NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

W. MICHAEL HAWES
INTERVIEWED BY SANDRA JOHNSON
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JOHNSON: Today is July 12th, 2017. This interview with Michael Hawes is being conducted at the NASA Johnson Space Center in Houston, Texas for the JSC Oral History Project. The interviewer is Sandra Johnson. I want to thank you again for coming by. I know you've got a busy schedule, especially now, and so I appreciate you taking some time out to talk about your history.

I want to start by talking about when you first graduated in '78. Why did you want to come to NASA? Was this something you'd thought about all along, or how did that interest start?

HAWES: I had thought about doing something with the space program since I was in middle school probably. I had watched most of the early missions [Mercury and Gemini] on TV. I actually used this at a session a couple months ago. I actually have a pamphlet from junior high school that says, "So you want to be a space scientist?" And it was written by Wernher von Braun. It was something from the school guidance office where they had all kinds of different careers, and I was perusing through it and found this one about space. It was written by von Braun and an educator for use in this process.

So my interest really goes back strongly to about the sixth-, seventh-grade timeframe. Now that's also about when we were landing on the Moon, so I'd been following the program for several years before that, but that was where it kicked in that there were actually careers that I

could go do. Then it just escalated from there. I decided engineering made sense, aerospace engineering made sense. I'm from a pretty small town in Pennsylvania so there weren't really role models or necessarily an easy identifiable path. I just followed those things that seemed to make sense if you wanted to go work in space.

JOHNSON: When you had that pamphlet at your junior high school, did they encourage you to follow that path? Or did anyone know enough about it to start encouraging you?

HAWES: I had a seventh grade science teacher, Mr. [Clifford] Ramsey, that had us build rockets in class, and had us collect notes and really highlighted what was going on with the Apollo Program. I want to say that the [Apollo 11] lunar landing was probably that summer in between seventh and eighth grade.

He did a lot to encourage my interest in that. He certainly taught a lot about it. We learned all the fundamentals about rocketry just by going down the block and shooting rockets off in the park. Then I took that and did it at home. I actually had done a bunch of that stuff already. That helped me, I think, really solidify into the idea that I could study and I could actually build towards a career in doing this.

JOHNSON: Then you went to school, and you didn't just go to any small school. You went to [University of] Notre Dame [Indiana].

HAWES: Yes. Notre Dame was mostly a family connection. My dad had gone to Notre Dame, my brother had as well. I applied to a few schools, but actually with the strong family connection I was very familiar with what Notre Dame offered.

One of the interesting things was, from an engineering standpoint, it's a relatively small program, particularly in the state of Indiana. Everybody compares it to Purdue [University, West Lafayette, Indiana], which is huge. But the smallness of that program meant that you actually had a lot of faculty contact. I had opportunity to do independent research as an undergraduate. I had opportunity to work with graduate students. There were some advantages in the program that I could see.

The disadvantage in the program is that most of the faculty at the time were more aeronautics-focused than astronautics-focused. So to carve a space kind of path through that, you had to work on your own to make sure that you were working on those aspects yourself. There were a couple faculty there that were amenable to help do that, but it wasn't necessarily an obvious way to the path to get here.

I met, my senior year of college, another Notre Dame alumnus who was working at JSC at the time. A guy by the name of Al [Mansour A.] Jowid who worked in the [Space Shuttle] Orbiter Project Office and was actually the Orbiter Project Engineer for [Space Shuttle] *Challenger*. Al helped me understand what might be available at JSC, and as it turned out JSC was beginning to hire up, particularly in flight operations for the Shuttle Program.

While a lot of the design and development was done, or well on its way, starting about that time there was a pretty good hiring path for both NASA and for several of the big local support contracts. I happened to get in on the NASA side really just by following this path. It seemed to make sense, and then there was an opening at the right time. I had a connection that

helped convince me there's an opening, I managed to get myself to Houston for interviews. Jim [James J.] Shannon [Sr.] interviewed me, hired me, and now I'm back here.

JOHNSON: It's interesting because in the '70s they'd had so many layoffs here, obviously because of the end of Apollo. Then there were a lot of delays with Shuttle, and a lot of things were going on when you came in in '78. What were your expectations when you first took that job in flight control? What did you think you would be doing, and how did that compare to what you were actually doing?

HAWES: I didn't have a real strong set of expectations. I knew some engineers growing up, but they were in very different fields so I didn't really have a sense of aerospace except in my own academic program. The folks that were hiring when I was interested were what was then Flight Operations [Directorate], as it is back now. It sounded really very appealing. I interviewed with several of the managers. Jim Shannon I mentioned. Jim [James E.] Saultz had the corresponding branch in payloads at that time. It sounded pretty interesting.

I also interviewed with some of the crew training folks and a variety of folks. I interviewed with both NASA and at the time with McDonnell Douglas [Corporation]. But it was all focused on flight operations, which to a kid coming out of college sounds pretty cool. "You're going to work in the [Mission] Control Center, you're going to train astronauts to fly."

I didn't have a strong expectation, but as I did the interview process it was pretty exciting. For somebody that wants to find a way to go work in the space program, especially the human space program, it was kind of like "how could I pass this up"-type opportunities.

I wasn't sure how much I would use my direct engineering skills, but clearly I've learned now over the years that that was not going to be a design and development analysis kind of job. It was going to be more your engineering background is an important tool to use in how you learn and assess spacecraft systems, how you then help train crews, how you support Mission Control with that level of expertise. I really learned to use my engineering tools for that. That's what the task was up front.

It was interesting, because I was on the very early end of that hiring, so most of the folks in the office were generally I would say 8 to 10 years older. They had been here through the end of Apollo and Skylab, and they were the first-line leaders that I worked for. But there was a pretty good age gap at that time. Then probably the next four or five years that hiring path not only continued but escalated as we really got into flying Shuttle pre-*Challenger* [STS-51L accident]. There were a lot of early career folks in their 20s, and in some ways that environment modeled what the Apollo folks had talked about in their early days, with a lot of folks all pretty much just into the job market, doing these things that they hadn't done before. That was what the environment was like for a lot of us in the early '80s.

JOHNSON: Speaking of doing things that hadn't been done before, one of the things you did, from what I read, was you were involved in Skylab and the deorbit.

HAWES: Thirty-eight years ago. Yes, a friend sent me an e-mail yesterday, which was interesting.

JOHNSON: It was yesterday, yes.

HAWES: He wished me a happy crashiversary. At the time NASA had determined that Skylab was decreasing in altitude much faster than they had predicted at the end of the program. They had boosted Skylab a little higher in orbit at the end of the last crew visit—although they didn't do as much as they had planned—with the idea that they would be able to do something, and that the Shuttle would get to it.

For a while one of my first tasks within the payload group was to work a mission of a system called the Teleoperator Retrieval System, which was going to be built by Martin Marietta [Corporation]. It was going to be on the third Shuttle mission, was going to fly over to Skylab, and either boost up in altitude or a controlled boost down into the ocean. I had been working on that. The job of reactivating Skylab and running a mission control team fell within the overall flight ops [operations] group to Charlie [Charles S.] Harlan, who was the head of the Operations Division at the time. Over time Charlie pinged a few of us that were fairly new to the workforce to go in and start to train with folks that had initiated that activity. I think it was late '77 that they had reactivated, and they had taken over one of the old control rooms in Building 30 and had a small team.

I got thrown into that. Or I volunteered, because to me that was how you learned; this is what mission control was, you went over and actually did the job. In a way it was a great experience, because not only did you learn what flight control was about, but you learned it at its most rudimentary form. Once you get to the Control Center and you have all the tools and the consoles, you're a step away from the real basics. With the Skylab team, we were so small, we really just dealt with very basic capabilities. You learned what it was about at a real basic level, which to me was really helpful.

I did that for nine months, and did a lot of the final mission scenario planning for the team. Then it just happened out that it was my shift on console when we were actually doing the reentry, so I did actually send the commands to start Skylab tumbling.

JOHNSON: You mentioned that it was voluntary and that a lot of them were young. We interviewed [Astronaut] Bonnie [J.] Dunbar. You actually started here at JSC at the same time. I saw a clip from the newspaper that you had started at the same time, so it's interesting.

HAWES: Yes. I started at the same time as the Thirty-Five New Guys as far as the Shuttle crews. Literally, Anna [L.] Fisher and I signed in to HR [Human Resources] the same day. Then folks like Bonnie and Mike [John M.] Lounge and Linda [M.] Godwin Nagel—who ultimately would become crew but weren't selected in that first class—came to JSC to work and learn more of the NASA system and then were selected in the '80 class [Godwin joined NASA 1980, astronaut selection in 1985]. Jerry [L.] Ross was another. Several of those folks, we all came in at the same time. They were a little more seasoned than I was, but that was who some of the early groups were.

JOHNSON: It's an interesting time at NASA.

HAWES: Yes, it was a fascinating time to watch all of this evolve.

JOHNSON: With the Thirty-Five New Guys [including] women and minorities, times were changing pretty quickly, at NASA anyway.

When you were working on Skylab you said you were the one that actually sent the commands. But in those nine months working up to it, what was the schedule like for monitoring it?

HAWES: The schedule was kind of crazy. At the time, at first it was a mission of "we're going to preserve the capability to get there with the Shuttle." Then over time, as the Shuttle slipped, it was more and more apparent that it was really going to be about a reentry mission, not a recovery mission.

We had relatively low priority with the tracking network. This is long before TDRS [Tracking and Data Relay Satellite]. This is the original ground station tracking. We usually got about one tracking pass an orbit. Think about 4 to 5 minutes of data every 90 minutes. In that in-between time we would do planning for whatever the day was. The position that I filled I've always felt was the classic NASA acronymese. The position was called an ASCO, which stood for ATMDC Software Control Officer, which meant Apollo Telescope Mount Digital Computer Software Control Officer. So triply nested acronyms. I thought that was great.

One of the jobs of the ASCO was to maintain the navigation state on the spacecraft. We took tracking data and we ran a ground-processing program, and so we updated the state vector of the spacecraft. Usually when I started you might do that once a week, but as it got lower and lower in altitude it was changing so dramatically you might do it a couple times a day. There were certain systems that we controlled. There were certain systems that the GNC [Guidance, Navigation, and Control] folks—like Bonnie controlled.

We each had different responsibilities, but maintaining the navigation state and attitude control were within my purview, so that's how it got to be "go send it to an attitude it can't find

so that it tumbles so that it's more predictable on reentry." That was really what the goal was at that time, to have a more predictable reentry profile.

It was about nine months that I actually worked on the mission in total. Usually you shifted from like five days of day shift, to five days of evenings, to five days of nights. There was a period when we knew it was this reentry mission. It was fairly stable, so we actually for a period of time dropped to a just daytime, long-day structure. Then as the spacecraft got lower in altitude it needed a lot more care, and then we were back into the 24/7 monitoring.

JOHNSON: During that whole time period there was a lot of publicity about what was happening. Of course in '78 the Russian Kosmos 954 satellite, they lost control.

HAWES: Crashed into Canada, yes.

JOHNSON: Crashed into Canada with radioactive debris. People were a little concerned about Skylab since the orbital path crossed 90 percent of inhabitable areas in the world. You were relatively young at that time, and I know sometimes when we've talked to people in mission control during Apollo, they were so focused on what they were doing, they didn't even know what was going on in the rest of the world. Was it like that for you, too? Were you aware?

HAWES: I would say we were aware. Because you could see the press articles, and you'd see people running around with funny crash helmets. But we knew the capability of the spacecraft, and we knew that the ability to really influence was pretty small. Having done the studies of the teleoperator retrieval system earlier, from my recollection we had picked orbits to actually do a

controlled reentry. Skylab picked one of those orbits to come in on. The orbit that at the endgame she was aimed for was pretty much straight down the center of the Atlantic Ocean. There were uncertainty bounds on that, on the "if she comes in early" kind of bounds; it was still over the continental U.S. and Canada. Tumbling the spacecraft was meant to shift the midpoint a little bit into the South Atlantic so that you didn't have the inhabited northeast United States and Canada under the track.

But the orbit, as it became clear a few days out, it would have been hard to really pick a better orbit that covered that much ocean and that little inhabited ground. As it turned out, the best I can recall from those days is that the spacecraft actually held together longer than the engineering projections. That's why some of the components did land in Australia, out in the relative Outback.

JOHNSON: It was expected by the time it got over eastern U.S. to start coming apart, and it didn't.

HAWES: Yes, it was expected to come apart and it hung together a little bit longer than the engineering analyses said.

JOHNSON: Was there a little breath holding?

HAWES: I would say it was mission-focused. We knew the tools that we had, the capability. Skylab didn't have a big propulsion system. It had small attitude control thrusters, and it had big gyroscopes. It really wasn't meant for boosting and reboosting, so you had the limitations of

what the spacecraft had. Like I said, the idea of tumbling it was just to make a more predictable reentry.

JOHNSON: I was reading about debris pattern calculations that had been made. Who was doing those calculations for you?

HAWES: We had the small flight ops team. We also had support from engineering and from the old Mission Planning and Analysis Division that was doing a lot of that trajectory analysis and debris planning.

Skylab was actually a project of the [NASA] Marshall Space Flight Center [Huntsville, Alabama], so we had an engineering support team from Marshall that was with us most all the time, operating out of the HOSC [Huntsville Operations Support Center] like they have done for years in support of missions. They were not full-time support until the end, but we all had counterparts at Marshall that we could deal with in terms of how the systems functioned and what was going on. The collective team of the JSC engineering and MPAD [Mission Planning and Analysis Division] folks and the Marshall folks were the ones that were doing that offline analysis of how the spacecraft was going to break apart.

JOHNSON: Also, before it actually came in, at one point there was another Russian rocket that was coming in and NASA had a chance to practice following that.

HAWES: It was more NASA and the Air Force being able to exercise the tracking systems and match that to the projections of what they thought was going to happen.

JOHNSON: It was just a little chance to make sure what they thought was going to happen really happened?

HAWES: Yes, because the Kosmos satellite took a lot of people by surprise when it landed in Canada. I think then they had an opportunity, where they had a little more knowledge of the system, and they would be able to actually track and see. But we had a lot of interest. The last few days all the media was actually set up in one of the old flight control rooms tracking things. They had a camera in our little control room where they would watch us.

JOHNSON: Did they have interaction at all with your room?

HAWES: Not much, no. Every once in a while one of us would get asked to go down and answer a question or drag a model. I think I took a model down to Jules Bergman [broadcast science journalist] somewhere in that process, but we were not offered up as media subjects very much.

JOHNSON: It's probably a good thing.

HAWES: Yes.

JOHNSON: Talk about when it did come in and the tumble started, and you saw that it was actually going to hit, because it didn't break up on time, and parts of it ended up in Australia.

How soon after it actually happened did you know or hear about those sightings in Australia and where it had hit exactly?

HAWES: That was actually hours and days. We were focused on what it is that we were doing, how we were going to influence whatever measure of control that we had. Chris [Christopher C.] Kraft [Jr.] was the Center Director. He was with us that whole night going through things, because it was overnight that the final commands had to be sent. He had the last-minute discussion with folks at [NASA] Headquarters [Washington, DC] and at the Center as to, "Should we go do this?" The next thing I knew he just looked up and said, "Go ahead, young man." Chris called everybody young man.

We sent the commands to tumble. At that point it was just wait and see. We knew it was about as good an orbit trajectory as you could hope for, but you didn't know. Even though you do all the warnings, you warn the shipping lanes—just as we do for not just reentries, but like we do for external tank on Shuttle—you just didn't know. We finished the shift, we did the press conference; a couple of us got hauled over to the final press conference to answer questions. Then, frankly, I think most of us all went to bed until we got together a little bit later in the day to just decompress. It was during the day that you got more reports of people had seen the track lots of places in the world and that there was suspected debris that had landed in Australia. But even that first day there weren't really confirmations.

It was actually several of the Marshall folks that had the task. I remember one of the guys that I worked with later on Space Station, Billy [M.] Adair, was one of the folks that went out and had to inspect debris and validate. "Yea, verily, this is from Skylab." But for something like that with such minor impact and such little damage, it was really astounding. Like I said, we

had picked that orbit trajectory as one of the primaries to try to deboost it if we were doing it in a controlled manner, and that was where she chose to come in.

JOHNSON: Amazing that nobody was hurt, no buildings. I read that there was a splatdown party after.

HAWES: We did have a splatdown party. We actually had one of the co-ops [cooperative education students] that was supporting us at the time—Lou Pare was very artistic. He had actually designed a splatdown T-shirt. I think I probably have one. I doubt that I fit it anymore.

In a throwback to the Apollo days where the teams always had splashdown parties, we decided we would just coin ours a splatdown party. It was most of the team ending up at Jim Saultz's house with a pool, and that was how we all just brought it to closure. Most of the folks had worked—I think a nine-month tour was not unusual. A few folks had been over there the whole reactivation time, which was closer to two years.

JOHNSON: I have a news article where Australia fined NASA for littering, as a joke of course.

HAWES: Yes, and the [U.S.] Space & Rocket Center over at Marshall does have some of the components that they brought back that I got to see several years later.

JOHNSON: That's quite a thing, for someone that had just graduated college, and then to have someone like Chris Kraft tell you to go ahead and send it. That's quite a jump.

HAWES: It was a big jump. My whole mindset was that of the small town kid. To all of a sudden be in these meetings with Chris Kraft and Gene [Eugene F.] Kranz and George [W. S.] Abbey, it's hard to describe. If you haven't studied the history and don't know who all these people are, that that's who you're dealing with on a regular basis was kind of amazing.

JOHNSON: Yes, I would say so, definitely amazing. Talk about what you did after that.

HAWES: Actually at the same time, like I said, there was a period of time when it was a little bit more quiescent. There was a point in time where I was actually doing both Skylab and simulations for STS-1. We had started sims [simulations]. I was assigned as part of the support room for the payload function for STS-1. We didn't have very much, but oddly enough we controlled an experiment package. Actually we would call it more of a DTO [Detailed Test Objective] now. It was the Aerodynamic Coefficient Instrumentation Package, or ACIP, but we controlled it as a payload. It was actually the predecessor of the MADS [Modular Auxiliary Data System] data recorder that was found after [Space Shuttle] *Columbia* [STS-107 accident] that provided a few additional seconds of data.

My position for STS-1 was called a Payload Data Engineer. I was in what was then called the Multipurpose Support Room or Payload MPSR. I was part of Neil [B.] Hutchinson's ascent/entry team. We had a little bit of payload data that we monitored, and then we actually loaded commands so that the recorder turned itself on with a stored program command right at the proper point of entry, right about entry interface, to record all this additional data.

I went through months of simulations for that, and then all the final preps [preparations] for the mission, and actually worked the mission. Then we transitioned formally to landing

parties, not splashdown or splatdown parties. But again, to be part of the whole first Shuttle mission was overwhelming as a young engineer.

JOHNSON: It was a unique mission, not only because of the spacecraft, but it was a test flight, but there were two astronauts on board.

HAWES: It was a test flight but there were two astronauts. There were times when I remember that they did force us to pause and really think about what we were doing. For each of the new vehicles they did a flight readiness firing. Before the flight readiness firing Neil got everybody on the flight loop and said, "Okay, pull out your console handbooks and read this procedure." It was the whole accident data archiving, safing procedure that they ultimately ended up using after *Challenger* and *Columbia*, although it had basically fallen into almost disuse over the years.

That was a very sobering thing to me, in that "Okay, you have to anticipate that things can go badly wrong with this." I think, to me anyway, that put me in a different mindset about the whole test-flight nature of the mission.

JOHNSON: A good reminder that there were humans on board and everything that you did—even just turning something on—potentially you have to be careful. Did you work all four of the first four missions?

HAWES: I worked STS-1 and then through a variety of shifts I ended up being the payload lead for STS-5. I was considerably younger than most of my counterparts at that time, and so I did an

OJT [on-the-job training] shift on STS-3 with Bill [William J.] Boone [III]. Bill was the lead for STS-3. That was my front room training for the Payload Officer slot.

Then I jumped right into full-time lead for STS-5, which was the first four-person crew, first commercial satellite launch. Two commercial satellites. There were going to be the first spacewalks, but both EMUs [Extravehicular Mobility Units] had problems. So an awful lot of activity going on, and I jumped right into that.

JOHNSON: Talk about that position as payload lead, with all of those things that you were talking about, the commercial satellites and the PAM [Payload Assist Module].

HAWES: The Payload Officer position had been identified in the early planning of the Shuttle basically to be the flight ops person that oversaw everything happening in the cargo bay. And then ultimately that extended to things like middeck experiments that we ended up flying inside the Shuttle.

I think early on there wasn't as much of a vision that we'd have a bunch of these small experiments, and they actually ended up growing quite a bit. STS-5 was identified as the first flight for these commercial satellites using a Payload Assist Module upper stage. NASA had worked on "How do you accommodate this upper stage?" for a long time. That was the group that I had been thrown into when I came off of Skylab. Again learning about those systems, developing the crew procedures, developing systems handbook drawings—all of the things that were the normal flight ops tools that we used.

Then actually being a big part of the customer interface. That mission was Telesat of Canada, who is still an operating satellite communications provider, and a group by the name of

Satellite Business Systems. Satellite Business Systems over time got bought by MCI [Communications], got bought by WorldCom, got bought by Verizon [Communications]. But they were an early company envisioning providing satellite comm [communication] services to a commercial marketplace.

In their view they were paying NASA for a service, so they wanted to see a standardized, well-refined process that they weren't inventing everything the first time. They had some different attitudes about how they were doing business. Most of my time, when we were starting to work on the PAMs, I was working with Mike Lounge. We looked at the Shuttle manifest published at the time, and there were dozens of these Payload Assist Module satellites, because that was the sweet spot of the comm satellite market at that time.

We schemed that the only way you're going to be successful with this is make it look almost the same every single time. We pushed really hard to keep procedures standard, to keep Shuttle interfaces standard. We really got down to the only change in the software from one spacecraft to another was one identifier in the software load. The procedures were almost always the same.

The satellites that rode on the Payload Assist Module varied a little bit over time. We started with Hughes [Space and Communications Company, now Boeing] 376 satellites, which were SBS [Satellite Business Systems] and Telesat. Later on we had a Ford Aerospace [and Communications Corporation, now Space Systems Loral] satellite with INSAT [Indian National Satellite System] and Arabsat [Arab Satellite Communications Organization]. We had some RCA [Astro Electronics now Lockheed Martin] satellites that flew later on. I think those were the main providers at the time. Pretty much anybody in the U.S. building satellites at the time we were going to fly a version of.

But STS-5 was the first time all that came together, so really potting that generic process, having the crews accept that the procedures were going to look the same. They actually embraced that, as "It's great to have this be the same every time I look at it, and every time we're going to deploy a different satellite," dealing with what the potential safety hazards were at the time, how we accommodated those. There were things that the Shuttle was choosing to do for the first time.

One of the big debates at the time was the fact that you had to send the signal to rotate the big motor safe and arm device while it was still in the cargo bay. But over time the program and the Agency decided that was an acceptable risk. You had lots of other protections in the circuitry, but there really wasn't any way to do that reliably once the payload left the Shuttle cargo bay. That was a do-or-die kind of mission success event.

We outlined all of that, we developed the software. We demonstrated the software in SAIL [Shuttle Avionics Integration Laboratory]. I spent a month in SAIL just going through all of the caution and warning software that we had. It was a small amount of software that it actually took to deploy a Payload Assist Module payload, but we still had to demonstrate everything in SAIL because it was a new thing, it was not built by NASA. They insisted that we have a full integrated test with the McDonnell Douglas [Astronautics Company] team providing the PAM, some simulated spacecraft capability, and then the NASA team, which were just a couple of us that were doing that at the time.

We managed to keep that standardized process. STS-5, from the satellite sense, was a success. We had two of the satellites on STS-7, one on STS-8, and then [STS-] 41B I was lead again. In that case both satellites [Westar (Western Union) and Palapa (Government of Indonesia] actually had a failure of the PAM motor. It was a failure of the nozzle material in the

motor. Both of those ended up going in errant orbits, although both of those were recovered again on 51A.

Over time we did launch 20 different satellites on Payload Assist Modules with the same procedures, the same software, the same displays. I would say that the generic process worked and was a very effective way for Shuttle to actually handle those kind of customers. After *Challenger*, President [Ronald W.] Reagan decreed that the Shuttle was not going to be in the commercial satellite launch business. Which in a way was unfortunate, because we had demonstrated that the Shuttle was actually really good at that business.

JOHNSON: I would think that using the PAMs and, like you said, making things so similar it would really streamline the training, as far as what was needed with the astronauts and everybody else running it, that that would be beneficial as far as timelines.

HAWES: Actually one of the payloads on 41B that unfortunately failed because of the booster was for Western Union [Company]. We actually demonstrated an ability, because it was the same kind of satellite. It was the same Hughes satellite, it was the same fundamental process, it was the same kind of measurements.

We were actually able to integrate that on the order of 13 months. It was a very quick integration, because Western Union had had another failure. Unfortunately they had a failure of that bird, but they had had an on-orbit failure that they were trying to make up for. We really demonstrated the capability of the Shuttle to be very responsive in the whole payload integration process through that point.

JOHNSON: As you mentioned, those further missions they were able to go in and get those satellites that had gone errant. I was looking at some of your bios [biographies] online, and it said you worked basically STS-5 through 61C. So I'm assuming you had something to do with all those missions.

There were a lot of things going on during that time. There were a lot of firsts happening with the crews, there were a lot of firsts happening on what the Shuttle was even capable of doing and the type of payloads that were being released. Just walk through those missions, and anything that comes to mind that was memorable for you.

HAWES: Demonstrating what I call the generic process of doing the PAM satellites was a big deal for me, because that was something we recognized as really being an advantage. We were able to demonstrate it and it worked really well. But along the way I worked several other missions. Each of those had some really unique tasks to it.

Even though we did the two satellites on STS-7, STS-7 also had the SPAS [Shuttle Pallet Satellite] payload, which was another interesting opportunity. The German Space Agency identified this mission that they wanted to fly. Again it was a relative short turnaround from the time that they proposed that and NASA accepted it. I remember the first documents for their PDR [Preliminary Design Review] all came to us in German. We had a couple folks in the office that had to basically translate some of the material. The idea that we were going to release a payload that was going to fly itself around the Shuttle while the crew was flying was unique.

We also had an incident on STS-7 that the PAM deploy had been late in the day, and one of the switches had been out of configuration. The deployment was successful, but it was all about the safing and the cleanup process with the PAM afterwards. We were in a state that the

crew could go through the procedure again but it would take time. They were close to bedtime, it had been a long day.

We knew that we could actually command from the ground to all the PAM systems. We had demonstrated it in a Cape [Canaveral, Florida] test when we had a similar situation, so I raised it to Tommy [Thomas W.] Holloway. I wasn't actually even supposed to be on console, I was filling in the management SPAN [Spacecraft Analysis room] job. But because the SPAS was having some issues and Jim [James R.] Gauthier, the lead, was off working with the SPAS team, I was filling in.

I pointed out to Tommy that we could go ahead and command the pins where they needed to be and safe the spin table and put it in the right configuration. After debating that a little bit he said, "Okay, well, you have your team build the command loads and then tell me when you're ready to do that."

Because we hadn't demonstrated it in a sim or in a mission scenario, we were a little nervous. Gene [Kranz] came down and perched right on my shoulder the whole time I was commanding to basically stabilize the spin table so it wasn't rotating. That was an interesting event, to on-the-fly convince the flight director that you're going to do something that you've never done, and get Mr. Kranz's personal attention.

Then you're right about all the firsts. Like the first night launch. Then we got to the repair missions. I worked all the repair missions as well as the PAMs. Part of that was because the PAMs were easily compartmented, they were really easy to do mixed manifest flights. You could do a couple PAM deploys while you had another kind of mission to do.

But I also worked the Solar Max [Maximum] repair mission, which was very different for me. The idea of we're sending folks out on the MMU to go and capture the satellite, and then

that didn't quite work. Then we had to ultimately "grab it with the arm"-type idea. I also did 41B, where we did the Manned Maneuvering Unit for the first time.

There was one entertaining aspect of that. Both PAMs had failed, the nozzles on the solid rocket motors had come apart. We actually had convinced the team between the first and second deployment that we could—we always put the belly of the orbiter in the direction of the solid rocket motor so that the windows wouldn't get damaged or the bay wouldn't get damaged. But we talked the team into basically hanging the arm with the wrist camera out. We actually saw the burn and saw it terminate early, so on the second one we actually had a much better feel for what had happened.

Then the next thing was called, I want to say, the Integrated Rendezvous Target. It was a big balloon, and it actually blew up. So everything that we'd put out of the cargo bay had blown up, and we were getting ready to send Bruce McCandless [II] out on the MMU. But the MMU flights went really well; Bruce was able to demonstrate it. Bruce was the prime. Bob [Robert L.] Stewart was the other crewman that did the MMU on that flight.

JOHNSON: He was MS2 [Mission Specialist 2] and McCandless was MS3 [Mission Specialist 3].

HAWES: That was the test flight to really be able to use it for Solar Max. That all worked well, but the capture device didn't work in the capture. So this is another lessons learned. That capture device didn't work because the configuration drawing that the team built from wasn't exactly right. There was some fastener, whether a rivet or something, that was just misplaced enough that it wouldn't allow the jaws to capture on the grapple fixture of the spacecraft. But we

were still able to get it with the arm even though the crew had done that. Then ultimately we utilized the MMUs to do the retrievals on 51A.

Each one built on each other, but it was such a dynamic time of process of doing things that you hadn't done before. One of the other repair missions was on 41D. We had the first Syncom [synchronous communication] satellite deploy [Leased Satellite (Leasat) program]. Syncom spun out of the bay like a Frisbee and had these switches that were supposed to pop out because it was spinning, and that would connect the electric circuit. So it was safed in the cargo bay, but then it would spin out.

During that mission the team wanted to try to activate the switches, and again just a lesson learned about thinking about problems different ways. We'd been dealing with the crew, we'd been dealing with folks out in MMUs. We actually ended up with a plan that had the crewman on the foot restraint on the arm. We were going to develop something—it ultimately got called a flyswatter. We took a cover off a flight data file book and carved a hole out of it so they could actually try to capture this thing.

Glynn [S.] Lunney was the Program Manager, and I remember him coming into the Mission Management Team. His question of the whole plan was something like, "So you want me to say yes to putting one human being in between a 230,000-pound orbiter and a 16,000-pound satellite. Why is that really a good idea?"

The plan shifted to taping the flyswatter onto the arm and using it that way without the human in the middle. But again, just a different way of thinking about the problem, and a different way of being aware of what the risks were in what we're doing. A little more step back every once in a while and think about "Where does the human make sense?" kind of task.

Each one of those repair missions had really unique challenges to it as well. Even when we ultimately went and got—Westar [6] and Palapa [B2] were the two satellites that had failed. We went through all the flight techniques meetings and said, "How are we going to do this? How are we going to have some device that they can capture the satellite, but we still have to be able to get the satellite back into the cargo bay?" In the middle of the meeting somebody said, "You know what we really need is we need a grapple fixture right on the astronaut's back."

I said, "Okay, well we can't really do that to the EMU." But that evolved again over a matter of another half an hour, hour into, "We have this capture device that's going to go into the motor. We know that part, because that's where it's got to go to get it. But if we extend a stinger out the side of that capture device with a grapple fixture on it, that's how we can actually grab it and bring it down into the cargo bay so that the crew can actually then get it locked in place to do the retrieval part of it." Again, every one of these missions was so new. Watching that thought process and watching people just invent on the fly was fascinating. And we got both satellites back.

Early on the satellite builders like Hughes said, "We won't have a use for the satellite, because you have to dump the propellant systems. It's just not going to be cost-effective." Both of those satellites ended up being relaunched, because once you got them back to the ground you still had most of the spacecraft, even though you needed to reenergize some of the propellant systems. It wasn't damaged, so you still shortened the build and development time of a new spacecraft by months to years. So in an era where having comm capability in space versus sitting on the ground, it still made financial trades.

Now I think both those satellites were bought at a pretty low discount because basically the original owners, who were Western Union and the Indonesian government, had filed their

insurance claims, so they got paid by the insurance companies. So it was actually the insurance companies that owned the satellites, and they sponsored the retrieval mission and then ended up selling the satellites over time.

JOHNSON: One of those missions, a TDRS satellite for the first time.

HAWES: TDRS was STS-6. My only exposure with TDRS—the group that I worked in worked on both of the big upper stages, the PAM and the inertial upper stage. While I was doing all the work on the PAM we had a whole other team that was working on the IUS [inertial upper stage] kind of missions.

Of course to the flight control team TDRS was a good and a bad. You had a lot of data, but you also had no time because you had constant data. Once you got two TDRS, you still had a zone of exclusion that you could go take a break and heat up your dinner. Then over time they've closed that zone so you have near constant data.

But it was so different from my time with Skylab and with the early Shuttle missions, that you still had what was then the GSTDN [Ground Spaceflight Tracking and Data Network] tracking network.

JOHNSON: Also early on they started adding payload specialists.

HAWES: They started adding payload specialists, and it was right around STS-7 that they added payload specialists. There were a number of reasons for that. They also started adding—from STS-5, where a couple of the crew had what's now space adaptation [syndrome]. That wasn't as

well understood back then. They started to add physicians to flights. Norm [Norman E.] Thagard was added on STS-7, Bill [William E.] Thornton was added on STS-8.

But they also started to add the beginning of the payload specialists. They had that already set for the Spacelab missions that were to follow, but they started to add them. I want to say that [Paul D.] Scully-Power was added on [STS-41G]. Then we got into the whole political payload specialist aspect with Senator [Edwin J. "Jake"] Garn and at the time Congressman, now Senator, [Clarence W. "Bill"] Nelson.

We got into the country and corporate payload specialists, so 51G we had Prince Sultan [Sultan bin Salman bin Abdulaziz Al Saud], 61B we had Rodolfo Neri [Vela] from Mexico, [61]C we had Bob [Robert J.] Cenker from RCA, and then of course leading up to the Teacher in Space and [S.] Christa [McAuliffe] and Greg [Gregory B.] Jarvis from Hughes on the *Challenger* mission [STS-51L].

So we had a number of folks. My payload team interacted with most of those folks in terms of preparation and training for their interior experiments that they were going to do. I didn't do as much with that, although I still did my Payload Officer shifts. But in '84 I became one of the section chiefs over in the Payloads Branch so I had folks that were working on those internal experiments, actually working with all the payload specialists in what their missions were going to entail.

JOHNSON: Then, like you mentioned corporate, Charlie [Charles D.] Walker [Payload Specialist for McDonnell Douglas].

HAWES: Yes. Charlie got to fly more than most NASA astronauts. Yes, and that's because a lot of folks saw huge promise on what the CFES [Continuous Flow Electrophoresis System] experiment was going to do potentially for big pharma [pharmaceutical] industry.

JOHNSON: Were there any other missions during that time that you can think of?

HAWES: Like I said, there were so many unique things. Every one of the repair or retrieval missions was very unique in and of itself.

JOHNSON: What about the Spacelab mission?

HAWES: Spacelab I did not do much with. That really had been a whole different set of people. That was a huge involvement with Marshall the first couple Spacelab flights. Even though Marshall staffed the Payload Ops Center, they came here at JSC and used a room in the MCC [Mission Control Center] to staff that function. Ultimately we moved it to Huntsville in what's for ISS [International Space Station] now the POIC [Payload Operations Integration Center].

The missions I worked really were the PAM missions and the repair and the retrieval missions.

JOHNSON: What about the DoD [Department of Defense] flights?

HAWES: DoD I did not work either. At the time I didn't have the higher clearance. We all had fundamentally a secret clearance, but that team you had to have the top secret SCI [Sensitive Compartmented Information] kind of clearances, so I did not work those missions.

JOHNSON: You said that you had moved to section head. Was that the Commercial Payload Section?

HAWES: Yes, it was the Commercial Payload Section. After *Challenger* they decided that they weren't going to fly commercial payloads, so it would not make sense for me to be head of a Commercial Payload Section anymore.

JOHNSON: As you mentioned, working up towards that there were those payload specialists like the senators, and then Bill Nelson flew the one right before *Challenger*. Over this time, especially with the PAMs and doing sims, how closely did you work with the astronauts?

HAWES: Very, very closely. Because it was so new I probably spent more time working directly with the early crews than I might otherwise, because the training group was still getting up to speed on some of the payload training stuff. We were probably just a little bit ahead of that team, although they became a stronger and stronger piece as we got further along.

All of the early crews—Bill [William B.] Lenoir and Joe [Joseph P.] Allen were the principal crew that I worked with on STS-5. John [M.] Fabian and Sally [K. Ride] on STS-7. Dale [A.] Gardner on STS-8. Then I had Vance [D. Brand] again as a commander on 41B, and

for the PAM business that was [Bob] Stewart and [Ronald E.] McNair focused on the PAM stuff. Bruce [McCandless] was all focused on the MMU.

Through my mission control time, through 61C, I spent a lot of time with the crews, whether as part of their training process or mission execution.—I usually did the beginning PAM familiarization training for all of the crews. Then ultimately over time somebody forced me to write it all down.

JOHNSON: I was going to ask about that, as far as writing all those instructions or those procedures.

HAWES: We had the procedures, and we had good support from the crew procedures group at the time. We had the systems handbook drawings that we had done.

That was an interesting challenge too because at the time the PAM was a commercial venture of McDonnell Douglas, so they wanted to protect their intellectual property. We had portions of the systems handbook that were totally open, and we had a small subset of things that were proprietary information that I literally doled out individually and kept track of who had the proprietary versions of the documents.

Which was a precursor to how you had to do the whole control for a DoD mission and some of these other things we started dealing with. Just having to deal with company proprietary data—we made it work. It definitely added overhead and was a bit of a challenge, but we certainly learned how to make it work.

I think the bigger challenge is that everybody really wanted a really simplified 101 class. I could come into your office and draw it on the chalkboard for you, but I never really wrote it

down. Not any particular reason, I just didn't have time to write it down. I think ultimately it got developed into a flight director handbook. I wrote it down for Gap [Granvil A.] Pennington and he put it in there.

JOHNSON: There were, as you said earlier, a lot of the Apollo and Skylab people who were older when you came in. Then they were the older guys as the newer people were coming into Shuttle. Talk about, for a minute, some of the influences. As you said, Chris Kraft, Glynn Lunney, Gene Kranz of course are the names we all recognize. But I know there were a lot of other people.

HAWES: That's a fantastic point. My first lead engineer when I came in was Larry [Lawrence S.] Bourgeois. Larry of course went on to be flight director and head of the Flight Director Office. Then I worked with Bill Boone, he was one of my leads. Mike Lounge for a couple years before he got selected as an astronaut.

But on the Skylab team there were lots of folks there that they were just really hardcore operators. I didn't do as much with them in the office setting, but over there is where they really were fantastic. Guys like Will [William E.] Fenner, Keith [K.] Kundel, DJ [Donald J.] McDonald, Bill [William P.] Gravett. Now Hal [Harold M.] Draughon I worked with over there, and then also when he was a flight director later on and we worked together. So a lot of folks there. Bill Boone was over there, too.

I was learning the fundamentals from those folks, and then in the Shuttle era it just naturally flowed into that. Skip [Axel M.] Larsen was my first section head. Then Bill [William] Molnar [Jr.]. Like I said, Jim Shannon had hired me. Charlie Harlan and then John

[W.] O'Neill were the division chiefs. I think those were really the people that I was learning from, doing all that work.

JOHNSON: That's quite an education.

HAWES: It was a huge education, and some really amazingly smart people. Some of them could sound like country boys and be pretty disarming, but some really amazingly smart people.

JOHNSON: Also, as you mentioned, what you were proposing, they were accepting of that.

HAWES: No, they were. We had good support over on the Program Office side of course, Glynn Lunney. When the Shuttle was being developed, the structure they had was Bob [Robert F.] Thompson was the Shuttle Program Manager for everything on the front end and the back end, and Glynn was the Program Manager for what was back then called SPIDPO, the Shuttle Payload Integration and Development Program Office.

Glynn owned everything in between the bulkheads. Leonard [S.] Nicholson was one of his primary guys running the whole payload integration group. They had a whole series of payload integration managers that I worked with, again to formulate all this generic process. They saw the value of being able to do things on a very repeatable basis and be able to integrate these folks in a pretty low cost, and they were trying to provide a low-cost, highly reliable launch service.

All those folks—Leonard, and Dick [Richard A.] Moke, Jerry [S.] Lowe, Vic [Victor L.] Ettredge, Jim [James L.] Smotherman, Dave [David A.] Hamilton, folks that I ended up

continuing to work with for years in different roles—they had moved into that "Let's formulate how we're going to integrate stuff into the Space Shuttle."

Because the flight ops piece touched so many different pieces, I probably spent as much time with them as I did some of the flight ops pieces. For PAM flights I actually had an approval vote on about half of the documents that get produced just because Leonard was tired of getting them with mistakes because they hadn't been through flight ops. So it worked.

JOHNSON: Let's talk about the loss of the *Challenger* and that mission, 51L. Were you working that mission?

HAWES: I was not working that mission. I had worked the two before, 61B and 61C, even though I knew most of the crew from a variety of other missions. Dick [Francis R.] Scobee had been the pilot on the Solar Max mission, 41C. Ron McNair had been on 41B. So I had a lot of connections. I had worked with J.R. [Judith A. "Judy" Resnik] on 41D I guess was the solar array experiment, but I'd also worked with her on PAM stuff over the years. El [Ellison S. Onizuka] had been the PAM astronaut for a while. I'd had connections with most of the crew in doing that.

I was watching the mission. Actually we were in Building 29 at the time. It would end up for things like that we would wander down and watch on the big bank of TVs that they had set up next to the WETF [Weightless Environment Training Facility] area. Actually Bill [William H.] Gerstenmaier and I were standing side-by-side watching the launch when the accident happened.

That whole day you didn't know what to do. You turned the TV on, you watched the commentary, you watched a lot of stupid comments that people were making. You watched some fair coverage. But nobody knew what had gone on, nobody knew. Since I wasn't involved in the level that really understood the precount deliberations, I didn't know anything about—we knew the temperature was low, but we didn't know about debates with the booster joints. That only came about for me later on.

We really didn't know what those aspects were. We just knew that we had lost a bunch of friends and a ship and had no clue what it was going to do to the program.

JOHNSON: Did you go to Mission Control at that point? Or did everyone go home?

HAWES: We stayed in the office, just not sure what help would they need. But we knew from our own knowledge of the procedures the Control Center is locked down. Unfortunately that team is going to be stuck there for hours doing data archival. We all stayed in the office just to be available for whatever, and tried to focus on whatever the next missions we were still supposedly focused on. Like I said, as a section head I had a TV in the office, so I could turn it on and watch the news coverage of what was going on and just see.

That evening you just went out and gathered with groups of friends trying to figure out how did you process that. I remember a couple days later we had a memorial service of sorts at Saint Paul's [St. Paul the Apostle Catholic] Church in Nassau Bay where I attended. They had asked me to speak, as a flight controller kind of person, at that. One of the crew that was prominent in the parish at the time was Bo [Karol J.] Bobko, so Bo and I spoke from those two different aspects of things.

But really you didn't know what to do. Then you just watched. You watched as yes, there's this recovery mission that you know they have divers going in seeing what they can find. But you're seeing the beginnings of the [William P.] Rogers Commission [Presidential Commission of the Space Shuttle *Challenger* Accident] get formed up and people getting tagged for that, and how's that going to spin up?

Obviously Sally [Ride] had already left the [Astronaut] Office, so she was pulled in to be part of the commission. You had no sense of whether there going to be some huge political stop. The best you could do was just go and start on teams of accident investigation versus planning any modifications. In the payload side we didn't have very much of that. We started working on more process kinds of things.

Over time, one of the things that teams identified was that they didn't think the training and certification process was strong enough. We ended up spending that time building a whole new training program and training books for all the flight controllers in every position. Defining what you had to do in terms of actual classroom training, what you had to do in terms of more experiential OJT kind of training. We spent time doing those kinds of things.

Thinking back, it was several months before you had a sense that we're going to keep moving forward, we're going to keep moving to plans. In that timeframe Gene Kranz asked me to change roles. He'd made up his mind we weren't going to do this commercial payload thing. The President had pretty much said that. So he took a handful of us and started building more Space Station-oriented sections within flight ops. I was one of those sections that he created out of that. Not something that I wanted to do, but he explained to me that it was for the good of my career, in a persuasive way.

For those of us that weren't really intimately tied to the redesign of the vehicle aspects, I got assigned to start actually working on Space Station back then. Space Station had started in '84, and in late '86 Gene assigned me to start doing some Space Station work. There were a few cats and dogs of Shuttle support things that he wanted done as well, so they rolled that into one section and created a new section as they were wiping out the Commercial Payload Section—which nobody remembers existed anymore by the way.

We had a payload reunion back in April, and they were having pictures of all these different organizations. I said, "Where's mine?" Some of the people are still here, but yes, the organization is gone.

JOHNSON: You would think they would remember just because there was history made.

HAWES: Yes, there was history. But it also made me realize that I'm one of the older guys now.

JOHNSON: Yes, it's always a shock, isn't it?

HAWES: Yes.

JOHNSON: Did some of those guys that had been through the Apollo 1 accident help after *Challenger*, as far as helping to guide you through that process that things are going to change, things are going to happen?

HAWES: I think they tried to message that, guys like Gene. If you think back then, Chris [Kraft] had retired. He was working at Rockwell [International Corp.]. A lot of the management had changed, but Gene was still there. I think even Glynn had left. I'm trying to remember now all the management changes. But they tried to message that.

The challenge was you were in a terribly uncertain political environment. You had an Acting Administrator because [NASA Administrator] Mr. [James M. "Jim"] Beggs was off fighting legal issues. You had Bill [William R.] Graham, then quickly after that they had brought Jesse [W.] Moore in to fill a role. You saw a lot of instability, from my view. I saw a lot of instability in Headquarters, whereas what I had seen in the past was not really that at all.

While these folks tried to message that, I think they didn't really know what political environment they were in either. It really was more about "Those of us that are working on understanding the failure are doing that, those of us that are working on modifying the vehicle are doing that. Those of you that aren't as involved, we have other things for you to do." But you really had gone from going crazy flying flights at a pretty high flight rate to having a lot more idle time.

JOHNSON: When you were assigned—or suggested that you work with Space Station, that was still here at JSC at that time.

HAWES: That was still here at JSC, yes.

JOHNSON: When did that move to Reston [Virginia]?

HAWES: I started that Space Station job in the fall of ’86 I think. As we got into it, we were really focused on the planning for “what’s the MOD [Mission Operations Directorate] kind of job?”

But the folks that were working the Space Station Program Office, which was at JSC—first Program Manager was Neil Hutchinson, and John [W.] Aaron was the Deputy. The folks that were working operations in that office came and talked to us and said, “We don’t really have an operations concept. A lot of these early ops products we haven’t gotten developed yet. Now that Gene has identified all you people”—because he actually created five sections of people that would focus on Space Station—“we really need help doing those things.”

Out of that spun something called the Space Station Operations Task Force, and it was co-chaired by Carl [B.] Shelley at JSC and Peter [T.] Lyman from the [NASA] JPL [Jet Propulsion Laboratory, Pasadena, California]. John [T.] Cox, one of the flight directors who I had worked closely with, started grabbing a couple people to say, “Hey, come help me on this Task Force.” He got tagged by Shelley.

We started building up, so Kranz agreed that I should go off and help with this Task Force. That ended up taking several months, well into March or so of ’87. In that same timeframe, the Rogers Commission is wrapping up the report and coming out and saying, “Lead Centers are not healthy for the Agency. We think program management should be moved to Headquarters, or at least to the Headquarters area.”

They actually staffed up a [Space] Shuttle Program Office at Headquarters that Arnie [Arnold D.] Aldrich ran, and they said “We’re going to move Space Station to the Washington area.” They ultimately picked Reston as the location, and Tom [Thomas L.] Moser from JSC

became the first Program Manager at Reston. Neil [Hutchinson] had retired. John was filling in the acting role—John Aaron—so they designated Moser.

They started to populate that office, and John Cox got tagged pretty early coming out of that Operations Task Force. Yes, we wrote volumes of reports that are probably in this building somewhere. Then John started picking people. At that time, I had pretty much decided that I wanted to try something more like program management than the pure console operations.

When John recruited me, I had gotten married in the meantime, and my Texas wife said, "Yes, we could go give that a try." Then she very quickly became a Virginian.

JOHNSON: Don't blame her.

HAWES: It's funny—she was raised in Pasadena [Texas], and even today I say we have an apartment in Houston and she says, "He has an apartment in Houston."

Knowing very little about a program office except what I had worked with in the Shuttle, we charged up to Reston and started doing that. At first it was just a TDY [temporary duty] kind of thing, "Let's help get it set up and then figure out what we're going to do." Then ultimately several of us transferred up there.

What NASA Headquarters had decided was we don't really have to be at Headquarters, but we have to be in the vicinity of Headquarters so that we have that influence and we're not viewed as one of the Centers having rule over another Center. The Lead Center was bad in that era. You had lots of debates about that. That's actually a really entertaining discussion. Probably that'd be an interesting symposium to do. One of the things I didn't realize is that the

NASA leadership at the time felt they were being told they had to do this and really didn't have a strong view one way or the other that it was good or bad. Probably felt more that it was bad.

At the highest level Reston was considered an experiment, and they staffed it from a bunch of people. John [Cox] managed to grab a bunch of folks from here [JSC] and Marshall and [NASA] Kennedy [Space Center, Florida] to fill out those roles. We took from our Shuttle experience and tried to create how we thought Space Station would operate.

We started out in downtown Washington, DC, in temporary offices, ended up moving out to Reston where they identified office space, and moved a couple times in that context. I permanently moved up there just at the end of '87 and lasted the whole six years of the Reston experience.

JOHNSON: Were you still considered a JSC employee?

HAWES: No, we were considered Headquarters employees. Pretty much everybody transferred from their home Center to be a Headquarters employee, even though you were still 30 miles away from Headquarters. Being after *Challenger*, that was when Jim [James C.] Fletcher was in as Administrator for his second tour and Dale [D.] Myers was the Deputy. They were the team when we started all of that.

Again, it was an interesting time. That whole "Lead Center" thing wasn't talked about as much. The debate that you heard people really talk about was that the engineering strength of the Agency is out in the Centers, so how capable is some independent body going to be in actually structuring a big, integrated program.

That was a big challenge of Space Station. Not so much that it was the geography of it, but you also had all these international partners. You had this spacecraft you were going to build in many, many flights, but every time you added a piece and flew away it had to be a functioning spacecraft. So you had to look at it not just as a total, but every piece and configuration—or stage as we ended up calling them—had to be able to fly and be sustained over time, so how would you actually construct that.

We had project offices at the Centers. Each project office had their own contractor. We had what started out as something called a program support contractor. That was Grumman [Aerospace Corp.], with a number of teammates, that we really over time merged into a stronger systems engineering and integration contractor. The first presumption was that to save money the government was going to do all that systems engineering, and I think that was a fallacy at the time. The government team wasn't really set up to do that, so we went out and hired an industry team to do that.

Then we started to build this sense of industry on top of industry, and teams on top of teams, so it made what ultimately was the [Space Station] Freedom Program look very bureaucratic in its structure. We rotated through a number of folks. As I said, Moser was the first, [E.] Ray Tanner was the second Program Manager, then Bob [Robert W.] Moorehead. So we went through JSC, Marshall, JSC influence over time. But everybody brought their own skills to the task for different phases.

I think Tom very much was more the start-up person of transitioning from JSC, and getting a team in, and building a base capability. At the far end, Moorehead was really getting hardware built, in that era before we transitioned back [to JSC].

But I think probably at my level we didn't realize that the Agency fundamentally thought it was a 50-50 shot that this could work, which was described to us by some of the higher-level executives later on.

JOHNSON: As you mentioned, '84 is when the President decided that he wanted a Space Station—Reagan at the time—and that we were going to invite other countries to work with us. Then funding was always an issue. First it was going to cost a certain amount, and then of course that kept changing, and all the redesigns and all the things that kept happening during that time.

I read that in '86 the *Challenger* accident caused them to reassess the design of the Space Station and to build a lifeboat capability, because all of a sudden it was like "Hey, we have to be able to get off this thing." Even in those very early years and when you first got involved, how often were those kind of things changing? "No, we can't do this," "Now there's this money," and Congress is telling you no.

HAWES: When we started we transitioned from Phase B, which was the study contracts, and they had a number of the primes [prime contractors]. I was actually on a team that went through and read all of the proposals for the design and development work, what NASA calls Phase C and D. I wasn't part of the SEBs [Source Evaluation Boards], but I was just part of an independent team looking for consistency and commonality across the proposals.

Then ultimately, within that first year we had selected Rocketdyne [division of Rockwell International] for Work Package 4, [The] Boeing [Company] for Work Package 1, McDonnell Douglas for Work Package 2. There was a GE [General Electric Co.] Work Package 3 at

[NASA] Goddard [Space Flight Center, Greenbelt, Maryland] that was external payload kind of stuff that over time vanished. The content just got cut out of the program.

Pretty much as soon as we were ready to award those contracts, Congress came in and cut the funding right away. So while we awarded the contracts, the funding was still a fraction of what had been. In that first year—that was the famous center beam with the dual keel configuration, they called it trusswork—Dr. Fletcher decided that we were going to portray Space Station as a Phase I and Phase II. The center spine would be Phase I, and the big dual keel would be Phase II.

He took that in to the [presidential] administration and they basically said, "Okay fine, you've got the center truss." So right away, you've spent, say, three years defining a Space Station that has all this capability, the big truss drives certain design considerations, then in one White House meeting, all of a sudden two-thirds of it are gone. You got the most important elements, but it changes a lot about the configuration that you had. You didn't have the big servicing bay, you didn't have co-orbiting satellites as part of the mission. At the same time you're dealing with international partners, some of them that have equities in those things, and some of them that don't, and how do you factor the partner things in. You have this whole effort of defining memorandums of understanding of how they're going to operate.

I actually had the fortune, supporting the Shuttle Program, where I had traveled a good bit in Europe visiting the space agencies and several companies, so I had seen a little bit of that. Some other governments were interested in the PAM satellites, so I had worked with other governments to do things already. So when I got into Space Station I had a little bit of experience, at least in the Europe and Canada.

Right away we started into those trades, and it seemed like each year had another redesign that you had to do. At the same time, I was tasked with putting an operations infrastructure into place. So I was tasked with figuring out what mods [modifications] to Building 30 were done. I ended up doing the Building 30 mods, adding [Building] 9C for the trainers, doing all the trainer mods.

I had a little bit of a hand in what ultimately became the NBL [Neutral Buoyancy Laboratory, Sonny Carter Training Facility, Houston, Texas], the new test and checkout system at the Cape, the Space Station Processing Facility, the new POIC upgrades in Marshall. I had the whole ground infrastructure program as part of my roles and responsibilities.

Plus, how are the operators going to influence the design? What kind of design reference missions, what kind of requirements are you actually levying on the design, how are the scientists going to play, what's the user aspect of this going to be? The way Space Station operates today we largely formulated back then. It's all still carrying through. But we did that at the same time that the design was getting whacked by all these different redesigns.

Then we had things like the Fisher-Price study [External Maintenance Task Team for Space Station Freedom, chaired by astronaut William F. Fisher and Charles R. Price] that looked at all the spacewalks required for building what was then Freedom and the impossibility of that task. Then we had to have a solutions team answer to the Fisher-Price study. They had to try to deal with what were you really going to do.

That spawned a series of missions with the Shuttle of maintaining spacewalk capabilities, and somehow over time I ended up with those. When we got to STS-49—ASEM [Assembly of Station by EVA (Extravehicular Activity) Methods] was what it was called—that was going to build a truss. We had just changed the program, but up until that point the premise of building

the Space Station was the astronauts were going to build it with individual truss members and connecting nodes. They were going to lay the utilities in along the truss, they were going to do all that via spacewalks.

About ’91, in one of our big redesigns, we had come to the conclusion that the “sticks and balls” build process was absolutely nuts. So we moved to something that we called preintegrated truss, meaning we were going to build big trusses on the ground, and fly them in the Shuttle and put them in place. The crew was going to do relatively minor connection of utilities and interface work, but weren’t going to lay in major infrastructure capabilities.

But we still had this flight experiment. We had done a number of things that Dick [Richard H.] Kohrs—who was then the Headquarters Program Director—sponsored in terms of keeping the EVA capability fresh and going. ASEM was one of those, but it was having the crew out in the payload bay building a truss out of the “sticks and balls” as we called it. Fortunately we had moved away from that mindset, which was probably good because we learned that it didn’t work very well. We learned that the space experience was a lot different than the NBL experience. It was a much harder project than we would have thought.

But even that had an interesting tie to it because they ended up building our truss out in the payload bay, and that was how we did the only three-person spacewalk out of the Shuttle to capture the INTELSAT [International Telecommunications Satellite Organization VI satellite]. That was that same mission. They used our truss to perch on out in the cargo bay to actually capture the satellite and then mount it to its new motor. So I was still part of a repair mission even though I wasn’t trying to be.

JOHNSON: Couldn’t get away from it.

HAWES: The ’91 redesign was probably the biggest that we did as that team, and then we got the new administration transitioning from [President George H. W.] Bush 41 to [President William J. “Bill”] Clinton that said, “Now it has to be cheaper, it has to be redesigned.”

At that time you could see that the Agency was already making the decision to move back to the Centers, which meant the whole Reston thing was going to be written off. “Okay, interesting experiment, now it’s time to get back to the Centers.” I thought we did a very good job transitioning—we supported the redesign teams, which were referred to as Crystal City, because that was the office space they used in northern Virginia just outside of the Pentagon area. It was Crystal City, Virginia. Some of us spent probably half the time in Crystal City and half the time still working the baseline program. Some were full-time Crystal City, and some weren’t impacted at all. They just kept doing their baseline work.

JOHNSON: Did you work at Crystal City?

HAWES: I did. I was once again pulled in by John Cox and John O’Neill to be part of the Crystal City ops team trying to formulate what it would be.

JOHNSON: Of course that’s during the time where you were coming up with the three A, B, and C designs.

HAWES: Those were Options A, B, and C. Then you had on the side, not yet connected, “What would the Russians do?” That was a separate team as well that over time had to merge pieces.

But when the redesign team started it was really just those Options A, B, and C. Actually Option B was pretty much a Freedom-type version.

We probably forced Option B even being there, because at the time I think [NASA Administrator] Dan [Daniel S.] Goldin really did not want anything that looked like the existing Freedom Program. He wanted it to look dramatically different. But when you don't change the fundamental mission, nor requirements you get a pretty similar answer. Bryan [D.] O'Connor led the redesign team in Crystal City. He was the Deputy in Code M [Office of Space Flight] at Headquarters at the time.

Over the years he would continually chide me jokingly that he had told us to build Option A and we ended up building Freedom. I responded with, "We built the one that was going to work, Bryan."

JOHNSON: In one of the interviews we had with him—I was going to mention that, that he said it was mostly Freedom with a lot of Russian stuff on it. That's the way he described it.

HAWES: That's right, it was Freedom with Russian stuff on it. Now it did give us some trades that we did get rid of some Freedom content. We had prop [propulsion] modules that now we don't have prop modules, and we had a few other things. But it was largely Freedom. Although you can remember varieties of Freedom that had the whole what we called "the racetrack" that had the lab and the hab [habitat] side-by-side with additional nodes connecting them. And had much more infrastructure, which over time got culled out and some replaced by the Russian modules.

But yes, that was where it ended up over time. To me the technical trades just took you there. You still had the same objectives in terms of the science you were trying to do and the requirements you were trying to meet, so the fundamental capabilities were still going to be what you had to build.

JOHNSON: I know during that time the hours working out there in Crystal City, and the changes that were happening because of Dan Goldin, George Abbey coming in and making changes sometimes late at night.

HAWES: Late at night, on weekends. It was a crazy time. It was also a frustrating time because the people at Reston were being treated very badly. That was where it became more important to me, this whole discussion that I had had with folks like Tommy [Thomas] Campbell who had been the [NASA] Comptroller. When you talk about Reston as kind of an experiment that they begrudgingly adopt, then you can see why the Agency would want to swing back to a different management model, but that doesn't mean that you mistreat the people that have tried to make it work. They were not part of trying to be subversive or fighting Agency change. They'd been given a task to try to make this work, and by and large they were trying to make it work.

There were probably some that were trying to keep it alive despite Agency decisions, but at the end the people were still treated badly, pretty much told to go find jobs. The more bizarre one was the senior executives [Senior Executive Service]—a couple days before Christmas in '93, they faxed from Headquarters a one-page list of the senior executives with your name and where you were supposed to report the next day.

Now I had already been recruited by Bryan to come into Code M and do some things, so that was what my name said. I think most of us had found places to be. But until Goldin's office sent the list, it was not confirmed where you were going to show up. So it was just a really bizarre way of handling things.

Headquarters, [Acting Associate Deputy Administrator] Jack [John R.] Dailey—I will give him credit that Jack directed folks to make room for Reston folks that weren't moving back to the Centers. In those kind of transitions it's always harder. When the Level B office transformed into Reston, we only got about a six percent capture of folks that had worked down at JSC that were willing to move to Reston.

It was very similar going back the other way, because that's about what you got. Some folks did make the move and ended up working in the ISS [International Space Station] Office for a while, but a lot of folks don't. Some went out into industry, found other jobs, but you still had a large contingent that ended up in Headquarters for years.

JOHNSON: We've been going a couple hours. I think I had you until 3:00, so I don't want to interfere with what you need to go do next. I think it'd probably be a good place to stop, then we can pick up the next time. But I appreciate you coming by and spending the time with us.

HAWES: Okay.

[End of interview]