

NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT

ORAL HISTORY TRANSCRIPT

THOMAS W. HOLLOWAY
INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is July 25, 2002. This oral history with Tommy Holloway is being conducted at the NASA Johnson Space Center for the Center's Oral History Project. Interviewer is Rebecca Wright.

Thank you again for taking your time for the project today. We appreciate that. Mr. Holloway, you announced your retirement just a few weeks ago after devoting forty years to the space agency, many years, and many accomplishments, and, of course, many memories. We'd like to start today with you telling us about how you first came to work for NASA.

HOLLOWAY: Well, in 1962, after having spent two years at a little school at Russellville, Arkansas, and then two and half years at University of Arkansas [Fayetteville, Arkansas], I was in the job market, and a NASA recruiter came to the campus of the University of Arkansas. I interviewed him, I believe; [the recruiter] was male. [He] was a general recruiter from across all of NASA talking about [NASA Lyndon B.] Johnson [Space Center, Houston, Texas]; of course, this Johnson Space Center didn't exist at the time—Kennedy Space Center [Cape Canaveral, Florida,] and the Marshall Space Flight Center [Huntsville, Alabama did]. Later, I received communications from a Mr. Lee [R.] Nichols, who was Warren [J.] North's executive officer, and we had exchanged some information, and he eventually made me a job offer.

I believe, altogether, I had six or eight job offers around the country, mostly from aerospace companies, but one which I found interesting, and I almost went to work for, was Chicago Iron & Bridge [Company]. They sounded very interesting in terms of their program that would let you grow up in the company and the exposure you would get and the mentoring you would get. But after some thought and consideration, I decided to go to work for NASA and come to the Johnson Space Center that was just then beginning to get formed here in Houston.

WRIGHT: What were your first duties and responsibilities here?

HOLLOWAY: Well, I came to work in a group that's primary job was to build crew timelines. We call them flight plans, and still call them flight plans today, a schedule of the crew activities and what they're to do, their work-rest cycle and the work they were to perform, and also, the crew procedures. Particularly in the early days, both of those jobs was an integral job, and we were just finishing the Mercury Program when I came.

I spent the first several months between a third of February and the end of May, really, more like the first of July, because of the post-flight report, following the people around that were working on the last Mercury flight, [L.] Gordon Cooper [Jr.'s] flight, and then immediately started working in the Gemini Program.

So for those first several years, our primary job was to do crew timelines and crew procedures, and in the beginning, they were for the two men [Gemini] Project.

WRIGHT: Do you recall if you worked on all of the Gemini missions, or which ones were more memorable to you?

HOLLOWAY: Well, Gemini, of course, was an exciting program, as I recall. It was the beginning of learning how to do many things, from how to rendezvous and dock and the first spacewalks or extravehicular activities; EVAs is the acronym we use. All were started in the Gemini Program. Some were really difficult from the Gemini IV experience to some of the EVAs that were done on later flights, say, Gemini IX, for example. Some did not go very well in the early days.

But Gemini was really an exciting program where we were learning and inventing how to do various things. We flew ten crewed flights: Gemini III through XII. The first two flights were unmanned. One, the first one, was a launch vehicle demonstration. The second one launched an unmanned vehicle from Florida off the coast of Africa. The rest were crewed vehicles. I worked on III, IV, VI, VIII, X, and XII, and one of my cohorts, named Ted [A.] Guillory, worked on the others, and we worked together during those phases and worked over in the control center with each other, helping each other during the flights.

The second part of your question is, what are some of the more memorable things about Gemini. Of course, just flying the first flight was exciting, with Gus [Virgil I.] Grissom and John [W.] Young getting started. It's a very fast-paced program. We launched every two months, so things went very quickly. Gemini IV, where we did the first U.S. EVA, or spacewalk, and then a number of really exciting activities, of course, Gemini VIII, where we had our close call [with] Dave [David R.] Scott and Neil [A.] Armstrong. Neil Armstrong was the commander, and it was the first flight, as it turned out, an execution where we rendezvoused and docked with another vehicle.

And after docking, one of the Gemini thrusters stuck on and established a rate on a vehicle that was joined together. Thinking the problem might be on the target vehicle, called the

Agena, the crew undocked, and after they undocked, the vehicle started rotating even faster. As we were to learn later, they were rotating at 270 degrees a second, and that's just about that fast. Dave Scott told me after the fact that he didn't know what he would have done if he'd have been the commander. But Neil Armstrong activated the forward RCS system, the reentry control system that was in the nose of the Gemini spacecraft, and managed to damp the rates using about two-thirds of the fuel in the spacecraft.

I will always remember AOS [Acquisition of Signal] at Hawaii. We used ground stations in those days, so you could not talk to the crew nearly as often as you can today. When all of this problem was unfolding and the results were—the ground was being notified of what was going on, that was really a very close call, and then we were lucky that Neil had the skills and the capability to get out of the situation.

Then later, we rendezvoused and docked with the Agena and performed an EVA on Gemini X, and retrieved a package, an experimental package, off an old Agena after we had rendezvoused with it. Buzz [Edwin E.] Aldrin flew on Gemini XII, and did a terrific job of doing a spacewalk, the first spacewalk that was really done well, I think. We'd done several prior to that time, but they had not gone particularly well.

So it was an interesting period, a learning period, a very good time for a young engineer to be working for NASA. Of course, all those times have been good times, I think.

WRIGHT: Part of the time that you were flight activities officer, you were in the support room, and then at some point, the flight activities officer was moved to the Mission Control area. Could you tell us the differences in your experiences of being right in the middle of everything, and was there a difference of being in the two different areas for your job?

HOLLOWAY: Well, that was an interesting transition. Glynn [S.] Lunney, who was a young flight director at that time, I believe, was instrumental in determining that the flight activities officer should effectively report to the flight director instead of reporting through the CapCom [Capsule Communicator], who has always been an astronaut. So in the very first few flights in the Gemini Program, we worked in a staff support function for the CapCom, and the CapCom made the inputs on the crew timelines and crew procedures.

Glynn discussed with me, and later got implemented a situation where the flight activities officer would report directly to the flight director. Of course, from the point of view of keeping us motivated and providing opportunity for us to provide our inputs directly, it was a very motivating situation, and it made our work more rewarding. It made us feel like we were able to get our inputs in directly to the person who was in charge. So it made a great deal of difference in our ability, we think, to get the job done correctly.

WRIGHT: At what point did you begin developing plans for the individual Apollo missions?

HOLLOWAY: Well, the Gemini Program was over in '66, late '65 or '66, and immediately after the Gemini Program was over, I had worked Gemini XII, so I'd been busy up until the end of Gemini XII. Some of my cohorts were already working on the first Apollo flight. Tom [Thomas P.] Stafford was to fly, at that time, the second Apollo flight, and I remember Tom explicitly asked our management to get me to working on his flight, because he wanted to get the timelines built and so on and so forth.

So I personally started working immediately after the Gemini XII flight, and had worked, as I remember it, not for too long a period when the fire occurred down in Florida, [Kennedy Space Center], which slipped the Apollo program to the right and redefined it somewhat. So we started working on Apollo flights in that time frame, then the fire occurred, resulted in some additional time to get ready, restructured the program, and I got a number of different assignments in the meantime.

Somewhere in that time frame, I became a first-line supervisor. In those days we called them section heads. I don't think that we have section heads today; we call them group leads. Then the people, for Apollo, who built crew flight plans all worked for me at the time we started launching the Apollo flights.

WRIGHT: After you learned of the fire and had time to think about that situation, did you ever think that NASA wouldn't recover from that loss, and maybe the plans that you had started to make would not reach fruition? Or did you believe that the agency would recover and move toward its goals?

HOLLOWAY: Well, at that time, I had a great deal of faith that we were going to go forward, and it may have been the position I was in, in the overall hierarchy that I didn't understand enough to be worried about it. I'm not sure. But as I reflect on those times, I always saw a great deal of sense of confidence in the terms of the team and what they were doing, the management teams and the actions that were being taken. George [M.] Low was named the new program manager, and it was a very positive influence on the overall program in terms of the stability and the leadership and our ability to move forward.

So, in retrospect, I was impressed. You'd have to be impressed in terms of how quickly the agency and the program responded to that situation, made corrections, and continued to fly. I think it reflected on the resiliency and the management skills and the leadership that was in place at the time. They should be complimented.

WRIGHT: And those same leaders made the decision not too long after that to send Apollo 8 to the Moon. Could you share with us your reaction to hearing that news and your involvement in those plans?

HOLLOWAY: Well, the same Ted Guillory that I talk about earlier actually did the timeline, built the flight plan for the Apollo 8 flight. I was working on the Apollo 9, which personally—and by that time, by the way, all of the flight planners worked for me. So, in effect, I was working on all of them. But when I first heard about it, I was amazed, of course, and somewhat astonished, I suppose, that we would take that giant step. But after a few days, a few weeks, and as the team matured and we all got involved and started working on that, it was really an exciting period, came together amazingly well. Challenge is what NASA responds to so well, be there new opportunities to perform work or problems that needs to be solved, but new challenge is what makes this place great.

WRIGHT: The Apollo 9 crew that you mentioned had a new challenge, because they were kind of moved out of their rotation but still had the same objectives. Are there any comments you'd like to make about their mission and the work that they had done?

HOLLOWAY: Well, Apollo 9—Jim [James A.] McDivitt was the commander—was the precursor to the lunar mission, only it was staged in Earth orbit, with a lunar module that separated from the command service module, performed a separation, came back and rendezvoused and docked, and the two crew that would have landed on the Moon were in the lunar module. Then later, Rusty [Russell L.] Schweickart performed a spacewalk to demonstrate the spacesuits, and so on and so forth. So it was a full rehearsal, except for the landing itself, in terms of the system requirements for the lunar flight. All the propulsion systems were exercised and the lunar flight was exercised, and it went quite well, with one exception. Rusty apparently had the space adaptation syndrome and did not do a full spacewalk that we had planned, and did a smaller version of it. But in the end, it all worked out great, and the flight went very well.

WRIGHT: I'm sure it must have been a rewarding feeling to know that your flight activities plan actually went to plan. Do you recall many occasions where things did not go to plan during those early Apollo flights?

HOLLOWAY: There's been many times when the flights didn't go well. I remember back on the Gemini flight, Ted Guillory was doing the actual planning at the time with the Angry Alligator on Gemini IX. We were to dock with a augmented docking target after we had lost the Agena, had the problems on a previous flight, and when we got there, the shroud over the docking target had not separated properly, and so we could not dock.

I remember on Apollo 10, when we were getting ready to separate, we had a problem with the docking mechanism and hooking the two vehicles together, and had to work that out.

Things were not always as smooth as some of us like to remember, so things didn't always go really well. Of course, Apollo 13, after the fire, was our biggest problem, and the team responded admirably well with that.

WRIGHT: Where were you, and what were your first thoughts when you heard that Apollo 13 was not going to follow the plan that you had set out?

HOLLOWAY: Of course, we had just launched Apollo 13, and back in those days, I alternately went to Florida to get the crew's flight data file ready to launch. I believe I traveled down to Florida, spent the last two to four weeks in Florida on Apollo 12 and 14 and 16, and someone else did it on the alternating flights.

On Apollo 13, I was in Houston on a weekend. I was out of town, as a matter of fact. We'd just launched. Of course, the launch had only occurred two days earlier. I'd been to Cleveland, Texas, to participate in a lay-witness mission, which is a religious activity where you spend the weekend with a church and their congregation and have a sharing experience and talk about your religious experiences. Anyway, those were very great times, but I won't dwell on that.

I was driving home on Sunday evening after this great weekend and heard on the radio that the explosion had happened, and, of course, typically, you don't learn much on the first report from the news media. So the first reaction, of course, was one of a great deal of concern, and the second reaction was one of wanting to do what you could to help, of course, so we came on home and immediately went to the control center and spent the next seventy—as I remember, the next seventy-two hours working, and I believe I slept about six hours during those seventy-

two hours. It was really a focused time where a large number of people came together to do a huge job of getting a lot of procedures and timelines and trajectory considerations worked out and new procedures worked out and how we could use the LM [Lunar Module] to get back to support the crew and to provide the propulsion to get back to the proper interface with Earth's atmosphere, and then the procedures to power the command module back up and get it ready to do the entry and get the crew back safely. It was really a very intense period.

WRIGHT: Did your role during that time period change from your normal activities? Did you have more tasks that you needed to do? Could you share with us exactly what you were able to—

HOLLOWAY: My personal role, of course, the people were leading there were people like [Eugene F.] Kranz and Glynn Lunney, and John [W.] Aaron played a big role. John was an electrical officer over in the control center. They played a tremendous role in terms of putting it all together with the flight director, Gene and Glynn in particular, as I recall, providing the leadership.

My primary role was one of providing a management function and making sure the simulators were ready. I worked in an organization that provided the crew training and the crew timelines and the crew procedures. We also made sure that people who worked on crew procedures were in all the groups that were working the various aspects of the flight, of the problem, and building these new time lines and these new procedures. So I spent most of my time coordinating, making sure people were working well together.

WRIGHT: Another time in the Apollo Program where there was a change in flight plans occurred on Apollo 11, when once safely on the Moon, Armstrong and Aldrin, with consent from Mission Control, decided to break from your flight plan and bypass their four-hour sleep period to proceed with the EVA. Could you share that moment with us of what it was like to be there and to witness that was going on?

HOLLOWAY: Well, I think people already had an indication that Neil would probably elect to suggest that he would like to get on with the first EVA. Can you imagine the idea of being the first people in history to land on the Moon, and then after you've been there for a few hours, told to go to sleep? This probably wasn't a very good idea. So I think most people expected, and we had understood, that that was what was going to happen.

Of course, I'd been working in the control center on a previous shift prior to the actual spacewalk, and finally decided to go home. So I went home and watched it in the privacy of my living room, and, of course, the impact of the fact that we had landed on the Moon really didn't strike me at that moment. Sometime later, as I was observing the Moon one day when the lighting was about right—what I mean by the lighting, when the Moon's phase was about like it ought to be when we would land. We always landed on the Moon when the sun angle was between something like ten to twenty degrees, and so that meant the phase of the Moon was a certain way every time lunar landings occurred.

I was observing the Moon one evening, and then it struck me that people had walked on the Moon, this other body that's 240,000 miles away, and then the enormity or the size of what had just happened, or what had happened and was still happening at that time, finally struck me. So I'm a little slow, I suppose. So it took a while. Then, as I reflect back on that, the work that

the agency did from building the infrastructure of the Apollo Program, creating the Johnson Space Center, it's just amazing in terms of what was done.

When I first came to Houston, I reported to work at a bank building down off the Gulf Freeway, and then went to work. That was where the human resource office was. Then went to work in Franklin Complex, which was in apartment buildings right off the Gulf Freeway about halfway downtown. Those buildings are still there, and they're real apartments today.

So, of course, one of the things one would do is drive down past what is to become the Johnson Space Center. NASA Road One was a two-lane highway at the time, and I looked out across what looked like a cow pasture. I was raised in the country, by the way. It looked like an empty field. Now, I think a lot of the tunnels and the foundations had already been poured, and that was in February of 1963.

In March of 1964, I moved into Building 4, which I spent the first twenty years of my career in Building 4, various offices in Building 4. Building 1 had been built, the nine-story building, the facilities had been built. This place appeared in thirteen months, the Kennedy Space Center and launch pads and the VAB [Vehicle Assembly Building], the [John C.] Stennis Space Center, [Mississippi], with all the canals and the test stands to test the big engines, and it's still being used today to test Shuttle engines. It was all put together in the early sixties.

Then we put it all together, built all the hardware, put the flight operations together, and got to the Moon in this decade, which was the challenge. So I always remind people of that when they want to take six or eight years to do what looks like a small project, to say we fought World War II in four years and we went to the Moon in seven, so we ought to be able to do some of these other things in a lot less time.

WRIGHT: I agree. I agree. The Apollo missions that followed Apollo 13 were successful, but yet they had been cut down. The administration had decided to not have as many as originally planned. How did that affect your overall planning activities, and how were you able to take some of the mission objectives that you had planned for some of the later flights and incorporate them into the flights that were actually going to be flown?

HOLLOWAY: Well, of course, we who were working on those flights in the Apollo Program [were] disappointed that Apollo 17 was the last flight to the Moon. We would have liked to have flown another three or four. Of course, a lot of the hardware was well on the way. In fact, you can see some of it out at the front gate, with the Saturn rocket.

I think some of the primary things were done. Of course, Jack [Harrison H.] Schmitt got to go to the Moon as a scientist in terms of the work that was done in geology. Overall, though, I think, by and large, we just executed the plans that we had. By the time we got to Apollo 15, the activities of the Apollo Program had shifted a great deal. What I mean by that, of course, on all the flights, that they were a geology expedition to recover samples, take a lot of photographs on the lunar surface, and that kept expanding.

But on Apollo 14 and 15, the work that was done in orbit and on the ground grew. The lunar module got some additional capability to carry hardware to the surface of the Moon. We were deploying instruments on the Moon much more than we had in the past.

We also carried the Moon buggy with us on Apollo 15, 16, and 17. That greatly expanded the ability to traverse the lunar surface, gave a much broader range of lunar surface activities. Then, starting on Apollo 15, the activities on orbit in terms of the observations made on the lunar surface, both with cameras and with sensors, expanded, starting expanded greatly,

and Apollo 17, we had a big mapping camera and a radar sounder that would bounce signals off the surface of the Moon.

So the program had evolved into a more focused scientific exploration program rather than just a pure exploration program. It came together very well and was moving along quite well at the end, and had gotten quite proficient.

WRIGHT: And actually moved into a new era for you with Skylab, which brought on the long-duration flight. You were the head of the mission operation section of the Flight Planning Branch at that time. Could you tell us what your role was in planning crew activities?

HOLLOWAY: Well, it's another one of those things kind of like the Gemini Program. There had already been a lot of work done on getting ready for the Skylab by one of my cohorts, a fellow named John Carter, getting ready for this Skylab Program, doing the planning for it.

Then when the Apollo program was over, my job evolved into being predominantly one of the mission operations activities in the control center, and all of the flight activities officers worked for me. We had five teams that rotated through three shifts. So we had five teams of people who prepared the crew's timelines and procedures updates that allowed them to execute the flights, and to some extent, very similar to what we do today, although the exact timing of it is different over in the International Space Station.

So one of the first things that I got involved in, it was defining the timeline for developing the plan in the real time—we call it “execute package.” We had two versions of that, one that we sent the crew, and another one that we distributed to the team on the ground. It was

really a package material, included crew timelines, the procedures updates that the crew needed, plus the new procedures that the crew needed to execute the timeline.

So we developed a timeline for building that package that involved developing a preliminary plan and then going through a couple of shifts in the control center where that was reviewed, and updating it, getting approved by the flight director, and then eventually distributing it to the team. So in the preparation phase, my primary contribution was transitioning from the previous program and developing the timeline and the procedures for executing that planning process.

Then I actually worked over in the control center on a shift and went through all of those shifts, which I never did like that very well, because it seemed like—I'd have to go back and check with Kranz to make sure, but we had five teams, and, of course, we worked three shifts, the swing shift, the midnight shift, and the day shift. So you'd work about five days, and then you'd rotate to another shift, after a day and half or so of being off, and after fifty-six or eighty-five days of that, it really got old.

So one of the things that I resolved is that in the future—and of course, I didn't anticipate it'd be quite as long as it has been. That was in '73, and so we really didn't get back into that business until a couple of years ago. I'd really thought we'd be there in ten or fifteen years. I really resolved that in the future that we would have a different, more people-friendly way of working people in the control center. So today we may not quite be there yet in the Station Program, but people are implementing innovative ways of working those problems so that so many people aren't tied up at odd hours so they have more of a normal family life. Of course, there's some people that like to work the midnight shift, and you find those, it works out quite well.

WRIGHT: Before the Apollo Program came to an official conclusion, we had our first partnership with the Russians with Apollo-Soyuz. Can you share with us what your responsibilities were and what your involvement was with the Apollo-Soyuz Test Project?

HOLLOWAY: The Apollo-Soyuz in a direct way—I was not directly involved, and what I mean by that is that I personally did not work with the Russians. I did not personally build timelines and so on and so forth. I had people that worked for me at the time, did that work. A fellow named Elvin [B.] Pippert was our primary planner, flight planner, and worked with the Russians during that time frame.

So my primary role was one of providing the management. By that time, I believe I was a branch chief, and I provided the management oversight for the crew procedures and the crew timelines and the overall flight data file that the crew used to execute flights.

Back on the flight data file, both for the Apollo flights and the Apollo-Soyuz flights, to give you an idea of the size of that, in a typical lunar flight we had to have about thirty-five pounds of books with various material from timelines to detailed crew procedures, to malfunction procedures, to systems description information, thirty-five pounds in the lunar module, and another sixty-five pounds or so in the command service module. So when I use the term flight data file, it was typically in a lunar flight I was talking about, around a hundred pounds of documents, and on a typical Apollo-Soyuz mission, it was more like the sixty-, seventy-pound version of that, I'd say.

So we had a large amount of procedures and timelines. A lot of it was backup information, contingency procedures, and that sort of thing. So I was, at that time, managing the

overall group that put the timelines and the crew procedures together, and provided them as a product that would be delivered down in Florida,. That's why I was going down to Florida on every other flight during the Apollo missions.

WRIGHT: Also during this time, NASA was preparing to make a transition into a new era with a new spacecraft. Can you share with us how you transitioned as well into the Shuttle era?

HOLLOWAY: Well, I think that would come in two parts. First, after the Apollo-Soyuz Program was over, we went through a period where we documented lessons learned and spent a great deal of time relative to the crew timeline function and the crew procedures activities documenting what we thought we had learned and providing that input for the future program.

Then in about 1977, Gene Kranz asked Neil [B.] Hutchinson and myself and Don [Donald R.] Puddy to work on, I think, all flight techniques to get ready to go do the flight operations job in the Shuttle Program. Flight techniques got started back in the Apollo days by a gentleman named [Howard W.] Tindall [Jr.], who did a terrific job of bringing the operations community and the technical community together to provide what I call the overall architect for the flight operations implementation. It is a framework for the flight rules and the way the flight operations group were to respond in different scenarios or different failure conditions, and so on and so forth.

Neil and Don and I spent a great deal of time, since it was the first Shuttle flight, and the Shuttle was a different vehicle than the previous vehicles, much more sophisticated. At the time it seemed, at least to me, to be much more fragile, and I still think that's probably true, but fragile in a way that I need to talk about a little bit. It just means that, for example, the surface of

the vehicle is made out of tile that is very easily damaged, and, of course, Apollo and the previous spacecraft, the Mercury and the Gemini spacecraft, were very fracture-resistant material and very hard to damage, and the Shuttle depended totally on an avionics system driven by computers, and in the previous vehicles, it had a lot more backup capability that it didn't depend upon on those computers.

We had these great big payload bay doors on the Shuttle that were going to open, and they needed to close correctly, and so on and so forth. We had very sophisticated software that would manage the redundancy in the system, and in some cases we worried about what would happen if that software management system didn't work quite the way we thought it was designed to work.

So we spent, starting in '77, turned out to be three or three and half years working on this thing called flight techniques. I did on orbit for all of that time. Neil started off on ascent, then went off to be the STS-1 ascent flight director, and I continued with ascent, and Don did entry. So I was a very busy fellow for all those years. I remember, altogether I had something like 130, over that period of time, formal meetings for the on-orbit work and about thirty for the ascent work.

One interesting thing in terms of reflecting on how people work, Don Puddy was a fellow who could survey the land, and he'd write his minutes before he had the meeting, and then he'd have the meeting and adjust a little bit, maybe. I was the kind of guy that'd have a meeting, and then I would try to write some minutes, and then I'd figure out that I probably didn't have the answer quite right, and I'd have to have two more meetings before I would finally get where I needed to get.

But anyway, that was a period where we developed and put together the overall operating infrastructure for the Shuttle Program that drove how we would do business and how the flight rules would be formulated, and so on and so forth. I spent a lot of time worrying about making sure that we could get the payload bay doors closed and what would happen, what we would do if we couldn't get it closed, how we would work around those problems, how many latches we really had to have, and all those kind of things.

I also worked on the IMU [Inertial Measurement Unit] redundancy management problem to make sure that we were not outsmarting ourselves and building all this software to control the IMUs. There was dozens and dozens of subjects like that, that we dealt with to get ready for the first flight.

The interesting thing is that for the next twenty years as I see things evolving in the Shuttle Program, the subjects are still the same and the answers probably stay in the same ballpark. They just get adjusted a bit.

WRIGHT: Before the first flight, you became a flight director. Tell us how that happened and why you moved into that direction.

HOLLOWAY: Well, I worked in FCOD, Flight Crew Operation Directorate, for the first almost fifteen years of my career, and flight directors were in a different organization until after Apollo was over in '73, perhaps, and then an organization was put together called Flight Operations Directorate, and Kenny [Kenneth S.] Kleinknecht was the first director, and later, George [W. S.] Abbey.

FCOD and the Flight Operations Directorate were put together, and they were called Flight Operations Directorate. I had never really considered that I might be a flight director someday. I was in a different organization, and typically, the flight operations organization that had provided flight directors and did the flight control operations did not go outside their own organization. The organization ran by [Christopher C.] Kraft in the formative days, to recruit flight directors. But the two organizations came together in '73, and I continued to work along doing those things that you and I have already talked about.

In the meantime, I had evolved to a point that I was a branch head. I have never been one to think a lot about what my long-term career path was. I can truthfully say I've always thought I had the best job in town in all those positions along the way. They were always very interesting, challenging, and I was always very happy with what I was doing, and the promotions came probably faster than they should have, particularly in the early days.

So in '77 or so, this flight techniques thing came to pass, and for a year or so I did that while concurrently managing the branch, also, which was a challenge in itself. Then the question came on, who was going to be flight directors for the early part of the Shuttle Program. There were three guys that were still in the program who were flight directors at the tail end of the Apollo Program: Chuck [Charles R.] Lewis and Don Puddy and Neil Hutchinson. They were still actively working, and Kranz decided they would be flight directors. I suppose I can say I was the fourth guy in the group.

He asked me to become a flight director. And I haven't talked about this with a lot of people, except my wife, because most people would never understand it, but I didn't know whether I wanted to be a flight director or not, and turns out, it shows that I wasn't very smart.

So I really struggled with whether I should accept the position or not, primarily because it's change.

I am a person that is slow to change. When my wife and I were younger, much younger, we went to one of these seminars where you take a test and then you come back every week, and on the twelve personality characteristics, they tell you how you are in these particular areas, and as I remember, there were twelve of them. One of them was on change and your responsiveness to change. In other words, were you a person that really liked new events and new situations and change in your life. My wife scored ninety. I mean, she really liked to—I scored zero, so that pointed out some of the problems in our lives, of course. But we both have merged over the last twenty-five years, by the way, and I suspect if we took the test over again, she'd probably be sixty or so and I'd maybe be forty or fifty, maybe.

The point of all of that is, I really was not one who eagerly jumped to new events and new situations and so on and so forth. I always start slow. I know when I moved to the Shuttle Program, one of the gentlemen over there after a year or so, "You know, I really appreciate you. You didn't come in and turn the world upside-down right away. You took a while to figure out what was going on," which is I what I like to do.

The point is, I really struggled with whether I should become a flight director or not, and of course, in terms of career opportunities, being a flight director during those formative years was a marvelous opportunity. It turns out that, in my view, being a flight director is some of the best training one can get in terms of developing skills and decision-making and understanding what's important and so on and so forth.

So after struggling with it for several weeks, I agreed to do that, and went off to be a flight director, spent a long time in that business in one facet or another, some probably thirteen or fourteen years altogether, counting the chief of the Flight Director Office.

WRIGHT: Do you recall your first mission as flight director?

HOLLOWAY: Well, yes, of course. The first mission was [STS]-2, and then I'll talk about [STS]-3, because it was really my first—I don't want to say difficult, but more challenging situation.

[STS]-2 originally had been planned for a several-day flight. I've forgotten exactly how long, three or four days. We had a fuel cell failure fairly soon after launch, and ended up bringing the flight home after one day, with Dick [Richard H.] Truly and [Joe H.] Engle.

But I was the planning shift flight director on the second shift, so as it turned out, my role during that flight was short and sweet, one shift, and there was not a great deal of difficult or serious activity to worry about on it relative to my part of that flight. Of course, the overall business of having a fuel cell fail and then deciding to bring a flight home and all that was the more predominant activity going on in the flight, but my role in that was secondary.

On [STS]-3, I was the ascent flight director, and I also worked the planning shift on that flight, also. It was a longer duration flight. Two things happened on the flight. As we were approaching launch, we lost the backup computers in the Mission Control Center. Of course, we could have delayed the launch. So we made a decision to go ahead and launch, and technically, depending on how you read the flight rules, one might decide that that was not what the flight rules said we ought to do.

Also, during ascent, the cooling on one of the auxiliary propulsion systems, the system that drives the hydraulic pump for a hydraulic system was not cooling at all; it was overheating. The flight rules said at that time that you should shut the APU [Auxiliary Power Unit] down after the temperature got to a certain level. We first detected the problem, probably about three minutes into the flight, and the thing that I remember about all that, going from liftoff to MECO [Main Engine Cutoff] is eight minutes and thirty seconds, and that is the longest eight minutes and thirty seconds I have ever spent in my entire life. The part waiting to decide in getting a recommendation from a guy named McClendon [phonetic] to shut the APU down just seemed like forever. Nothing else was going on. Everything else was going fine, fortunately, so that was the only thing we had to deal with.

So at about a minute or so to go, to the end of the powered flight—and by the way, why this was important is, is that it would put one of the main engines into what we call hydraulic lockup, in terms of controlling the mixture ratio of the engines, and it was not totally sure what was going to happen when—well, let me say it differently. The test data that supported that was small.

So at about a minute to go, I directed the CapCom to tell the crew to shut the APU off, and I'm told later that Dr. Kraft, who was sitting on the back row, came up out of his chair halfway over the console and then just sat back down. [Laughs] He, at that time, had decided that "the young man,"—he always called me "the young man," at least in those days. He called a lot of people "young man," I think. But I think he was not so sure that the young man had made the right decision. So that was one of the interesting days that we had in the early days of the program.

Some others were associated with the DOD [Department of Defense] flights. I worked two of the DOD flights directly, myself, one after I became chief of Flight Director Office. Of course, they were classified and still are. Nothing dramatic happened on those flights. They all went very well, and we got the work done quite well, but just being associated with those programs and knowing what they were and what they do, it was quite rewarding.

In fact, you know, the ones who did those DOD [missions], they gave me a couple of medals for the DOD flights, and they were so classified at the time that it was a secret that you had the medal. So the way that works in that world, at least they worked in this case, is they would give you the medal, and then they would take it back and put it in a safe. Now, the reason I can talk about it is that since that time, some ten or so years later, they sent me the medal, so I assume they've declassified it, the fact that I got the medal. So it's an interesting story.

WRIGHT: Yes. While you were chief flight director, you had the misfortune of the second time in your career to be a part of a loss not just to the NASA community, but to the nation, when we lost the *Challenger* crew. Could you briefly describe for us the situation as you experienced it when you heard of what had happened to the *Challenger*?

HOLLOWAY: Well, on that flight, I was chief of Flight Director Office, and I also, at the same time, we were launching an IUS [Inertial Upper Stage] flight to put a TDRS [Tracking and Data Relay Satellite], a NASA communication satellite called TDRS, up into geosynchronous orbit using an interim upper stage that was built by the Air Force, by Boeing [Airplane Company] for the Air Force, and NASA procured the upper stage from the Air Force.

I was the admission director in addition to being chief of Flight Director Office, the mission director being the one who worried about the integrated operation of the whole operation, including getting the IUS to geosync [geosynchronous orbit]. The IUS control center was in Sunnyvale, California, in an Air Force facility, and the TDRS control center was in New Mexico, [White Sands Test Facility, Las Cruces], and the Shuttle control center, of course, was here at the Johnson Space Center. During the dock phase, they all three worked together, and Houston, the Johnson Shuttle Control Center, was the integration control center, the one that was in charge, so to speak, and the other two responded to them. Then once the IUS and TDRS was deployed from the Shuttle [payload] bay, the control center in Sunnyvale, California, run by the Air Force, was in charge, and took inputs from the TDRS control center, until they got the system to geosynch, and the IUS had done its job, and then separate the TDRS from the IUS, and then, of course, they went their separate ways.

So I was the mission director; John [T.] Cox, and I were in Sunnyvale, California, in the management room when we launched the *Challenger*. Of course, I hadn't been an ascent flight director for half a dozen flights or so when I saw the view that we all have burned in our brain, the ones of us that experienced this, of the Shuttle coming apart and the big cloud and the trail of the two SRBs [Solid Rocket Boosters] going their separate ways.

I knew instantly that the crew had been lost. There were no hope. I took my headset off and threw it on the floor, and then just sat down, because I knew there was nothing anyone could do. People went through the motions, but I really knew there were no hope for the crew. Of course, I called back to Houston, and my secretary was weeping, and everyone was in total shock.

John and I and a couple of other support people managed to get back to Houston that evening, and of course, then the whole history of what happened after that.

But that was where I was at, and how [I] was exposed. It was quite a traumatic event, in that I believe that most of us did not believe that would ever happen. Unfortunately, it did, and it can happen again. It's something that is part of our heritage and something we should remember as long as we fly people in space, and requires diligence and attention to detail and all of the things that makes what we do go so well, and we need to keep doing it as long as we fly people into space.

WRIGHT: September 29th, 1988 was a joyous time for the NASA community, because we returned to flight with STS-26. Share your thoughts and your experiences when you were able to be a part of that great occasion.

HOLLOWAY: Well, you know, there's been three or four particularly rewarding periods in my career, and the return-to-flight work that we did getting ready for STS-26 was one of those. Of course, the flight techniques work that I talked about earlier was one of the four or so, also, and had provided a wealth of background. During the time preceding STS-26, at that time I was chief of Flight Director Office, and eventually evolved to the point where Mr. Kranz, by and large, had delegated the technical Shuttle operations job to me, and I was, in fact, the mission operations director on STS-26 the first time I had had that job and had it for a period of time, between that and the time I finally came to the Shuttle Program.

So this work that we did during this period was a period where we strengthened the overall operations situation for what I call the long haul. I think the work that we did back in the

late seventies and early eighties, and I talked about earlier, is no reflection on that, but we did things like go back through and review all of that and make sure we're still happy with it. We added a rationale for all of the flight rules so that we had an historical record of why we do what we do rather than just stating what it was so that you could interpret it correctly and, hopefully, improve the implementation of it.

We also put in place a formal control process for controlling flight rules. I remember Gene and I had a difference of an opinion on that. In the old days, since each flight was different and each one was unique and so on and so forth, the individual team developed flight rules, they approved flight rules and so on and so forth, and out of that background, Gene thought that worked fine. I came to the conclusion that a lot of these flights had a lot of commonality in it, and that we ought to have a rigorous process for controlling and managing the flight. So we put all that together, re-reviewed that, I think, strengthened, the way I would characterize it, strengthened the overall flight operations foundation and process that had been put in place in the early days and worked through in the early part of the program, and provided a firmer foundation for the future. Of course, the actual launch itself, we were in the flight operations business, so flying is what we like to do. So looking forward to that was a very enjoyable period.

I know that the management was very worried. We had lost a crew on the last flight. Dr. [Aaron] Cohen, who was Center Director at the time, was in the control center with, I think with Gene and I, and I think all three of us was back on the back row where the mission operations director sat, and Dr. Cohen was really concerned about this first launch.

I had participated with Arnie [Arnold D.] Aldridge in the team. Arnie was the program director through all of that return of flight activity, and Arnie had instituted a program management review of activity where he got all of the primary participants in the program

together on a regular basis. I had watched all of them work together over those years of strengthening the programs, so I had a great deal of confidence that all would be well, and of course it was. The flight went extremely well and very smooth. But we were glad to be back in business, so to speak.

WRIGHT: As a person who didn't particularly like change, once again you were moving into a new position when you got promoted to assistant director for Space Shuttle Program. Tell us about those responsibilities as well as becoming the deputy manager for program integration.

HOLLOWAY: Well, I like to tell that little story about change, because in the Shuttle Program and in the Station Program, I've often been characterized as an agent of change, so that's quite a dichotomy, and it's not in my normal character, as a matter of fact. Of course, most of us don't really like change, although my wife was pretty good at that. But change, in the end, can be very good for us.

In the early phases that I talked about earlier when I was still working in the Mission Operations Directorate as chief of the Flight Director Office, and then as the Mission Operations Directorate over in the control center, Kranz had basically delegated the technical management of the Shuttle operations to me when I was still chief of the Flight Director Office while he still ran the administrative part. People worked for him, the division chiefs worked for him, and he ran the contract. He managed the contractors.

After STS-26, Kranz reorganized. He was focusing primarily on Station. Of course, he was assuming at that time the Station would be deployed a little earlier than it eventually was deployed. So in the early nineties or late eighties, he was focusing primarily on Station.

Eventually, he made me the assistant director for Shuttle operations and put six of his divisions working directly for me as part of the organizations. Then he had another organization that was getting ready to do the Station work, and he spent most of his time working on the Station program. He still managed our operations contract from an administrative point of view, but eventually I got involved in that to some degree.

Then in 1991, as I recall, I was coming back from a trip from someplace, and I don't remember where, when Leonard [S.] Nicholson asked me—we were driving back, must have been from International Airport [currently called William P. Hobby Airport, Houston, Texas]. We were driving back home, and he asked me if I'd come to work for him, be his deputy at that time. Of course, I didn't respond immediately, but after a while, I thought about that some and told Lenny that, no, I really didn't think I wanted to be a deputy. I probably didn't say it that way. I didn't think I wanted to make the transition. The fact is, I didn't think the idea of being deputy was too good a way of traveling.

But time passed fairly quickly, and perhaps it was already in transition, already being worked, and Bill [William A.] Lenoir, when he was AA [Associate Administrator for Spaceflight], developed a plan that would transition the Shuttle Program management infrastructure to Florida, subsystem managing went down to Florida, and the basic Shuttle Program would move to Florida. The program manager would work down in Florida, and the technical integration people, or Shuttle integration people, would move to Florida, and so on and so forth.

So Leonard called me again and said, "Well, we're going to Florida. How would you like to be the deputy program manager and stay in Houston and manage the flight operations aspect of the program from a program perspective?" That would involve requirements,

definition, and the overall integration of the program and working with MOD [Mission Operations Directorate] and the crew office, and so on and so forth, and being the mission chairman of the Mission Management Team, MMT chairman, over in the control center and all.

I thought about that for a while, and I said, “Well, that’s different. The boss will be off down in Florida and that’s different from being a regular deputy.” So I said, “Okay,” and I moved over to the Shuttle Program, started working on that, and within weeks or probably a few months, [Daniel S.] Goldin became the Administrator, and shortly after that, Bill Lenoir was moved on, and Goldin changed all of that. He left the program in Houston, which probably was the right decision. So that’s how I ended up in the Shuttle Program.

An interesting sideline, Frank [T.] Buzzard, who is working in Washington [D.C.] today in the International Space Station Program, was in the integration part of the Shuttle Program at the time. He had already bought a home down in Florida, and effectively had transitioned to Florida. So he had to turn around, sell his place in Florida, come back and get another place, and reestablish back up in Houston.

But that’s how I got over into the Shuttle Program in ’91. Of course, since then, it’s really been fast paced.

WRIGHT: Wasn’t too long after that you learned that you were making another change, because they moved you to head up another program called the Shuttle-Mir Program. How did you find out you were going to be working with this new partnership with the Russians?

HOLLOWAY: Well, I first had a hint that some kind of relationship with the Russians were evolving, probably in mid-’91 or so, or some point in time in ’91. I was down in Florida and got

a call from Leonard, and the question was, “When could we launch a Russian on a Shuttle and do a joint Russian-U.S. spacewalk?”

Of course, my initial reaction was, “Why would we want to do a crazy thing like that?” So we went off and looked at the opportunities to do such a thing. And I don’t know, that idea went away, didn’t fit very well and didn’t work very well, like I said, probably wasn’t a very good idea.

So the next thing that came along, Leonard said, “Well, the people want to look at a mission to fly the Shuttle one time,” at least that’s what I had in my mind, “one time to the Mir and dock with it, and I think you ought to lead the activity from the Shuttle Program perspective.” This was sometime in the first half of ’92.

So it evolved that we were to go to Moscow [Russia] and the first trip was in July of ’92, with the task of working with the Russians to sort out, one, could we do a Shuttle? Could we accomplish such a thing, have a joint docking mechanism? Could we dock? Could we do this? And so on and so forth.

Then the second task was to make a recommendation on what kind of docking system that we would use. At that particular time, we had two obvious choices. We could continue with the development of the U.S. airlock and build our own docking system, put it on top of the airlock. Had three choices, I suppose. The second choice, the Russians had launched earlier their Shuttle, Buran, and flew it one time around the world and landed it one time. They had a docking system. They also had an airlock that would fit in the payload bay, and goes right behind the forward bulkhead similar to where ours eventually ended up. We could also use their entire system, including their airlock and their docking mechanism. The third option was to put the Russian docking system on the top of our airlock. So those were the three options.

So our task was to figure out, one, can we do this thing, and what were the problems associated with it? And, two, pick and recommend a system to do it with. Our first trip was in July of '92. I believe the second one was September, and the third one was in November. At some point after that, probably before the end of the year, we made a recommendation. We recommended that we put the Russian docking system on top of the U.S. airlock, and, of course, that's what we're using today to dock with the International Space Station.

Remember, when I first started this activity, I thought it was one flight. We're going to do this one time. There were some who wanted to do ten flights in the beginning, based on what the Station schedule was. I think from '92 to '94, I was the pseudo program manager without having the official title. It was officially part of the Station Program. But it had so many tentacles into the Shuttle Program, it was a very integrated activity that had a lot of development work to do, had to be highly integrated.

So I did all of that in '93 and part of '94, and they eventually decided they needed a formal program director for the Mir Program, and they named me program director in '94. So we went from one flight to ten flights, back to seven, and then, eventually, when the Station Program slipped, they added three more flights to the Mir Program, back to ten. So we ended up with ten flights to the Mir before it was all over.

WRIGHT: Did you have any idea on that first trip in July of '92 that ten years later we would be in full partnership with the Russians on the International Space Station?

HOLLOWAY: No, I did not. I suspect that the management in Washington had some clue that that might be in the cards, but I did not know that at the time. I really thought we were working on one flight to the Mir.

WRIGHT: How did your experiences with Shuttle-Mir help prepare you for your role as the program manager of the International Space Station?

HOLLOWAY: Well, I think overall, the Shuttle-Mir Program did three or four things for the Station Program in general. I'll talk about me as the program manager for the International Space Station, probably secondly. The first is just what the Russians brought to the table. They have a crew rescue vehicle in the Soyuz in place. It's extremely reliable. The vehicle has been used for many, many years and worked very well for three people, and didn't require development. It was in place and ready to go. They also had a logistics capability and a propulsion capability that was quite capable and had been demonstrated on the Shuttle-Mir. So they brought to the table almost a readymade capability that at that time NASA did not have.

The second thing, given that we were working the program jointly with the Russians, the thing the Shuttle-Mir Program did for us, it enabled us to learn to work with the Russians. That was one of the major objectives of the early program, and I would characterize that in two or three categories. First of all, the Russians are culturally significantly different than we are. They're very capable in the work that they do. Their thought processes are much like ours, but there's a lot of things that are different about how the Russians do business and what they consider to be important and how they work and relate to one another. So I think the Shuttle-Mir Program gave us an opportunity to begin to understand that.

There's a lot of things the Russians do that for you and I would be insulting to each other, or vice versa, perhaps, but in their culture, it's not. So, learning about those sort of things. They have a historical background of how they have done business and what is important to them based on long-duration flights that is somewhat different than what we have, having flown predominantly with the Skylab being the exception to that, shorter flights, things like contamination. You worry a lot more about contamination in the atmosphere in a vehicle that you're going to permanently, more or less permanently, have crews in than one that you're going to be there for ten or twenty days.

So the overall approach to risk management and the way the Russians deal with that is somewhat different than what we do. The Russians are able to take risk in stride better than we are. We do not like to take any risk that we don't need to for very overt reason. It seems to me they're better able to judge what are real risks and what are not. So there's a whole litany of different approaches of what's important, and I think Shuttle-Mir gave us an opportunity to learn to appreciate those things and learn to relate to those.

Of course, there's some problems in all that, as you might expect. You know, they had a certain way of doing business, of setting a certain criteria, and we had a certain criteria. They'd want to do something one way and we'd want to do it the other way. We both thought we were right, and then that has to be resolved. And they also felt like they were in charge, to a certain degree. They've been doing this business for thirty-five years, and we're the new guys on the block relative to the long-duration thing.

So this allowed us the opportunity to understand the Russians, understand how they think. One of the more important things is that in the Russian environment or culture, personal working relationships are very, very important. Many of these people have been doing the same

job for twenty or thirty years, and continuity and relationships are extremely important over a period of time. Shuttle-Mir gave us an opportunity to, in some cases, to reestablish some of those from the Apollo-Soyuz, and in other cases, to build new relationships that then transitioned to the Station Program. So I think in the end, the Shuttle-Mir Program provided a firm foundation for which to engage the Russians in the implementation of the Station Program.

WRIGHT: As program manager of the ISS [International Space Station], you had so many other challenges to overcome and many goals to reach. Are there some that are more significant than others at this point in your time where you're retiring and can reflect back on your days as program manager of the ISS?

HOLLOWAY: Well, I think, historically, when I came to the program, I think the biggest challenge was to evolve from an environment where we were slipping to the right in real time. In other words, launch date was going as fast as time was going. Overall, what I found was an environment where people expected flights not to launch on time and for us to stretch the schedule out, so to speak. So one of the biggest challenges in the beginning was twofold. First is to evolve to an attitude and approach that schedules were going to be met. At least that was our approach and our attitude toward schedules. The second part was building the overall team and dividing it up and getting it focused; they could do both the development job that still was remaining and then having them focus on the flight operations part that we're flying the flights that were in place. So getting that wired together so it would work well together [were] the two things that I think we probably contributed the most to in the formative stages, in the earlier part of my watch.

Of course, the third thing is what's still yet to be played out, and that's what are we to do with the cost problem. We found that there simply was not enough money, and given the situation that we had, the program had slipped, two to three years, depending on how you want to measure it, whether it was beginning of the program or the end of the program, and money had not gone with it. There'd been a lot of additions made to the program that did not have additional money added to cover the additions.

In my view, the program had been underestimated in the beginning, and a lot of things that ought to be done in the realm of human spaceflight had been omitted from the beginning that had to be dealt with. So dealing with the cost problem was probably the major thing that I had to contend with. I simply did not believe that we could execute the program for the [amount of] money that we had, and at that point in the program, we were at the point where it was time to face reality. We could either let things [continue or stop flying]. If you're not flying flights, we could get along fine with the money that we had. But if we were going to execute the program, we had to face up to reality.

So this whole business of going through cost estimation process and doing all we could to reduce what was a very large number at one time, and work it down to the minimum, the new administration, the [George W.] Bush administration, providing us some guidelines, working through that, and now, then, we're still working through it because we're currently limited to three people on the Station based on the amount of money that we currently have and what we think we can do with that money, and how that's all going to play out remains to be seen.

I think we have done a very thorough job of defining an austere budget of what it's going to take to do the work that we think is important for the future, and we're going through a methodical process of requirements and understanding those and what drives the need to have a

space station, and we really want to do all of these things. So it'd probably another budget year or so before we really know the results of that. So that's yet to play out.

WRIGHT: Mr. Holloway, before we close today, I would like for you to take a moment and share with us what you believe to be one or even more of the greatest challenges that you had to face during your four decades here with NASA.

HOLLOWAY: Well, it's really difficult to focus on one or two. Now working backwards, in International Space Station certainly coming to grips with this budget issue and defining the budget issue, going through the processes of independent review committee, called the IMCE [International Space Station Management and Cost Evaluation] Committee, and responding to their action items and responding to their questions, and bringing all that together in a way that reflected what we think the requirements were was a particularly difficult time for us.

Doing the cost-reduction activities that we went through and making judgments on where cost reductions could be made is not exactly a science. Some of these things are a matter of just having to decide. It's a matter of making decisions in terms of what might be important in the future and might not be as important in the future. So all of that was a particularly challenging time frame for us.

I think in the Shuttle Program, the Shuttle era when I was both the Shuttle Program manager and worked in the Shuttle Program, the cost reduction that we went through, I wouldn't call it a challenge, but it was a particularly rewarding time. Overall, Brewster [H.] Shaw and I reduced the Shuttle cost some 40 percent during our periods when I worked for Brewster, and later when I was a program manager, myself, and phasing the S flight [phonetic] contractor into

the program and doing that in a deliberate, safe, and rigorous way is something that I think was both a challenge and an activity that from that standpoint worked out quite well.

Back to the Station Program, of course, the integration of the international part of this program is particularly challenging. I often tell people that I was the manager of the International Space Station, not the manager of the NASA Space Station, and that also NASA is responsible for the integration and the overall management of the program, and from that sense, I considered myself to be the manager of the international, including the interest of the other four partners, the Russians and the ESA [European Space Agency] and the Canadians and the Japanese. Of course, they are diverse cultures and have different approaches to doing business. So that's a very unique situation that you have to deal with.

Back in the mission operations days, of course, getting ready for a return-to-flight was both a challenging and a rewarding time. That's something we talked about earlier. The initial flight preparation for the first Shuttle flight, when Neil and Don and I did all the flight techniques, it was particularly rewarding.

Back on Apollo, of course, all of it was a challenge and a great deal of interest, but Apollo 17 was particularly rewarding. The individual that was going to do the crew flight plan for Apollo 17 decided he wanted a career change and eventually ended up being a lawyer, and works in Houston as a lawyer today. So he had decided to go to law school, so I ended up doing his job myself, even though I was the first-line supervisor at the time. Other people were transitioning to the Skylab Program, and so I got to work a level deeper in the activities on Apollo 17, and it was really quite rewarding.

I've often asked what some of the defining moments in my career have been, and I think there's probably been two or three. During the Mercury Program, I came to work in February.

We launched the last Mercury flight in May, Gordon Cooper and MA [Mercury Atlas]-9, and we all went down to Florida. They graciously let me go with them. I'd only been around a few months. I didn't really know what was going on. I stayed down in Florida for a couple of months getting ready for the launch, and then at that time they did the post-flight work down in Florida for about six weeks, finished the training the last few weeks down in Florida. Mission Control Center in the early days was in Florida up through Gemini IV, and then it transitioned here to Houston.

But I remember, on Gordon's flight, walking outside the Mission Control Center. I was in the Mission Control Center for the launch preparation and watching the liftoff, and about 10,000 feet, I realized that Cooper was in the spacecraft; there was a human being on board. And in that came an awesome responsibility for what it is that we do.

It was reinforced by an event of a couple of weeks earlier when I had walked outside the cafeteria at Cape Canaveral Air Force Station [Florida] and saw a Titan, which the Gemini would eventually be launched on, pitch over at about forty or fifty thousand feet and be destroyed by the range safety officer. So those two events came together in my mind to give me a sense of the risks that we take when we fly people in space and the responsibilities that we have in terms of being rigorous about what we do.

The fire in which we lost what was eventually called Apollo [1] crew down in Florida is something that even though I was, as all of us in NASA were, very emotionally attached to the fact that these—and I'd known Gus from flight from the Gemini days, so I knew them as individuals. But that event did not touch me in that way nearly as much as later events.

Apollo 13, I talked earlier about having worked all during that period between the time of the accident, the explosion, and the time that we recovered the crew. I remember walking across

the campus between Building 4 and the Mission Control Center and telling myself that in the future, I and the people that worked for me would be better prepared to avoid and deal with circumstances like the Apollo 13 event to help make sure, one, it didn't happen again, and, second, if it did, to be able to respond and solve the problems.

Of course, *Challenger* is something that is an integral part of all of work on the Shuttle Program for its duration's heritage. The image of the *Challenger* accident and the vapor cloud and the SRB plumes, separating plumes, are permanently burned in your brain. And out of that process came a team, and evolved a team that had been through the fire, so to speak, had been rigorously developed and were committed to doing what they had to do to avoid things similar to that in the future.

I had the privilege—of course, at that time I never dreamed that some few years later that I would be a program manager for the Shuttle Program. I didn't have the slightest clue that Leonard Nicholson would ever ask me to come work in the Shuttle Program. But as I watched that team operate from '91 through '98 and almost four years as program manager, they had evolved to being an extremely dedicated, committed group of people as all are who work in human spaceflight. But also, they developed a way of doing business that both in terms of their dedication and commitment and their abilities and their discipline, to stick to the basic principles that I think is unsurpassed in our culture. So all of those thoughts come to my mind when you ask those kinds of questions.

The overall question about why are we in this business, I think over the last forty years we have tended to be in the business of flying humans in space, for the sake of flying humans in space. The time has come where we must transition to having a purpose that's more related to other objectives from commercial aspects to scientific aspects, to preparing ourselves for the

future and whatever that might be, and so there's a wide litany of possibilities, but no longer can we afford to just depend upon the glory of flying people in space as being a reason to spend the kind of money we do spend for human spaceflight.

The international aspects of the program and the International Space Station, I think, are extremely important. Backing up a step, the International Space Station has an enormous potential for doing research and technology development and work compared to what we have done in the past; [the station] has an enormous capability with the support of six or so Shuttle flights a year, and if we can get back to six or seven people as a crew complement, the international aspect is, I think, is tremendously important. When we leave Earth orbit, eventually—and of course, I believe the human race is destined to leave Earth orbit someday, and someday it will be in big ways. Humans will routinely live somewhere else, and this, of course, is just the beginning.

When the next step is taken, I believe it'll be an international effort, simply because the overall cost and the Station can, and is, playing a big role in terms of bringing a coalition together that could be the starter for such an alliance in the future.

Also, in a small way, the world is getting smaller, and as we work together, it's much more difficult to be enemies, and I believe that working together can help us in terms of becoming closer together as a world society rather than a people who spend their time and energy destroying each other. So I think we have a great range of potentials in the future.

But it's a great time to be in this business of flight operations. Human spaceflight is doing a really tremendous job today. It's never been done better in terms of execution. Many say the human spaceflight operations is way too expensive, and I think with the right focus, the

sum cost can be reduced. But overall, if you bought a new car lately, things are expensive, and flying people in space is expensive today and will stay that way for quite some time.

WRIGHT: Are there some lessons that the human race or society can learn from NASA and its pursuit of space exploration? What have we learned as a people based on what NASA has learned as a community?

HOLLOWAY: Well, I think it's interesting to observe [how] the Russians and the United States—Americans, if you will—interact with each other, particularly the people that were in the military, and the people who are positioned for conflict in the Cold War era when there might have been a conflict between the Russians and the United States, people who were focused on being prepared to kill each other, some as short as fifteen years ago, and, of course, going back for forty or fifty years ago, and their perspective on life.

One of the things that I think you learn is, people are more alike than they are different. They all have families, and they all are very concerned about their family. They all have similar concerns about life and what's important to them, and they may have a different view of what makes the world go around, to some point. So as people work together and learn [from] each other, they come to a conclusion that they're really not a lot different; they're not really the bad guy. And so it's a very interesting process to watch.

WRIGHT: You had been quoted earlier as saying that the most important thing you've learned during your forty years of civil service is that people matter most of all. You certainly have met hundreds of people in your jobs and your positions and all of the responsibilities that you have.

If you had a statement that you would like to make that you have learned about what's important about people, could you share that with us now?

HOLLOWAY: Well, I think the bottom line is that everyone is important, and the team is much stronger than the individuals. Everyone can make a very positive and contributing contribution, and in the end, I believe that when everyone is making a contribution that the total team is stronger and is able to do more because of that. I'd have to admit that earlier in my career, I thought that the movers and shakers of the world [are] the ones that made things happen, and, of course, you do need a few movers and shakers, but in the end, all of us are important. All of us are individuals. All of us have a particular role to play, and when we're all working together, working well together, and are able to make our contribution, the entire team is much stronger because of that.

Over the years, I've become more and more convinced of that, that ultimately, the best organization is one where the entire team and all the people are fully appreciated and employed, and they're treated well as human beings.

WRIGHT: We've talked today and touched on most of your career, and somewhat on a serious basis, but surely there must have been some lighter moments of what had happened during your time here with NASA. Can you think of any of the times that you can remember that were somewhat on a lighter note? We've learned that there were times when the mission controllers might play different antics with each other as far as the simulations were concerned or different times just to lighten up some of the overall pressures that you went through day-to-day. Does anything come to mind?

HOLLOWAY: I'm sure there's been many, but I'm fresh out of ideas.

WRIGHT: Well, maybe we'll have a chance for you to reflect on those, and we can visit with that another time.

As you begin your exit here from NASA, have you thought about what you'll be missing the most from not coming to work every day at this Center?

HOLLOWAY: Well, my wife says my truck knows the way up here. You know, all you have to do is turn a key on; it'll come. Also, since I came to the program office, I've always lived on the fifth floor—worked on the fifth floor, and I resolved to climb the stairs soon after I came over here. So I don't ride the elevators, either going to the ninth floor from the fifth floor, or going from the first floor to the fifth floor, and so that's one of the ways I've gotten my exercise over the last ten years, and so I'd have to substitute that, now that we're transitioning to the retired life to other activities. So my wife and I are developing a exercise routine that we're going to do everyday. Anyway, the transition is just beginning. It'll take a while.

WRIGHT: Before we close today, I wanted to ask you if you had any other thoughts or reflections that you would like to share with us before we close out for now, and I look forward to the next time that we talk and find more, but as far as today's session, if you had some other thoughts or some other experiences that you would like to share for the moment.

HOLLOWAY: Well, perhaps a couple of things. The work associated with flying humans in space has evolved tremendously over the last forty years. The quality and capabilities of what we do today is significantly higher and has gotten better year after year after year. We do things much better today than we did a few years ago or twenty years ago or thirty years, and we make less embarrassing mistakes, if you will. So things have evolved exceptionally well.

This group I have found to be the most dedicated, committed group of people, based on information that I have, anywhere around. So I've been privileged to work with them all of these years and expect that they will carry that well into the future as long as we fly humans in space.

The second thing is that the heritage that human spaceflight has should be nurtured in terms of what it takes to carry on in that tradition. The next *Challenger* will, at least temporarily, stop, at least in my opinion, human spaceflight, and it must not happen. So we should remember the *Challenger* and what it takes to keep it from happening.

WRIGHT: There were many lessons that NASA has learned and many accomplishments, and a lot of that has been attributed to your contributions, and I'm sure that if we ask many of your coworkers if they would be first to say that they're glad you didn't go to work at the Chicago Iron & Bridge Company, but yet chose this position. I certainly appreciate your time today and wish you well in the next weeks getting used to all the other tasks that you have to do, and I look forward to talking with you again for the project.

HOLLOWAY: All of the people have been so kind and gracious over the last several weeks, far beyond what I deserve.

WRIGHT: Well, I'm sure there'll be a lot of people that argue with that, so just enjoy those days, and we're so glad that you're part of this Center. So thank you again for today.

Holloway: Thank you.

[End of interview]