

NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT

ORAL HISTORY TRANSCRIPT

TERRY J. HART
INTERVIEWED BY JENNIFER ROSS-NAZZAL
HOUSTON, TEXAS – 10 APRIL 2003

ROSS-NAZZAL: Today is April 10th, 2003. This oral history with Terry J. Hart is being conducted for the Johnson Space Center Oral History Project in Houston, Texas. Jennifer Ross-Nazzal is the interviewer, and she is assisted by Sandra Johnson.

Thank you for joining us this afternoon. We really appreciate it. I'd like to start by asking you some questions about the 1978 Shuttle class. Can you talk to us about the astronaut candidate application and the interview process?

HART: It was interesting. I think there were about eight thousand applicants, a little over eight thousand applicants that applied, I guess, that met the basic requirements. I had actually not ever really planned on applying, and I had two careers going. I was an engineer at Bell Labs, and I also had come back from active-duty Air Force, and I was flying with National Guard on the weekends. So I sort of had two parallel tracks going.

I saw an advertisement that NASA had put in one of the National Guard magazines, actually saying that they were going to be recruiting astronauts, since they hadn't hired any since Apollo. I thought, well, gee, that would be an interesting thing. I'd never be selected, but it'd be fun to apply. Maybe I had enough background to go through some of the testing, and that might be interesting just to go through the testing.

ROSS-NAZZAL: What was the interview like, once you found out that you were one of those selected to come down to Houston?

HART: Well, I guess they were taking, I think, twenty at a time for a period of weeks, and a little over two hundred altogether were going through the testing program. That was very exciting. I was hoping to get that far, just to see what the experience would be like. I came down to Houston and met Sally [K.] Ride and [Margaret] Rhea Seddon and a few others that ended up being classmates in the process, and was very excited to go through the testing. It was mostly physical and medical testing, and then a couple of psychiatric exams.

But the highlight of the week was the selection committee, which was led by George [W. S.] Abbey, of course, who I just saw at Pe-Te's [Cajun Bar B Que House], where I was up having lunch with Jim [James F.] Buchli at Pe-Te's, and George was there. And that was really the highlight of the week, obviously, since that was the most important part, assuming you got through all the medical testing and everything.

It was interesting, because I had gone through some of the—I guess my interview was scheduled for Wednesday, and Monday and then again on Tuesday I took some blood tests, and there was one parameter in there, I think it was uric acid, which I didn't have any idea what uric acid does. But I was out of limits and the doctors were kind of forewarned about that, and the basic message I was getting was that that was going to be disqualifying. And in a sense I think that really helped me, because I went into the interview just—again, I was down here for the experience and everything, and so I was relatively relaxed as you could be for such an interview, I guess, and went through that interview process and finished the week up, and went home and told my wife that it was a wonderful experience, but, you know, I wasn't going to make it, which is what I thought from the beginning.

But I was a little disappointed at that point, because as you get into the process, your competitive juices start flowing and everything. You really want to be part of this very exciting adventure that was about to begin. Yet realistically, I'd met all these people that I was going through the testing with that were Ph.D.'s and test pilots, and they all seemed to be so much more qualified than I was. So I was a little disappointed, but I was glad I had had the experience, and I went home. That must have been sometime in the summer, I think, of '77. And then, of course, the announcement wasn't made, then, until January.

ROSS-NAZZAL: And once you actually heard from George Abbey, what was your reaction?

HART: I was floored. In fact, I was going to work that morning with some of my friends. I was in a carpool with some other engineers, and we were all driving in to work together. We had heard the day before, maybe, that NASA was going to make the announcement. It was supposed to be done before the holidays, but it delayed on into January. At the time we thought they were going to select forty, and then the news release said, no, there were only thirty-five being selected. I said, "Well, if I had a chance before, it's gone now."

I often tell my wife this story. The rest of the news release was that there were six women in this group. And I said, "Six women? I'll never make it now." [Laughs]

So I went to work even more convinced that I wasn't going to make it. So I'm sitting at my desk around ten o'clock that morning when the phone rang, and it was George. So I said, "Well, it's nice of him to call the losers as well as the winners."

And then he said, "Well, if you're still interested and you'd like to come down to Texas, we'd like to have you down here," is what George said.

I said, “Yes, George, I’m interested.”

So that was a real exciting day, of course, having thought that I didn’t have a chance of making it. So obviously they waived uric acid, whatever that was. And ever since, my blood test has been fine for uric acid.

ROSS-NAZZAL: That’s great. What did your wife think when you told her?

HART: She was very excited. I mean, it was a mix of things going on at the time. She was pregnant with our second child at that time, and we had a one-year-old at home, so the thought of uprooting and moving to a place she’d never been before was a little bit unnerving, but she was excited and caught up in all the excitement with me.

ROSS-NAZZAL: So tell us about moving down here to Houston.

HART: It was a little bit of an ordeal. It was the middle of the summer. I guess we showed up toward the end of June. We had come earlier in the spring, of course, and found a house, and that was a nice experience. We’d met a real nice realtor and got settled in El Lago [Texas] with a nice little home for us to move into. Of course, all the other astronauts—Jim Buchli was right around the corner from us and Steve [Steven R.] Nagel was a block away, so we were all kind of in the same community, and that was all very nice for the families.

But at that point she was six months pregnant when we came down. I remember driving down with the dog, and then she flew down a little bit later with our one-year-old. And I think her mother and her sister came out and helped us get settled.

But it was so nice, because it was such a wonderful community. When I'd been in the military before, as a single person, I understood how military families work so well to support each other. It's just a wonderful environment. And I was pleased to see that NASA had that and more, and it was a very supportive environment to bring a family in, under these rather exciting conditions, but also stressful, for people moving, especially when you're six months pregnant.

ROSS-NAZZAL: Well you started training, then, after you came down to Houston. Can you talk to us about that training period?

HART: It was a great experience. I think a lot of people would think of the training program as being somewhat stressful, and testing, and everything of that nature, but it was very much—very professional, but not in a stressful way. It was just all mission oriented, and learning what you needed to learn, and the degree of professionalism among the training people and the way they worked you through the syllabus and everything was very reassuring.

The task is a little bit daunting, in the sense that the astronauts all have such different backgrounds. I mean, roughly half were pilots and half were scientists or doctors, and yet they had to bring everybody up to some common level of understanding of engineering and science disciplines. Most were familiar with some, but not all. It was just so much fun to go through all that, and, of course, not having the pressure of exams like you do in a university environment made it that much more pleasant. And the camaraderie, and the sense of teamwork that you build up with your mutual experiences, and the social life, and everything, it's just a wonderful experience.

ROSS-NAZZAL: How do you think your background in engineering and also with the Air Force and the National Guard helped you through this experience?

HART: Yes, I was fortunate in that role. I think one of the reasons I didn't think I was going to be selected was because even though I had a breadth of experience in engineering and flying and everything, I didn't have the depth that a lot of people had, and particularly the mission specialists, who were often very deep in their area of science. But that served me well, in the sense of I could fly the T-38s since I was a fighter pilot in the National Guard, and yet I had a good grounding in science and engineering through my work at Bell Labs and all. So I was very comfortable with all that, and it was fun sometimes to be able to help the people. Like the other mission specialists that didn't know as much about flying, I could take them flying with me in the back seat, and in a sense I think we bonded more than they would with a pilot, because we had more in common because of our engineering or science backgrounds or whatever. Yet I was also a pilot. So it was kind of nice to be sort of a little bit in the middle, in that regard.

And I was also flying with the Texas Air Guard on mostly the weekends, right out of Ellington [Field, Houston, Texas]. Since I was with the National Guard in New Jersey, I just transitioned to the Guard unit here in Ellington. So I was really fortunate to be—I had the best of both worlds. In fact, the pilot astronauts were jealous, because they could fly a T-38 like I did, but in the evening I'd go down and fly an F-4 [Phantom]. So the fact I can do some military flying, really, I was very fortunate to be in the position I was.

ROSS-NAZZAL: What part of training did you think was the most interesting?

HART: I think the integrated training with Mission Control. When you got to that point in your mission preparation where you were doing long-term integrated training, and you begin to shake down the teamwork between Mission Control and the crew, that was the most rewarding. I often tell people the most interesting experience I had in the whole six years was that sense of understanding the teamwork that builds so well within the NASA community, the sense of mission, and working together for a common purpose and all. And it's something I try to recreate in my business world, trying to get people to focus on the mission and work well together as a team. But no one does that better. The military does it very well, but NASA's even better at it. NASA's really something to behold.

ROSS-NAZZAL: Once you finished training, what were your main assignments until you were assigned to a mission or a crew?

HART: I had, I guess, two different avenues to my assignments. Since I had a technical background, John [W.] Young had asked me to—mostly mechanical engineering—had asked me to follow the main engine development. This was a couple of years before STS-1. In fact, it was ironic that we showed up down here in '78, and everyone said we're one year away from the first Shuttle launch, and two years later, we were still one year away from the first Shuttle launch, and it was really because of two main areas of technical difficulty. The main engine development was somewhat problematic, with some turbo pump failures that they'd had on the test stand, and the tiles. We had difficulty with the tiles being bonded on properly and staying on.

But the main engine was one that John Young wanted me to follow for him, and so I spent a lot of time going back and forth to [Marshall Space Flight Center] Huntsville [Alabama]

and to NSTL, the National Space Technology Laboratories, in Bay St. Louis [Mississippi, currently called the NASA John C. Stennis Space Center], where NASA tested the engines. And Huntsville, of course, was where the program office was for the main engines. And that was very exciting. I mean, I was like a kid in a candy store, in the sense that a mechanical engineer being able to kibitz in this technology, with the tremendous power of the fuel pumps and the oxidizer pumps, and the whole engine design, I thought, was just phenomenal.

The hard part of that job was when we had failures on the test stand, which were, unfortunately, too frequent. I'd get the pleasure of standing up in front of John Young and the rest of the astronauts on Monday morning to explain what happened. And, of course, everyone was always very disappointed, because we knew this was setting back the first launch and it was a jeopardy to the whole program. But we got through that, and the engines have done extremely well all through the program here, where it was always thought to be the weak link in the design.

ROSS-NAZZAL: Were you also assigned to track Spacelab 1? Was this one of your assignments?

HART: A little bit, yes. You must have done some reading. I forgot all about that. I worked a little bit around that same time, I guess, or maybe even before the main engine assignment, with Owen [K.] Garriott, and that was more on some of the science experiments that were scheduled for Spacelab 1 to help ostensibly get the principal investigators, the PIs, for those experiments familiar with the crew operations and the procedures and all. So, yes, that was a lot of fun. For just a few months, I think, Mike [Richard M.] Mullane and Kathy [Kathryn D.] Sullivan and I did that for a while, supporting Owen.

ROSS-NAZZAL: You were actually a support crew member for four different missions.

HART: The first four, yes.

ROSS-NAZZAL: Can you talk to us about your duties as a support crew member?

HART: Mostly it was as a CapCom [Capsule Communicator], and, again, because of my main engine work, that John Young had asked me to do—I got more involved with the ascent phase, so I was on the ascent team for the first three. Yes, just the first three launches, I guess. So Dan [Daniel C.] Brandenstein and I did the first two launches, and I was on the third launch. I forget who my backup was, but we did the launch CapCom duty, which was a lot of fun, learning how the Mission Control team did all the launch procedures.

My fourth one may have been later actually. I think it was STS-7, actually, now that you remind me. Sally Ride was on that flight with a couple others of our classmates, and I was a CapCom for the on-orbit phase, I think, then. I'd kind of forgotten about that. But the launch I was prime on was the third launch, which was [C.] Gordon Fullerton and Jack [R.] Lousma, when they went up on *Columbia* STS-3, so I was the prime CapCom.

ROSS-NAZZAL: How did your training as a support crew member differ from the training that you had received as an AsCan [Astronaut Candidate]?

HART: It was much more into the mission procedures and specifics, whereas as an astronaut candidate, the kind of assignment I had with the main engines was more typical. It was focused

on one particular thing. Once you're on a support crew, you're really integrated with the mission preparation and all, training and everything, to make sure the crew is getting all the support they need for the mission, help them develop procedures and so forth.

ROSS-NAZZAL: I know on STS-2 you were tracking the science pallet. Can you talk to us about some of your duties there?

HART: No. [Laughs] Let me think for a second. The science pallet.

ROSS-NAZZAL: I think it was the OSTA-1 [Office of Space and Terrestrial Applications-1].

HART: Oh, yes. I don't remember too much about that. I don't think I was real heavily involved in that. My duties on STS-2, were, again—were STS-1 and 2 and 3, were really ascent oriented. At that time we were doing a lot of work on developing the abort procedures. Initially the program had just the return-to-launch site abort for an early engine failure, and then it had a once-around abort, where you'd go all the way around and land at Edwards [Air Force Base, California]. We felt a need to try to do something in the middle, so I think we even got it ready for STS-1. We had aborts into [Naval Air Station] Rota [Spain] and to Dakar [Senegal], Africa, so Spain and Africa were landing sites for launch aborts. And all that was somewhat late to the program, and it wasn't envisioned as being in abort mode early on, so we had a lot of procedure development in the simulators, and working with the crews and the trainers to figure out how to bring the Shuttle down in either Africa or Spain right after launch. That's what I remember as being my main focus during those years.

ROSS-NAZZAL: Why don't you talk to us about being a CapCom, especially on STS-1, the first mission.

HART: Oh, it was really just great. It was wonderful, just being in the room and everything. It's ironic. I mean, the whole country, or most of the world, saw STS-1 lift off and go into orbit. I didn't see it, because in Mission Control at that time, we didn't have video. You just had to focus on your data displays and everything, and, of course, the radios with the crews is what Dan and I were responsible for. So it was kind of a strange sensation for this to be going on, and you could visualize it and understand it and all, obviously, but then it was like an hour or two later before I actually saw the video of the liftoff, and it was wonderful.

But I think the most memorable moment—and the mission was pretty flawless, as you recall, in that there weren't a whole lot of problems. A little bit with some tiles that I could talk about later. It was an interesting experience, but the most memorable moment for me was really on the landing. I was off duty, so I had no responsibilities, but I came into Mission Control and I was on the com [communications] desk over on the side there, just watching the landing come back. And there they did put the video up during landing, and when the Shuttle came down to land, I had tears in my eyes. It was just so emotional. And yet on launch, typically you're just focused on what you have to do and everything, but to watch the *Columbia* come in and land like that, it was really beautiful and it was kind of like a highlight. Even though I wasn't really involved, I could actually enjoy the moment more by being a spectator.

ROSS-NAZZAL: You had mentioned that there was some trouble with the tiles. Can you talk to us about that?

HART: I think it was all on the air and in the public at the time, at least most of it was, because it was some behind-the-scenes activities under way as well, but the problem was that right after liftoff, there were—well, a couple of things happened. The crew opened the payload bay doors when they got on orbit. They looked back on the tail, and here were some tiles missing on the top of the OMS [Orbital Maneuvering System] pods, the engine pods in the back, which immediately raised a concern. Was there something underneath missing, too?

Of course, we'd had all these problems during the preparation, with the tiles coming off during ferry flights and so forth, and the concern was real. I think they found some pieces of tiles in the flame trench after launch as well, so there was kind of a tone of concern at the time, not knowing what kind of condition the bottom of the Shuttle was in, and we had no way to do an inspection.

So we were all kind of wringing our hands after the first shift or two, and on the second night, the launch team, the CapComs and all, do the launch, of course, and then we're off shift. Then we come back in when the crew is sleeping. So we have to do all of our training around the launch, and then the rest of it we're just kind of doing the hand holding on the data and everything when the crew is sleeping.

So we were on the sleep shift on the second night, I guess, and we were all still worried about this problem. All of a sudden the word kind of started buzzing around Mission Control that we don't have to worry anymore. So we all said, "Why don't we have to worry anymore?"

"Can't tell you. You don't have to worry anymore."

So about an hour later, Gene [Eugene F.] Kranz walked in and he had these pictures of the bottom of the Shuttle. It was, “How did you get those?”

He said, “I can’t tell you.”

But we could see that the Shuttle was fine, so then we all relaxed a little bit and knew that it was going to come back just fine, which it did. And, of course, that came out recently, unfortunately, with the loss of *Columbia*, that the nation does have the capability to photograph the bottom of a Shuttle with some of our national technical assets, as they call them.

But that was an interesting experience to go through, to see how the country could garner up all the resources to support NASA when they needed to.

ROSS-NAZZAL: Are there any other memorable events from any of the other missions, from STS-2, 3, or 7, that you’d like to share?

HART: Yes. Two was a tough one, in that we learned a hard lesson there, and NASA has learned several times before, is we overworked the crew. Dan and I, as the CapComs on one of our subsequent shifts, had felt kind of bad about one of our parts in that. It turned out that President [Ronald] Reagan was visiting Mission Control during the STS-2, and it was just a couple, three months maybe after he had been shot. He had been shot in Washington [D.C.], and recovered, and this was one of his first public events since recovering from that.

Of course, everyone was very excited about that, and it turned out he was coming in on our shift, when Dan and I were back on as the ascent CapComs. We came back on for one of the other shifts the day before reentry, and Mission Control was kind of all excited about the president coming and everything.

He came in, and I was just amazed how large a man he was. I guess TV doesn't make people look as large as they sometimes are. And I was on com, so I was actually the one talking to the crew at that time when he came in. So I had the chance then to give him my seat and show him how to use the radios, and then I actually introduced him to the crew. I said something to the effect that, "*Columbia*, this is Houston. We have a visiting CapCom here today." I said, "I guess you could call him CapCom One." [Laughs]

And then the president smiled and he sat down and had a nice conversation for a few minutes with the crew. So that was the good side, but the bad side was that what we didn't realize we had not communicated properly to the crew, and the crew thought this was going to be a video downlink opportunity for them. So they had gone through a very busy timeline where this was not planned to be done. They had set up TV cameras inside the Shuttle to show themselves to Mission Control while they were talking to the president, when the plan was only to have an audio call with the president, because the particular ground station they were over at that time didn't have video downlink. And we had wasted about an hour or two of the crew's time, so we kind of felt bad about that.

We didn't learn about that until after. It didn't occur to us in all the excitement that we had forgot to tell them that it was only an audio pass. But it all worked out and everything, but it just shows you how important it is to communicate effectively with the crews and to work together as a team and all. And, of course, most of the crews, the astronauts, they're all troopers. They want to do their very best, and if Mission Control is not careful, you'll let them overwork themselves, which is what we had done there. When they got back from that mission, they were really exhausted, and it was just like a three-day flight, but they were exhausted, because several things went wrong, too. There were some problems inside the Shuttle with some of the

environmental systems. I recall that they were having to work extra time to try to fix these things and still maintain their timeline on all the other things to be done.

ROSS-NAZZAL: Any memories from Sally Ride's mission?

HART: Yes, a few. I think the thing that was most exciting about Sally's mission was the photography that they brought back, because they flew—for the first time, they had—what was the name of satellite? SPAS [Shuttle Pallet Satellite], I think, was a German science satellite that they deployed, and they flew the Shuttle around it. But on it was a Hassleblad camera, a 70-millimeter camera, that they used [it] to snap several pictures of the Shuttle, and that was the first time we all saw high-quality photographs of the Shuttle in space, and it was really spectacular. I mean, I remember being so excited when those pictures came back, to see what it really looked like.

ROSS-NAZZAL: Is there anything in particular that you learned that was a valuable lesson as a CapCom?

HART: Yes. Again, I think the sense of teamwork that builds up between the crew and Mission Control was so critical. I mean, it was really what saved the astronauts on Apollo 13. It was so wonderful that Tom Hanks did that movie, because I think it really captured for the people in our country how good NASA is at doing that kind of thing. And that was really a case in study for all astronauts in training, I think, to see how they were able to improvise and work together effectively as a team. And the only way you get there is by constant training and constantly

being self-critical of yourself and your team members in a way to constantly make your ability better and better to overcome unforeseeable things, and that more than anything else. So you begin to get a flavor of that as a CapCom working on the Mission Control team, and, of course, you carry that into orbit with you.

ROSS-NAZZAL: Talk to us about your selection for a flight. Talk to us about when you learned you were selected for STS 41-C, and what your reaction was.

HART: Of course, everybody wants to fly right away. So, Sally and John [M.] Fabian and Norm [Norman E.] Thagard, I think, were the first three in our class to fly on STS-7, and, of course, we all wanted to go right away. So every mission that went by, you'd hope. But I had been assigned, actually, after I came off the main engine project. Even when I was still CapCom'ing, I think, on STS-3, they had assigned me to work rendezvous, again I think maybe because of some of my technical background in that area, where I had done some orbital mechanics and all in school.

And the Shuttle had never done a rendezvous before. And, of course, we had done lots of rendezvous in the Apollo Program and earlier in Gemini, but this was like a different game, in that the Shuttle was this big truck and it had a very limited amount of fuel on board, whereas the Apollo command module and Gemini were like sports cars. They could zip around and change orbits much more readily, especially in close, around an object they could just kind of move right around with great ease, whereas now we are very limited. If we started to do too much of that, we'd very quickly run out of fuel on the Shuttle and have to de-orbit.

So we had to come up with new design trajectories and procedures to accommodate that difference to ensure that we were flying the most fuel-optimal approach during a rendezvous. So for about two years, I guess, I was working on that.

And then out of that, one day George Abbey put the crew together for what at the time was STS-13, which is another story we should get back to. We heard very early that Bob [Robert L.] Crippen and Dick [Francis R.] Scobee were going to be—we didn't know who the mission specialists were right away, and then George [D. "Pinky"] Nelson and Jim [D. A. "Ox"] van Hoften and I myself got called in to be the mission specialists, but we didn't know what our duties were. But we knew this mission was very exciting, because it had the first satellite repair and the first rendezvous.

I'd been working the rendezvous, so I figured I'd be doing the rendezvous. I don't know why; there must have been several days went by here before we knew what our assignments were. I knew I was a mission specialist when George called me in. Then people started saying, "Well, you're going to be one of the EVA [Extravehicular Activity] guys."

And I said, "What? I've been working the rendezvous. I don't think I'm going to be EVA."

They said, "Well, Jim is—." Ox was his nickname. "He's too big to do an EVA." That wasn't true. He's six-four or something like that. Everyone, obviously, is within the limits to do EVAs.

But after several days, then, Crippen came to me one day and said, "I want you do the rendezvous with me. You've been working on that for two years."

And then Pinky and Ox would do the spacewalk—spacewalks, I should say, because there were a couple scheduled. So we had an opportunity then to start training together, and it was just a wonderful time.

ROSS-NAZZAL: Tell us about STS-13. You said there was an interesting story there.

HART: Well, yes, I mean, the Apollo 13 experience gave NASA a bad case of triskaidekaphobia, or whatever the word is for “fear of thirteen,” because I think it launched on a Friday the thirteenth or something. Maybe it launched at 13:13 or something. I don’t know. There were a whole bunch of thirteens in that, and, of course, that was the mission that had the oxygen tank explode. The crew got back, fortunately.

We actually came out as STS-13. It was in the manifest and everything. Then all of a sudden, like three or four months later, there was an edict that was coming down from [NASA] Headquarters [Washington, D.C.] that they were going to change the numbering system. And we said, “Why are they doing that?”

No one would say anything, but we were sure the reason that we were doing it was because they didn’t want to fly on STS-13. And it turned out that the way the calendars were falling, we were supposed to launch on April 13th, which was a Friday, in 1984. So it was kind of lining up just like Apollo 13 and I think they said, “We’re not going to do this.”

So they went through this Byzantine structure then. We became 41-C, which, the “4” meant 1984 and the “1” meant a Cape Kennedy, Cape Canaveral [Florida] launch versus a Vandenberg [Air Force Base, California] launch. And then “C”, we were the third mission of

that year. So the whole thing started, then, with—STS-11 became “A” and 12 was “B” and we were “C”, I guess.

In the meantime, we had designed our patch, which was a conventional patch, and Dick Scobee actually came up with the concept of it. But we also had another patch, which was our underground patch that Headquarters did not approve, and it was a black cat with a big “13” on it, and lightning bolts kind of flying all around, and then the Shuttle coming underneath the belly of the cat. I still have a couple of them around. But it was a great patch ([view patch](#)). And we did our coffee mug with the Headquarters-approved STS 41-C patch on the front of the coffee cup, and on the back of the coffee cup we had the unapproved black cat with “STS-13” on it. So that was the triskaidekaphobia story.

As it turned out, two of the missions in front of us—let’s see, they flew 10. One mission was canceled; I forget which one. I think it was 10 that was canceled, and one mission was delayed. So we ended up being the eleventh flight as it turned out anyways. But they also moved the date around. Since it was well before the launch, there was nothing forcing the date, but they just moved the date to get away from the Friday the 13th thing, because then it turned out we were going to go early. We were going to launch on the sixth of April and land on the twelfth, but we had a problem during our mission that I should get into later, I guess, that delayed us one day. So we ended up landing on Friday the 13th. [Laughs] But we made it.

ROSS-NAZZAL: Yes, you did. The mission actually ended up being quite successful.

HART: Yes. We thought for a time that it wasn’t going to be, but we took one extra day to do it.

ROSS-NAZZAL: Why don't you talk to us about training for the mission. How much time did you spend training on the RMS [Remote Manipulator System], for instance, and can you talk about training on the RMS?

HART: Yes, the RMS had been tested on STS-2, by itself, basically, and then on the subsequent flights they had maneuvered a few smaller payloads around. In fact, Sally Ride had used it for the SPAS payload and deployed the SPAS payload. But they really wanted to understand the full capabilities of the arm to move very large payloads, and the largest one to be flown to date was one we were taking up called the Long-Duration Exposure Facility. I forget the numbers on it. But it filled up most of the payload bay, a large cylindrical satellite. I think it weighed around 30,000 pounds, as I recall now.

The arm engineers wanted to make sure we properly tested the arm moving such a large object, so they could understand that it was going to be able to do what it was designed to do, which was up to 65,000 pounds, I guess, so I spent a lot of time working with the engineers to make sure that I was doing everything that they wanted done during the testing. The bulk of it was done here in the facilities at Johnson Space Center, but the best simulator in terms of the dynamics of the arm, the flex modes and everything of that nature, was actually at the manufacturer's up in Toronto, Canada. Spar [Aerospace Ltd.] was the Canadian company that built the arm for NASA.

So I spent several weeks up there over the year or two before launch to simulate two things. One was lifting up the Long-Duration Exposure Facility to test the flex of the arm with a heavy payload, and then the other was using the arm to capture the Solar Max [Maximum Satellite] in a rotating mode. And their concern was, could the arm track something that was

moving, and when you snared it, would it tend to cause stresses that were undesirable in the arm. Those were the kind of two things. So we went through a lot of different scenarios. And part of it was really just trying to understand what the practical limits were for capturing something that was moving, rotating, or translating. You know, could you keep up with it, with the arm, well enough to snare it, or did it have to be pretty steady. So we did a lot of—with me as the guinea pig—what limits could you go to before you'd either exceed my ability to track it or the arm's ability to stop it without breaking.

They were great folks to work with. The Canadians up there were really dedicated, talented engineers that understood the design very well, and they had the best simulator.

ROSS-NAZZAL: You finally got to launch. Can you describe your feelings during the launch, and describe liftoff for us?

HART: Yes, well it's real exciting. It was a clear, cool morning there in April of '84, and we went out in the whole morning, going through the traditions of having breakfast together, and there was always a cake there for the crew before they go out. And then going into the van and realizing that all the Mercury guys went on that van, it was really a very heady experience. And then out to the launch pad and up the elevator. As usual, people don't say much in elevators. It's true whether you're in a hotel or on the launch pad. You kind of watch the numbers tick by, and instead of floors, they do everything in feet in the elevators, so you're so many feet above sea level.

And then across the gantry, and when you walk across the gantry you're looking down into the flame trench. And you've been there before, but the obvious thing that's striking you is

that this is for real, we're going to go. At least you hope we're going to go today. And everything was pretty smooth on our launch countdown. No, I can't recall any problems at all. So we got strapped in, and, again, the guys strapping us in were a lot of the same guys that strapped in Al [Alan B.] Shepard on his flight. So it was a very heady time.

I had kind of the mission specialist duties on launch, which are basically just having the checklist there in case the crew needed some help. And off we went, right on time. We had like a thirteen-minute launch window, but we were right in the front of it. A perfectly clear day, so it was a great visibility opportunity.

I guess there were a couple of things. You talk a lot, obviously, and you see a lot of pictures, and you think about it a lot, so you think you're pretty well prepared and you probably won't have too many surprises, but I had a couple of surprises. The shake, rattle, and roll for the first two minutes, then was about what I thought, maybe even a little bit less than what I thought it would be, because the solid rockets kind of have a "whoof-whoof" kind of—you don't really hear it, you more feel it. It's like a very low-frequency rumble, and just a tremendous sense of power as you liftoff and all. You can look back over your shoulder or look out the top window when you're in the flight deck mission specialist seats there, and kind of watch the world disappearing behind you. It's a very heady experience.

Very quickly, then, the solid rockets taper off and separate, and that was the first surprise I had, because your G-loading builds up to, I guess, close to two and a half Gs or maybe a little bit more during that first two minutes as the solid rockets are reaching their peak thrust and the main engines are at 100 percent. And then very quickly that thrust tapers off as the solid rockets burn off, and they separate.

Well, the sensation that you have at that point I wasn't quite prepared for, because you go from two and a half Gs back to about one and a half. Well, when you get used to two and a half, and it feels pretty good. You're going somewhere, you know. When you go back to one and a half, one and a half feels like about a half. So the sensation you have is that you're losing out, that you're falling back into the water. You don't think like you're accelerating as much as you should be to get going. And, of course, I had worked the main engine program anyway, so I was very familiar with what the engines could do or not do.

And I think in the next minute I must have checked—every five seconds I checked the main engines to make sure they were running, because I swear we only had two working, because it just didn't feel like we had enough thrust to make it to orbit. But then gradually the external tank gets lighter, and as it does, of course, then, with the same thrust on engines, you begin to accelerate faster and faster. So after a couple of minutes I felt like, yes, I guess they're all working. We're back to two Gs, and then two and a half Gs, and three Gs.

Then my next surprise came just a few minutes later. Well, the zero-G I was pretty well prepared for. [As] a fighter pilot and the experience at NASA in the zero-G trainer, you're pretty familiar with what it feels like to be weightless, but what I wasn't prepared for was the first look out the window. You don't know what black is until you see space. I mean, I was startled with just how black it was. You don't see stars. You could barely see the Moon, it's because there's so much light coming off the Earth and off the tiles of the Shuttle, that there's a tremendous ambient light from all those sources, so your eyes are constricted greatly.

And then because of that constriction, when you look into space you can't see the stars or anything. I mean, it's like really black. It's palpable. You think you can almost reach out and touch it. I don't know quite how to describe it. It's sort of like black velvet, but it's just totally

palpable. And not being able to see the stars or anything, of course, I knew that intellectually. I guess I knew that I wouldn't be able to see the stars when we were on the day side of the Earth. But still, when you look out there and see the blackness, it really was striking to me.

ROSS-NAZZAL: What were your thoughts when you finally made it up into space?

HART: I think when the engine shut down and everything, it was like euphoric. You figure that's probably like 90 percent of the risk, is that launch phase, or most of us felt. Especially I felt that way, because I was so close to the main engines, I could see what they do when they fail. Everything worked fine. We had a near-perfect launch and everything. You're euphoric when you reach that point. Of course, the crew, the pilot and the commander, were very busy at that time, so they didn't have as much as I did to enjoy, to take in the view. We were all rookies except for Crippen. This was his third flight, actually, so he had done a good job of coaching us as to what to expect. But still, everyone has a little different reaction, I think, as to what they didn't expect that is rather dramatic.

ROSS-NAZZAL: Talk to us about deploying the LDEF [Long Duration Exposure Facility].

HART: Do you want to take things chronologically? I should probably tell you about how sick I was the first day.

ROSS-NAZZAL: Yes, please. Please tell us.

HART: Just so I don't forget something. I had never had any motion sickness. I was a fighter pilot; I could do anything in an airplane. I had a light airplane I used to aerobatics in, and nothing ever bothered me, in terms of flying or riding a boat or a train or a car or whatever. I wasn't weightless for more than three minutes and I knew I was in trouble. [Laughs] I could just tell my whole GI [gastrointestinal] system was going into high-speed reverse and I didn't understand it, because psychologically, I mean, I was elated. I was there, you know. Now, one thing, maybe I got up too quick and started moving around, and the excitement. I started looking out the window too soon. But I triggered something in my chemistry that started my whole system to go into reverse.

So for the whole first day I was really pretty much out of it. I just felt awful, and I was throwing up, mostly just dry heaves, every thirty minutes or so for a day. It was just awful. We kind of suppressed that. I got on camera once during the day, just so they knew I was there. And my wife saw me, and she said, "He's sick."

And, of course, everyone went, "Naw, he's fine, he's fine."

But I could barely force myself to get out of the corner of the cabin and get up on camera. And there were some things I had to do that first day, but they were minimal. I just had to unstow the arm, and I barely made it through that. I really was totally incapacitated for the first day. And I tried the usual drugs that they give you to help, but I had it so bad, nothing helped at all.

That night when we got ready to go to sleep, I was just totally exhausted. I was really depleted. I remember falling asleep, and I was asleep for maybe a half hour when I started dreaming, and I dreamt that I was falling, which I was. I was falling. But I had like a visceral reaction to a fear of falling all of a sudden. I remember I was in the blue sleeping bag and I

remember reaching to grab something as I came awake, to stop my falling, and I did it with such force that I ripped the bag that I was sleeping in. It was that violent. And I grabbed onto something, and then I realized where I was. I don't think the other guys were asleep yet, but if they were, I woke them up when I yelled out. That was kind of a low spot, and after that I acclimated.

I told the doctors this. They probably had a good chuckle. But I think I had some kind of a fundamental like neurological brainstem reaction, which is totally subconscious, to a fear of falling. And I think my initial sickness, after like three or four minutes of weightlessness, was something that triggered my basic instincts of falling, even though it wasn't conscious. I couldn't detect it consciously. And I think that stayed with me for that first night.

And then the next day I felt a little washed out, but I was able to do all my duties the next day, once I got through that first night. But it was just a terrible experience. I had never heard anyone else relate such a bad experience. And other people that have had a history of being sick in airplanes or being sick in cars or roller coasters or any other kind of motion sickness have gone up and been fine. And myself, and I think Bill [William R.] Pogue was another one. He was a Thunderbird that went on Skylab, and I think he often talked about his experience being sick the first day. And here was a guy that did everything you could do on an airplane.

So it's like there's a totally different mechanism going on from the Earthbound kinds of motion sickness. But whatever that mechanism is, I had it in spades. It really triggered. But like everyone else, after a day or so, everyone recovers and your body acclimates and everybody does fine, which is why NASA doesn't schedule spacewalks until the third day. It gives everybody a chance to settle down, in case they have some kind of distress.

ROSS-NAZZAL: That must have been difficult.

HART: Yes. It was disappointing. And I think, had I flown other missions, apparently it still would have been there, but each time it gets a little bit better. Your body remembers what weightlessness is like, and you adapt a little quicker. But I've heard other people say that it took two or three missions before they finally got past that point where they got sick on the first day.

ROSS-NAZZAL: Tell us about the second day that you were up on flight.

HART: We deployed the LDEF on the second day, and that was exciting. The concern there was that I was going to get to get it stuck, then we couldn't close the payload bay doors, and then we couldn't come home. So we had to be careful. So Crippen and I were the two that were trained on the RMS. I was prime, of course, with him watching and making sure everything was going well.

It all went pretty well. First I had to lift it out straight, and then the arm did everything it was supposed to do. And then I think I put it back in again just to make sure it would go back in before I lifted it out one more time to deploy it. We left it out on the arm and did some slow maneuvers to verify all the dynamics and all the things that the engineers wanted to understand about lifting heavy objects out of the Shuttle. And then we very carefully deployed it. It wasn't detectable at all when I released it. I mean, it was just totally steady, and we very carefully backed away and got some great photographs of it as we backed away.

The LDEF was supposed to stay up for six months or a year, something like that. It was that kind of time frame. And on it were eighty-five, I think was the right number of trays, and

about 150 scientists from all around the world had designed the experiments, which were mostly aimed at gathering micrometeorites and dust from space, or analyzing how radiation affects things for long-term duration. Then it was supposed to come back, but actually it was delayed as the mission profile slipped. They were going to get it, and then we lost the *Challenger*. It ended up staying up for like about six years, which actually ruined some of the experiments on board, but others, it actually gave them more data, the ones that were looking at the weathering effects and all.

In my office in New Jersey I've got a plaque from the LDEF team down at Langley [Research Center, Hampton, Virginia], and there's one of the little brackets that held on one of the trays that they'd put on a plaque and gave to me after the LDEF was recovered six years later, so that must have been around 1990 that it was recovered.

It was a wonderful experience. And, then, again, the Langley NASA team to work with were just wonderful people. They had coordinated, of course, all these scientists from all around the world and they had all done their thing. My job was easiest—just had to lift it up and put it out there.

ROSS-NAZZAL: But the most important.

HART: No, I don't think so. The most fun, maybe.

ROSS-NAZZAL: Let's talk about the Solar Max.

HART: Oh, yes. That was the highlight of our mission, of course. A fellow at Goddard [Space Flight Center, Greenbelt, Maryland], Frank Ceppolina was his name, I think he's since retired from NASA, but Frank had, early on, understood that there's an opportunity here to do something very special with the Space Shuttle. Goddard had launched a solar observatory satellite called Solar Maximum mission, Solar Maximum being the point in the eleven-year cycle of the Sun when the Sunspots are most active. The astronomers want to study the Sun at that time particularly.

But they had launched this satellite to study the Sun during its peak. In just a very few months after it had been put into orbit on a Delta satellite in 1980, it actually started popping fuses. There was a thermal problem, and some of the fuses got too hot. They had derated the fuses and they had caused them to pop, and the fuses were powering the attitude-control electronics on the satellite. So as a result, the satellite was spinning and they couldn't control it. It was pointed at the Sun, but it was wobbling so that it was not of any use to the scientists.

However, this was the first satellite that was designed to be repaired in space, and that they knew the Shuttle was coming, so NASA had designed this satellite to be very modular, and the one module was the one that had failed, the attitude-control module. So we knew exactly what needed to be done to repair it.

So for most of the two-year training period we had practiced and developed the tools, first of all for—since the satellite was spinning—it wasn't spinning faster than what the arm could do, and I'd shown up in Toronto, that in—I think it was like a half a degree per second it was spinning, that at that rate I could come up and grab it with the arm.

We felt that the better approach, more prudent approach, would be to have George Nelson fly over with a backpack and dock himself to the satellite first, stabilize the satellite, then

I could come in and grab it with the arm. That was the preferred approach, and the concept that was developed by Frank Ceppolina, working with Bruce McCandless, actually, and Bruce had been the Astronaut Office proponent for the Manned Maneuvering Unit, the backpack. So this was all kind of coming together between the two of them as to how we should do this mission.

We went off and everything was nominal. The LDEF was gone on day two, and now it was day three and we were on the right rendezvous trajectory. I was working with Crippen to use the radar and the optical star trackers to find the Solar Max, and everything was kind of just falling in right, as it should. And, of course, we had plenty of backup for Mission Control. If something went wrong with the rendezvous, they could basically guide us in by doing maneuvers almost in the blind, because they had good radar tracking on the Shuttle and the Solar Max together.

But we came up and picked it up about 300 miles away with the star trackers, and as we got closer with the radar, processed all that, and the navigation system and everything was just “tickety-boo,” as Pete [Charles] Conrad used to say, we came in, and Crippen took over manually as we got into a few hundred feet from the Solar Max. And as we were doing this approach and everything, Pinky and Ox were putting their spacesuits on and going out into the payload bay. Pinky was putting his backpack on and Ox was assisting him to fly the last couple hundred feet over to the Solar Max as it was spinning. So everything was very nominal and we were right in position, and Pinky departed and went over, and we think this is going to be a walk in the park, a piece of cake. All two years of training and everything is just perfect.

And Pinky came in at about two-tenths of a foot per second, closing on the Solar Max, and he was lined up perfectly, and he went right into the pin that he was supposed to dock to, and he came right back out at two-tenths of a foot per second. So he made a pure elastic collision

with the satellite. So we didn't know what was wrong, but we all, being mechanical engineers, we say, "If a small hammer doesn't work, use a bigger hammer." So he went in twice as fast the next time, and he hit again and bounced right off again. So I think he maybe tried even a third time, but it was clear that the docking adaptor wasn't working.

Now our backup plan was for me to use the arm to grab the Solar Max, which I could have done in the original spin, but now because he was banging into it, instead of spinning, it was tumbling. It was kind of moving in all sorts of strange attitudes. And the pin I had to grab was right underneath one of the large solar panels, so I could only get in there under certain conditions, and it was very hard to predict how it was doing, but we knew it was wobbling too much.

So Crippen asked Pinky to grab onto one of the solar panels to see if he could fire some thrusters onto his backpack and stop this crazy motion. And as he did that, it seemed to make it transition into some other crazy motion that was very hard to control, like grabbing on like that. And, of course, we never even talked about this scenario over a cup of coffee. I mean, this was total freelance at this point. We didn't know what to do.

And the other problem is that Crippen had to be very cognizant of where Pinky was, because he always wanted to keep Pinky between the Shuttle and the satellite, never wanted to let Pinky get around to the other side. So as a result, Crippen was maneuvering the Shuttle in other positions to try to stay up with it, and that took a tremendous amount of fuel. So we're watching the fuel gauges go down, and everyone's getting very nervous.

So he told Pinky to let go and come back, and then we just kind of watched it for a second. Crip said, "Why don't you try to grab it with the arm." And it was tumbling. So I tried. Two or three times I got real close to it and I was like maybe a foot away from getting it, but I'd

reach some limit on the elbow or the wrist. I couldn't go far enough fast enough to get it. It may be a good thing, because it was tumbling so much that if I had gotten it, it may have actually broken the arm if I'd gotten it. But we weren't sure, because we couldn't tell what the rates were, and no one could tell, but there was a risk there. So we felt like we were kind of dangling on the edge a little too much at that point.

So Crippen, rightfully, said, "King's X. Let's go back."

So we got the Shuttle back in position in front of the satellite, on the velocity vector of the Solar Max, and then we stabilized everything. We had fuel left, but not enough to do what we were doing anymore. So we had a conversation with the ground then, the people at Mission Control and particularly the people at Goddard, who were controlling the satellite. The attitude control had failed. They had some magnetic torquers on there that they could do some limited things with it. They said, "Well, why don't you let us try to get it back under control. You guys go ahead and back away."

So we did a reverse rendezvous, in a sense, and we backed away and set up like 100 miles behind the satellite, and stabilized in the same orbit as the satellite, about 100 miles behind it. And overnight, and we got up the next morning, the folks at Goddard had gotten the satellite back under control. It was a close call, because all the bumping and everything had knocked it off the Sun, so it wasn't pointed at the Sun anymore, it was just kind of maneuvering wherever it was going to tumble.

In the last pass, as it went through the Earth's shadow—of course, it doesn't get any Sun at that point at all—the batteries were almost completely depleted, which would have meant the satellite would have gone dead. But just as it came out of the Earth's shadow that morning—we were asleep at this point—they had just enough. It turned out it was pointed roughly at the Sun,

and the battery started to recharge again, and then they got it stabilized with the magnetic torquers, and they actually put it back into a slow spin to keep it stabilized on the Sun.

Then we talked about what we had to do, and Mission Control worked the fuel real close, but we took an extra day, then, and decided we would do a second rendezvous. And at this time Pinky and Ox would just stay inside and I would try to capture it with the arm.

At that point they had figured out what the problem was with the docking adaptor, and this was kind of a real “gotcha.” The pin that they were trying to attach to was a pin that held the satellite during launch, and around it there were some thermal blankets, some gold blankets. No one had noticed, and the docking adaptor on Pinky’s chest was like a round shroud with a hole in it, and what no one had noticed is that one of the blankets had been put on with a little plastic standoff that the grommets on the blanket would fit over. The drawings, the engineering drawings, didn’t specify where those standoffs could be, so the technicians, when they assembled the satellite, would just put one wherever the grommet was. They’d put a standoff there. They’d glue it or bond it onto the metal frame and then stick the blanket on. So that was the correct thing to do, because no one envisioned having to use that pin again for anything.

But when they were designing the docking adaptor, no one noticed that—they had closeout photographs, but no one had noticed that there was a pin there. So when he went to dock, the pin interfered with the docking adaptor. So they figured that out overnight and told us the next morning, so we knew we couldn’t use the docking adaptor.

So we calculated all the fuel and everything. We had just enough fuel to do one more rendezvous. As long as there was no more difficulty around the spacecraft, we’d be able to do a second rendezvous. So we came back in again, and that one went just fine, too.

But we had an interesting conversation, actually, before that, because, again, this is the communication thing. This time it's the crew, Mission Control, and the Goddard Space Flight Center that are controlling the satellite, so we had three teams to make sure we were all on the same page. So they got the satellite back under control, and then they told us, with a lot of pride, that they had totally stabilized the satellite. It wasn't spinning at all. And I look at Crippen and he looks at me, and I said, "Bob, you've got to get them to spin it again." Because, see, the problem is, if we came in in front of the satellite and the grapple fixture that I had to grab with the arm was on the wrong side—we didn't know where it was, because all they knew is they stopped the satellite entirely—we would have to move the Shuttle all the way around so I could get at it, and we didn't have enough fuel to do that. So the interesting radio call, then, was from Crippen. After Crippen and I talked about this he said, "Well, I'll tell them."

He said, "Houston, this is *Challenger*. We need you to spin the satellite up so we can make sure we see it."

And there was this pause come back. They said, "You want us to spin it?" Because they were so proud of themselves that they had stabilized it, figuring they were helping us. So they said, "Okay, we'll try."

So after a few hours they came back, then told us it was spinning at a half a degree per second, which I was very comfortable with or maybe it was a little bit less than that. So we came up and got right in front of the satellite, and we just watched as it came around. And as it came around to the right place, then I reached over and grabbed it, so everything was just fine. But it was a dramatic moment for Mission Control.

ROSS-NAZZAL: What was your reaction when you were finally able to grapple that satellite, and what was the crew's reaction, in general?

HART: It was euphoric. I mean, we really felt that the mission was at risk, which it was, and we were really on a mission that was demonstrating the flexibility and the usefulness of the Shuttle to do things like repair. We were afraid that we were disappointing a lot of people, the scientists, of course, wanting to put the science satellite back into service, but all the people at NASA that were showing what the Shuttle could do.

In reality, we demonstrated even more just the flexibility of human spaceflight, that you can adapt to things that are unexpected, like this pin and the problems that it caused us. So it was a good opportunity to show even better what the Shuttle could do.

ROSS-NAZZAL: This crew, I have read, was actually a model crew.

HART: A model? [Laughs]

ROSS-NAZZAL: This is what I've read. The most experienced Space Shuttle commander served.

HART: Crippen, yes.

ROSS-NAZZAL: One of the best pilots from the '78 class.

HART: Dick Scobee. Wonderful, yes.

ROSS-NAZZAL: Two of the best EVA people.

HART: Yes. They were great.

ROSS-NAZZAL: And you, one of the best RMS operators.

HART: Well, we all got along great. We were a good bunch. It's funny, you could tell we were all rookies right from the very beginning, because I remember the day we posed for our crew picture. So you all put your blue suits on and you bring the helmets in or something, and we took, I don't know, maybe twenty pictures they get, trying to get us all to have the right expressions on our face or whatever. And then the tradition is, you bring them back to the Astronaut Office and then you ask the secretaries to pick which one is best.

So Crippen and Scobee and Pinky and Ox and I are sitting around, looking at all these pictures. In one of them, one of us would be winking or our smile would be crooked or something like that. Every one of us had maybe a 50 percent hit rate on the pictures, having the right expression on our face. And we looked at Crippen, who, you know, this is I don't know how many years he'd been in the public eye here, from STS-1 now to this mission. Every photograph had the same expression on Bob Crippen's face. He had it down pat. He knew exactly how to smile.

But it was a great team. We really worked very well together, as we did with the rest of the Mission Control team.

ROSS-NAZZAL: Can you talk about what you did in your spare time during the flight?

HART: Yes, after I felt better, I marveled at moving around. The first day or two, you tend to over control your body a little bit and you tend to use your feet too much, so you flail a little bit, you know, kind of bounce into things. But by the third day you really get the hang of it, so you just use your fingertips to kind of pull your body around. It's almost like swimming under water a little bit. It's kind of a graceful kind of motion that you want to get used to making, and once you learn it, it's just a wonderful place to work. Our crew with just five, I mean, some crews have had seven, I guess, or even eight, but trying to do training on the ground with five people in the crew compartment, you're always kind of in each other's way. And then you find out very quickly when you're weightless and moving around in the volume of the Shuttle instead of just the floor, that you have all this space to work with. And then, of course, the view out the window.

I didn't have a whole lot of time, since we were fairly busy on the flight, but the last night on orbit I had no duties at all. In reentry I'd be down below. I was switching with Pinky so he could ride reentry upstairs. I guess Pinky and I were down—yes, there just one MS [Mission Specialist] upstairs, so Ox was upstairs and Pinky and I were downstairs on reentry. I was up that night before. I just figured I'm not going to sleep at all. At this point I knew I wasn't going to fly again. I had turned down a second mission and I was going to go back to AT&T [Corporation], so I knew this was my last chance to be in space. So I was damned if I was going to sleep, so I stayed up all night and just looked out the window while the rest of the crew was sleeping, and watched the Himalayas go by, and other parts of the world that I didn't see during

the regular shifts when we were sleeping. It was just a wonderful memory of just pondering the Earth from space and all.

ROSS-NAZZAL: This flight also took up an IMAX camera and a Cinema 360 camera. Did you participate in any of the filming of this footage?

HART: Yes, I was actually lead for the IMAX camera, so Crippen and I were trained to do it, but I did most of it because of his need to be focused on his commander's duty. That was a great experience, too, working with the IMAX crew. Graham Ferguson was the president of IMAX and the fellow that invented the camera and the projection system. They were also, ironically, in Toronto, so I got to Toronto for two reasons. One, for the Spar, people that did the mechanical arm, and then also for the IMAX people. And they were very concerned, because none of us knew much about photography, let alone cinematography. They had a large list of things that they wanted us to do, some of which we couldn't do. They wanted us to shoot the IMAX footage of capturing the Solar Max, but we just couldn't do that, because the IMAX took up a whole window, and Crippen and I were both busy at the time. So there were some things we had to take off their list of things that they wanted us to do.

But we got most of it in, and learned that you could actually handle that camera much better in weightlessness than you could on the ground. It was very heavy and you had to change the film out inside these big black bags, where you put your arms in the bags so the film wouldn't be exposed, and put it in the canisters. So all that stuff ended up being easier to do in space than it was on the ground. But after they worked with us for a few months, they were very nervous that they might not get anything back that was usable for a production film. And it

turned out that we got everything that they wanted, or that we could get. Everything that we promised to get for them, we got. A couple of the inside shots were a little grainy, because we only had one light to put up for shooting inside photography. So they learned on the missions after that to fly an extra light so they could do a little bit better job. So a couple of the indoor shots were a little grainy, but most of it was very usable.

And then the one surprise that I gave them, that Graham Ferguson forever thanked me for, was an unrehearsed, unscripted thirty seconds that I got for him. Because we had six film canisters, and we had gone through all of them and we had gotten all the shots that they wanted us to get during the mission. And I figured I had—I think they were like three minutes a roll or something, or maybe six minutes a roll. I figured I had at least thirty seconds left on the last roll.

So I'm kind of, "What can I shoot?" I just want to shoot some indoor thing. And we were in the night side, and Crippen said, "Well, the Sun's going to come up in about three minutes here."

So I quickly put the camera up and focused on the Earth's horizon just as the Sun was starting to break through the horizon. And just as it started to glow a little bit, I ran the last thirty seconds off, and you could see the Earth's limb all illuminated and you could see how thin the atmosphere is from that perspective. And just then the Sun blossomed on the horizon, and I ran out of film.

So in *The Dream is Alive*, which was the feature they put together from our mission and the two that followed us, there's that sequence in there of the Sunrise, where Walter Cronkite's saying, "And here's what an orbital Sunrise looks like."

So it never occurred to them or us, for some reason, to shoot that particular kind of thing, but when we were up there, we knew that was a dramatic event. So as soon as it was coming, we captured it, fortunately.

ROSS-NAZZAL: That must have been exciting to finally see that on film.

HART: Yes. It took them quite a while to put the feature together. They needed two more flights, and then time to edit it and get Walter Cronkite to do the narration and all, and script it. But we had looked at our raw footage probably five or six weeks after our mission. We went up to Fort Worth [Texas] to an Omnimax theater there, and the IMAX people were there and they were all smiles. They said, "You're not going to believe what you did there."

And then they showed the raw footage to us, and it was so vivid in our minds, just being five or six weeks from the mission, that it was almost like being there again, because the IMAX fills your entire field of view with the sensation of being in space. That was a great cooperative effort with the IMAX people, and they've done several since then, I guess. I haven't seen the latest one. I think it shows some of the Space Station footage.

ROSS-NAZZAL: Great. We'll have to go see it.

HART: Yes. I'll have to do that. Graham Ferguson has since sold the business, I guess, and retired. They've become a little more Hollywood now, I think. They're doing all kinds of productions and building new theaters around the world.

ROSS-NAZZAL: This crew was also called the Ace Satellite Repair Company. Can you tell us who coined that phrase?

HART: [Laughs] I don't know. It came from somewhere in the Astronaut Office. I think one of the earlier flights had deployed a satellite, maybe one of the first satellites that deployed from the Shuttle, and they coined themselves the Ace Trucking Company. So that we followed suit then, and became the Ace Satellite Repair Company. I guess at one point we put on our little jerseys with the "Ace Satellite Repair Company" on them.

That reminds me. Can I go back to my CapCom days? Because we had a wonderful experience. Maybe Dan Brandenstein had related this one, too, because it was his idea. STS-1, when we were getting ready for the first flight, we were the two ascent CapComs. And Dan came up with the idea that we ought to have a special tie, and we called it a "cue tie," meaning the cue to do a certain event during launch ([view tie](#)). And what Dan did was, we took these dark blue ties, and in orange we had silk-screened on them all the calls that we made, from liftoff through separation, on the tie. So you could pick the tie—it was upside down. So the person wearing the tie could lift it up and read. I still have mine, of course, our STS-1 cue ties. I have that and I still have my Ace Satellite Repair Company patch in my stuff at home.

ROSS-NAZZAL: Those are nice mementos.

HART: Yes.

ROSS-NAZZAL: Do you have any other memories of the mission that you would like to share with us?

HART: Reentry was just a wonderful thing. I told you I stayed up all night before, and then I think watching the fireball around the vehicle was really breathtaking. The engineer side of me wanted to see the G buildup, but I remember I had a camera that I was holding during reentry. I remember just letting it go and it would just kind of sit there, of course, when we were weightless. And as we started to hit the upper parts of the atmosphere, I watched the camera accelerate forward as you let go, because we were decelerating, the vehicle was decelerating. So you knew you were getting into the—even before your body felt it, you could see objects start to go forward.

And then I was downstairs, but I was able to stick my head up every once in a while before I strapped in and looked out, and you could see the fireball overhead kind of flickering and all. A very impressive experience coming through that, but very smooth and quiet all the way down.

We had tried to land at Cape Canaveral. I think we were about ten minutes from doing the de-orbit burn when they waved us off, because there was a thunderstorm right near the field. And sure enough, the time we would have landed, the thunderstorm was right over the field. The Shuttle won't do well in rain, because it will actually cause the tiles to be damaged, flying through rain. So we didn't do the de-orbit burn, went around one more time, and landed in Edwards Air Force Base instead.

So my family and the bags and everything else were in Cape Canaveral, and we were landing in California, but still it was beautiful. We got on the ground, and, of course, before you

get out—even after a week, I can only imagine what the crews feel like after three or four months up there, but after a week, when you go to get out of our seat, you feel like you're using almost all your strength just to get up. You're used to moving your body around with just your fingertips, and now all of a sudden you have to exert all this force to get up. And, of course, you don't want to fall down the stairs on national television, so we're all in there doing deep knee bends to make sure we get our blood flowing again to go down the steps.

But the whole reentry was very beautiful to watch. It was a very clear, cool morning on the desert when we stepped outside, and the first breath of fresh air when you're in the desert like that is really dramatic. Plus, we were so elated that the mission was a success, after the problem we had.

ROSS-NAZZAL: You told us that you decided you were no longer going to work at NASA. You were going to return to AT&T.

HART: Yes. It was a difficult decision. I had taken a leave of absence from Bell Labs. I told them I'd be gone probably six years, and I figured during that six years I was going to fly two or maybe three missions. Again, in '78, we thought we were one year from the first, and our class would start flying around the sixth mission. So I figured, well, I'll get maybe two, maybe three and then go back. And here it was, at four years I was put on a crew, but I wasn't going to fly until two years later, so I was gone six years.

And it was a difficult time for AT&T, because in 1984, right at the time I was flying this mission, they were breaking up the Bell system. All the local telephone companies were splitting from AT&T. They twisted my arm somewhat and said that "We've never had a leave of

absence beyond four years and you've been gone for six, so if you want to have a career here, you really need to come back."

That all happened maybe six or eight months before I flew my mission. George Abbey had called me in and offered me a second flight. It was a good flight. It was a science mission with the Germans, and would have been interesting, but it was like a three-year preparation to get ready for it. So I went back and I talked to my executive management team at Bell Labs, and was torn for a while, but then I decided I probably should settle down into a real career, because I was always an engineer at heart. I wanted to get back to that, I felt. So I felt a little bit bad not flying a couple more missions, but it would have been quite a bit longer away from my main career.

ROSS-NAZZAL: And what have you been doing with AT&T since you left NASA?

HART: Well, I went back and had a couple of interesting assignments, first with the government side of AT&T, doing some defense projects. One of those led to an assignment in Stockholm, Sweden, for a couple of years. I took my family over there and did some work with the Swedish defense on computer technology that we had been developing at Bell Labs. It was a wonderful experience.

I came back into the AT&T space program then, which was the Telestar satellites. We were just at that time launching the second and third of the Telestar 3 family on the Space Shuttle. So right after I left, they had actually launched those. Then I came back from Stockholm. I went into that part of AT&T and was the Director of Engineering and Operations for the Telestar satellites, and I continued doing that until they decided to sell the business in

1997. At that point I went with the business, and then I became president and am still running the business with LORAL [Skynet].

So it was a nice transition I made, coming back to AT&T. We're doing quite well. We've got about ten Telestar satellites now around the world, and growing the business, and providing a lot of good communication services to broadcasters and data networks.

ROSS-NAZZAL: Well, great. So you still have some connection to the space agency.

HART: Yes, I do. Again, I think the thing that helped me the most was just understanding how valuable it is to build a team of people that are all focused on doing the right job. The satellites we fly today are relatively straightforward compared with the NASA science satellites, but it still requires a lot of diligence and focus to make sure they work right so that our customers, the TV networks and all, have reliable service. So a lot of the things I learned at NASA I apply in my business world, in terms of focus and rigor and running a space operation.

ROSS-NAZZAL: I just have a couple of general questions for you. What do you think was your biggest challenge while working for NASA?

HART: My biggest challenge? Gee, I don't know. I mean, it's all challenging, but there's nothing that is insurmountable, because you know you have so much help. It's not like a thing where you're ever worried about failing or whatever, because there's so much support behind you. So you just need to learn how to take advantage of all that support. So I guess, in a sense, that's the challenge, is to fully integrate yourself with the team at NASA to ensure that you're all

doing what's necessary for the mission. You're all focused on the right thing, and when things go wrong, you can fall back on that and find ways to work around the problems.

ROSS-NAZZAL: On the flip side, what do you think was your most significant accomplishment at NASA?

HART: I guess the most visible thing was the Solar Max capture, and getting the satellite on board. [Laughs] I'm sure George Abbey felt that was—I earned my keep in that ten seconds that I reached over and grabbed the satellite or whatever. But I'd like to think more that I helped a lot with that sense of building the team and all. Within my class and all, I felt good about my relationships with all the other guys in my class, and the gals. We all worked together well. So I always kind of looked upon myself as being a bit of an instigator of teamwork and someone that helped promote those kinds of things, which, you know, that's a very natural thing at NASA.

ROSS-NAZZAL: Would you mind if I asked Sandra if she had any questions for you before we close?

HART: No. Sure.

JOHNSON: I was just curious. You had trouble adapting or acclimating to space that first day. Once you got back on Earth, you mentioned that you did the deep knee bends. Did you have any problems acclimating to Earth?

HART: No, not really. Just the normal ones. You feel just a little tipsy the first day or two. One of the other problems is you tend to dehydrate in space because your body controls the amount of fluid from the pressure in your head. When you're in space, your fluids come up and your head gets kind of puffy, so you end up losing a lot of fluids in the first two or three days, which you don't really replace effectively until you get back. So when you come back, they try to get you to take salt. You're supposed to take salt pills and drink a lot of water before you reenter, to help build the fluids back up again, but I probably didn't do too much of that. I didn't have to fly the Shuttle or land it, so if I passed out, what the heck.

When I got back, though, they do medical testing right away, I noticed. They have you stand up against the wall with your back to the wall, and then they have you tilt back and lean against the wall. I don't know exactly what's going on there, but as soon as I did that, I like almost fell down, because it requires your body to have a reflex. Your veins and arteries have a reflex mechanism which keeps the blood pressure up in your head.

Well, that reflex mechanism relaxes when you're in space, so when you come back, it's like it has to consciously engage again, and it takes some hours for that to happen. So when they put you through this little test, if you haven't had enough fluids, you tend to black out right away, which I did. But you feel fine. And psychologically, of course, you're elated to be back, especially after a good mission. After twenty-four hours, I think you're pretty much totally back to normal, if you have only been up for a week. Obviously, the crews that go up for months at a time require some more time to acclimate back to Earth.

JOHNSON: Did you exercise while you were up?

HART: I don't remember. Maybe I did a little bit, yes. I remember Ox exercising more than I did. I might have a little bit, but I wasn't too worried about falling out of shape in a week up there. I think if I had [been] the pilot or the commander, I probably would have been a little more diligent about it, because they've got to make sure their blood pressure is up when they're trying to land the Shuttle, which I don't think has ever been a problem, because your heart's beating so fast.

I remember the famous quote from John Young. It was during one of the press conferences. I guess at that time they were still wearing the med [medical] harnesses, so NASA was telling the press what John's pulse rate was on launch, which was like ninety or something, which I thought was amazing. But then when John was landing STS-1, his pulse was like 140. And one of the guys asked him why it wasn't any higher than ninety on launch, and he said, "Well, that's as fast as I could make it go that day." [Laughs]

JOHNSON: Thank you.

HART: Good.

ROSS-NAZZAL: Is there anything else you would like to discuss or talk about before we close?

HART: No, I think I got everything. STS-3, a couple things. I was launch CapCom. We lost an APU [Auxiliary Power Unit], which is the first time we had a major failure on launch. The engine continues to run, but it won't throttle, we lost the APU. But we handled that fine.

Between the flight director and myself and the crew, we got the right message up to the crew to shut down that APU, because it had failed. That worked out.

And then there's a great story from STS-3. Jack Lousma was the commander and Gordon Fullerton was the pilot. Gordon had a couple of minutes and he grabbed a Hassleblad camera, and just as he came over New Jersey, he snapped this picture out the window, totally unplanned. This was March of '82, it must have been. It had all of New Jersey and New York and parts of Pennsylvania, where I live, in one picture. There were just a couple of clouds, and a little snow up in the mountains in Pennsylvania. But he had that picture, and he came back and showed me that picture, and I've had about fifteen or sixteen thousand posters made of that picture that Gordo took that day. We've used them for fundraising at Lehigh University [Bethlehem, Pennsylvania] and Rutgers [University, New Brunswick, New Jersey], my two alma maters, that are on the picture there. A lot of good memories like that, kind of special things that, if you're lucky, you're able to take some things with you after you leave NASA and other people can enjoy the experience you've been through.

ROSS-NAZZAL: It sounds like it was a fantastic opportunity for you.

HART: Yes.

ROSS-NAZZAL: We've enjoyed hearing about your stories and we appreciate you coming by.

HART: I guess my voice lasted just long enough.

ROSS-NAZZAL: Well, thanks again. We appreciate it.

[End of interview]



Back to oral history

STS-1
ASCENT CAPCOM
CUE TIE



Go At 40

Go At Throttle Up

Negative Seats

Go For SRB SEP

Evap Is Go

Press For MECO

Negative Return

Go At 5-30

Single Eng Rota

Single Eng
Press For MECO

Go At 8-00

Go For Nominal
OMS 1
and
APU Shutdown

Back to oral history