that the vehicle will be launched on time and it won't be delayed because somebody is sick.

WRIGHT: One last question I had, you very early on in the oral history session, you talked about procedures and manuals that you helped compile to be used by the astronauts when they were on missions, especially we were talking about, I think, Apollo 9 about the photography. Tell us about that process. How were those manuals compiled?

NYGREN: There was a flight data file manager that was identified who was responsible for the flight data file in total, and that was all of the books, the library of books, the ascent checklist, the entry checklist, the on-orbit checklist, specific experiment procedures. He was responsible for all of the books, and he would have an inventory. It's got a table of contents of all of the books that were part of the compilation of the flight data file.

Then they would have a book manager that was responsible for each one of those books and all of the contents that would be in a particular flight data file for a particular event. The

book manager was responsible for going out to all of the technical experts to identify what it is that he needed to put in his particular book. Let me build a scenario for you but the concept is the same. I'm going to pick on one that says during Apollo 9. Dave [David R.] Scott was going to open the hatch and he was going to stick his head out and he was going to take some pictures back along the Service Module. The checklist manager was responsible for the book that dealt with the procedure for opening the hatch and getting ready for it. Part of that was setting up the 16-millimeter camera that would be operated during the hatch activities and when Dave Scott was out there.

The book manager would go to the 16-millimeter camera guys and say, "Okay, I got to have this photography being done. I need for you to tell me which lens I need, which camera I need, what shutter speeds I need, what F-stops I need, so that I can write that into the checklist so that I can write all of that, write the checklist and get it all in there." He'd go to the camera guy and the camera guy would give him all of the information as best he knew it, and then the guy would come to somebody. In this particular case, I was the crew station engineer, and he'd come to me and he says, "Okay, we're going to want to take a picture of the crew guy, Dave Scott, when he's out of the hatch. We're going to use this particular camera. Where do I need to set the camera up in the spacecraft?"

I would sit there and I'd say, "Okay, well, if this is the shot that you're looking for, here's a handrail that you can put this particular camera mount on. Then knowing what he wanted, I'd go over to a mockup where I could get the camera, lens and bracket, I could mount them on the handrail.

I'd tell him which utility outlet to hook it up to. The power switch for the outlet is this nomenclature. I give him a set of parameters that said, "Okay, this is the camera bracket that you

want. These are the settings on the camera bracket that you want. This is the utility power outlet that you want. This is the switch that powers the utility outlet." And I'd give him that information.

Then the book manager would put all of this detail into the checklist. I want him to get this camera gear out, I want him to attach it to this camera bracket, and I want him to set this camera bracket angles on it, and then I want him to set it aside." Then the next set of sequence may be: I'm going get into the suit, Then he'd sit in and he'd go talk to the suit guys about: what do I have to tell the guy to do, what do I have to tell him to make sure he verifies that oxygen connectors and the glove seals and the helmet seals.

He'd get the procedures for donning his suit and then say, "Okay, we're going to drop the spacecraft to a vacuum because we're going to open the hatch. How do you write the venting procedure? What switches do you throw?" He'd go talk to the ECLSS [environmental control and life support system] systems guys and get the procedure for venting the spacecraft. Then they'd say, "When the guy gets done, he's going to have to open the hatch. I need some procedures for what I do to open the hatch."

The guy would come back to me and say, "What's the procedure for opening the hatch? What does he have to do to open the hatch? What specific steps does he do?" I'd tell him how he was going to open the hatch, what needs to be done.

He's gathering all of these subtasks from technical experts and then he would write up a checklist that covered the time from when they said, "We're going to pick up this checklist and it's going to be the EVA checklist." They'd go through what all has to be done. He has to get in the suit. He has to set the camera up. And then while he's opening the hatch, well, maybe the cameras can't be in that area because when he's opening the hatch, the camera's in the road.

We end up taking the procedure the book manager, myself in the case of a crew station, a suit tech [technician] and somebody—either a support astronaut or somebody that was a suit technician that would actually get in the suit—and we'd take his procedure and run it through. And then we'd mark it up, and say, "We got you hooked up to this utility panel over here, and when he's trying to get in his suit and get out here, the cable's in the road. So we can't hook up yet, we have to hook up after he gets past there."

Maybe we'll have a different crewman connect him up at different time. So we would dry run the procedure and make sure that it would, in fact, work the way that we wanted it to work in a mockup or a simulator.

Then as the book manager, he was responsible for maintaining configuration control of that particular document. They would baseline it and say, "This is how we're going to go do it." It may turn out that we just throw something in artificially, "Okay, we went through all of this and we set it all up, but somebody decided later that along with the 16-millimeter camera that we were going to set up for TV pictures at the same time, or we wanted to get a 35-millimeter still picture of it."

So now we've got to set a sequence in there that says, "We're going to do 35-millimeter, so we've got to get out the Nikon; we've got to get out the camera with this lens put this kind of a filter on it. We want to make sure it has this film in it." Here's a new sequence. Well, we put that sequence into that checklist also. They have a special procedure and a form called a 482 that they process that says, "Okay, I want to change this book. It's baselined. But I want to put these changes into it."

They fill out this 482 form and then they send it out to a standard distribution for everybody to look through and buy off on it, and it's got a check by everybody that has to review

the change. When everybody buys off that "yes, that's the right procedure," they send it back to the book manager and the book manager would incorporate it into his procedure. If it was something relatively simple, he would just write it.

If it was something that was a little more complex or he thought, "Well I don't know if this thing really works exactly the same or there was enough change in here that my timeline might change. Instead of needing forty minutes to do what I've scheduled, I might need an hour now, so I need to go back to the timeline. So I better get everybody together, and we're going to go back over, we're going to dry run this procedure in the mockup again." And he'd run us through the checklist. We'd all do our activity and verify, yeah, verily, what he's inserted does fit the way it's supposed to fit, and then add five minutes to this timeline.

He'd have his checklist and it would still be baselined with one rev [revolution] with a 482, but maybe it did change the time. Then he'd go to the timeline guy and say, "I need five more minutes from you, so when you build your timeline you've got to extend my time a certain amount." And then the timeline guy would start going off to go work that, and depending on how all of that played out, you could—taking a worst-case scenario here—you could walk in and say, "Well I redid all of this stuff, and I really need ten minutes."

And the guy says, "Well I can't start you earlier, but I can let you run ten minutes longer." But the problem is that now you're going to be doing your procedure, you're going to be doing this in the dark. You're in the night side instead of in the daylight. So then you go, "Well, that means I've got to go change all my F-stop settings and my shutter speeds and all that other stuff that fits into it."

It's one of those "integration things." The flight data file guys—you had the data file manager that oversaw all of this stuff, and then you had guys that did ascent checklist and entry

checklists, on-orbit checklists, and crew procedures, and you had systems handbooks with system procedures that they had for different schematics for how things worked. It's building a book and verifying the data that you're putting in the book does work the way it's supposed to work, and making sure that other people who are building other books and timelines aren't impacted by what you might be doing to your book.

WRIGHT: Amazing.

NYGREN: Very intricate. And that was paper. Now it's almost all electronic, and they go through the same process. The process is essentially the same, but it's electronic in that where you'd be doing something and it didn't work exactly the way you thought it was supposed to work, a crewman would look at it and say, "That's not right. Well, let me look at my systems data." And he'd access his systems data on an electronic file, not in a book.

Now you scroll down and get to the next step, and you want the background data on it, you push on a button, and a system file comes up. Then you click on it for a schematic and the schematic comes up. World of difference of how you do flight data files now versus how you did them before. It gives you a tremendous amount of depth and information that's available to you compared to what we could fly on Apollo when we were putting it on a piece of paper.

WRIGHT: It's certainly a lot of respect for how much every step affects the next one.

NYGREN: Absolutely, absolutely. In those days, it was choreographed for anything like an EVA or whether it was what Dave Scott did looking out the back or if it was on the lunar surface, everything was choreographed numerous times to make sure you're not missing anything.

WRIGHT: You've shared so many different aspects of what you've done with NASA and even afterwards, is there one that you consider to be the most challenging that you've ever had to deal with, the most challenging aspect you encountered in your career with NASA?

NYGREN: It depends on the interpretation of challenging. Challenging, frustrating. There are a lot of different ways. But I think the one that was probably the most challenging to me and certainly the most emotional was dealing with the [Space Shuttle] *Challenger* [STS 51-L] accident and being right there with the family and seeing their grief and feeling so helpless in how you can actually help them. How can you try and offload some of the grief that they're going through at that point in time? So that was probably the toughest.

Depends on what you mean by challenging, as to how many hours you have to put in at work to get the job done. As far as just emotionally involved and stressful and at the same time feeling helpless in a lot of ways that you can't do anything to make it better, I would say the *Challenger* accident was probably that time.

WRIGHT: What about the most rewarding?

NYGREN: I think it would be a toss-up probably between the Shuttle-*Mir* Program and the Approach and Landing Test [ALT] Program. I say that both for the same reason for both of

them. That is that they were both small programs. In my own mind, I felt I had a significant role in both of them. They both came off very well. You can be proud of what you got accomplished in those programs. At the end of the day, you can feel that you had made a difference. In the ALT, I really enjoyed the people I was working with and establishing the rapport with them, and the crews guys, Fred [W. Haise] and Gordo [C. Gordon Fullerton], Joe [Engle] and Dick [Truly] were just fantastic to work with.

And then the Shuttle-*Mir*, again, it was small. It was a small team. We talked about trying to get all of the hardware built and then interfacing with the Russians and then having the opportunity to also get exposed to the Europeans, all of that was really a lot of fun. You'd have never gotten me to say that during the programs, either one of them.

WRIGHT: It's amazing what time will do.

NYGREN: That's right.

WRIGHT: Well, I don't have anything else left on my list, unless there are some things that you want to cover, any closing thoughts.

NYGREN: We've talked about a lot of stuff. It will be interesting if there's a way you could actually make it coherent, but I enjoyed my thirty-five-plus years with NASA. It was interesting in that I never went and looked for a job after I went to work for NASA. They always came to me and said, "Do this." And I would think that if you looked back on that, you'd say, "Man, that

probably wasn't very rewarding," but in my particular case every job I ever had was one that was really rewarding, I had a lot of fun at all of them.

The Agency treated me really well. I have to say that it's unfortunate that the bureaucracy settles into an agency as it gets older, compared to how it was in the beginning. I still think that they've got a lot of good folks doing a lot of good work, and they've got some really big challenges in front of them in trying to get on with exploration, along with trying to figure out how to do it within the Agency.

It will soon become an international endeavor. The Russians are talking about going to the Moon. The Chinese are talking about going to the Moon. We're talking about going back to the Moon. As people start looking at the billions and billions of dollars that it takes, hopefully there will be an incentive there for the countries to get together and collaborate and find more reasons to work together and will build on tearing down older barriers and things that might cause us to have wars and terrorist attacks, but did get the world closer together and have some common goals.

I've got no regrets from the thirty-five years I worked for NASA and the four years afterwards, I've learned a lot. It's been interesting. I just wished I could be more effective as a consultant than I am. That's a personal choice, so I'll just have to live with it.

WRIGHT: I have no doubt that as all those things happen you'll be somewhat more involved. We may have to do another oral history at some point. Thanks again for all the time you gave to us.

NYGREN: There you go, oral history, yes, that could be, could be. Thanks for having me.

[End of interview]