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EDITED ORAL HISTORY TRANSCRIPT 2

J. MILTON HEFLIN, JR.
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is May 30th, 2017. This interview with Milt Heflin is being conducted at the Johnson Space Center for the JSC Oral History Project. The interviewer is Jennifer Ross-Nazzal, assisted by Sandra Johnson. Thanks again for taking some time. I know you're busy with other things these days.

HEFLIN: Ladies, glad to be here. Yes, I'm not all that busy. My busy today is stuff that there's no schedules typically associated with them.

ROSS-NAZZAL: That's nice to have some flexibility. I thought we'd start with *Challenger* [STS-51L]. I understand you were at the Action Center in Building 30 during the launch. Can you talk to us about that day?

HEFLIN: Sure. I had worked the mission right before that as a flight director. Would that be [STS]-61C?

ROSS-NAZZAL: Yes.

HEFLIN: Yes, 61C, I'm thinking. Jay [H.] Greene was the lead flight director. I think I might have mentioned this last time. He was mentoring me and I was doing a lot of the lead flight

director role, preparing myself to become a lead flight director on that mission. It landed, and this is one of those times where we're trying to fly Shuttles quicker. We launched 10 days later.

If you go all the way back to every manned spaceflight this country has had, I don't think I have missed a single one. A lot of times I listened to it on the radio—when I was at sea on board recovery ships. Since I'm working here, I'm going to be in the control center, if I'm not working during that time.

I went over to the Action Center and sat down just to watch. I had been aware of the cold atmosphere down at the Cape [Canaveral, Florida] during that time. I certainly did not get directly involved with it and wasn't. I wasn't aware at the time that there was this huge issue with the solid rocket booster joint seals and the temperature. I just wasn't. I was sitting there just watching and thinking this is going to be okay.

ROSS-NAZZAL: What are your memories of things as they unfolded during the launch?

HEFLIN: At the time [of the] explosion and seeing that happen, I think the first thing that I noticed—as it turns out the solid rocket boosters themselves were still flying. I think I said something to the effect of, "Oh, there it is, there it goes," knowing this was a disaster, but somehow just probably hoping more than anything that what I saw was actually the Shuttle still ascending where they would be able to get into a position to bail out.

ROSS-NAZZAL: What did you do after you realized the crew hadn't survived and they had to—didn't they detonate the SRBs [solid rocket boosters] at one point?

HEFLIN: I'm not sure. I don't know whether the self-destruction was required or not. I just don't remember that. I started walking the back rooms, the staff support rooms, to all the front room flight controllers. I started going from room to room to support the people, primarily just being a flight director, seeing what they were doing, helping them if I could do anything, as they began to gather data. There were also a number of people that were certainly not in any shape to do anything at that moment. Either that [or] they needed a hug and a pat on the shoulder. I spent quite a lot of time going from room to room and talking to people and trying to help.

ROSS-NAZZAL: What were you involved in those next months as there was a flight hiatus? Nobody was flying anything. What was MOD [Mission Operations Directorate] working on?

HEFLIN: Flight Director Office, Tommy [Thomas W.] Holloway was the chief at the time. It took a while to get there, Jennifer. Eventually we got [to] a point where aside from the investigation, even though we haven't learned everything yet, and we're going to learn more—[we thought about] what should we be thinking of doing to start preparing for getting beyond this and eventually returning back to flight.

We sat down, brainstormed. What sorts of things can we do? One of the things that we're in charge of in the Flight Director Office are mission rules, flight rules. We began a super effort to take every flight rule that we had in the book and ask ourselves, "Is this still a good flight rule?" One of the great spin-offs of thinking about this—we decided, right below the rule, we would write a rationale. We'd write the rationale down as to why that rule the way it was. We didn't have that prior to that. We had the rule, and you knew the background behind the rule, but we decided, "We're going to write it down." That flight rules book turned out to be

excellent in the future; every flight rule in the book had a rationale with it. That obviously helped. Any time you're implementing a rule, you can refresh with the team what the rationale says to do.

Procedures, we broke up into different teams and started looking at all of the onboard procedures. Even finding ways to write rationale behind some of these procedures too. Basically all the tools that we used to fly the Space Shuttle from a checklist standpoint, we scrubbed them completely and ended up when we returned to flight certainly [with] a much better set of documents to guide us.

ROSS-NAZZAL: I'm curious if you could describe how *Challenger* impacted the Flight Director Office in terms of feelings, emotions. MOD has the tough and competent attitude of Gene [Eugene F.] Kranz, and you guys are these steely-eyed engineers. I wonder if it broke through that shell at some point.

HEFLIN: That's a really good question. I'm not sure I'm going to have a really good answer. Personally I don't know that it affected me any other way than the fact that I had lost some friends and associates. Then beyond that it was not in a cold way, but I just want to go find some things that I can get myself buried into and work as much as I can to get by this and do something constructive. There was certainly a big effort to do that.

I certainly don't remember the Office getting into some sort of an environment where it was sad, we're handicapped here, we can't move, we can't do anything. I couldn't sense that at all. Throughout Mission Operations, and I think throughout Engineering at the Johnson Space

Center, people just came together, "Okay, once we get over the initial shock here let's find ways to make this better in the future and learn from it."

Here again we had the Apollo 1 fire and things we shouldn't have done; things we knew. Here we had *Challenger*, which we ended up learning, "Okay, we had things that we shouldn't have done that we did." Eventually we ended up with *Columbia* [STS-107] years later where again we solved things that were going on. Learning a lesson is one thing, but living by what you learned later is sometimes difficult I think.

ROSS-NAZZAL: That's a good point. Were you assigned to the Return to Flight mission?

HEFLIN: Yes. Luck of the draw. I was assigned to STS-26. I really felt good about that. That was a great time, getting ready for it, anticipating it, and getting through that was a good thing. I feel very fortunate to have been associated with the flights that I did. That was a good time.

ROSS-NAZZAL: I understand from the recording we had done earlier, the tour [of Mission Control], that's when the roses started appearing again. Can you talk about that?

HEFLIN: Oh my goodness, the roses. Absolutely. The Shelton family from the Dallas-Fort Worth area, Mark, Terry, and a little girl named MacKenzie. Towards the end of the first flight, Return to Flight, STS-26, two or three days before reentry and landing, roses showed up in the control center. There were five roses of the same color, I want to say red, and then I think there might have been one white rose. I don't remember exactly. But there was a rose for each [crew member in space during the mission]. Roses brought up into the control center, set close to the

flight director console. I think I was the first one to grab the card and read the card. It was from the Shelton family, who of course we didn't know. It said, "Congratulations, Return to Flight." A few other really nice comforting words on the card. That was really cool.

After the flight, I took it upon myself to track these people down. [I] was fortunate to be able to go to the flower company here in the area that brought the flowers. Those were the days I guess where you could find out information like that. We tracked them down in the Dallas-Fort Worth area. I got a phone number and called them and got to talk to them. I learned that they felt really very proud of what had been done and thought so highly of [the space program]. That was it.

This could go on forever, it's a long story, but I'm going to make it short. We sent up some patches and pictures. The next flight that we flew, a couple days before reentry roses showed up again in the control center from the Shelton family. The flight after that, same thing. We invited them to come down. They came down to visit us, and we showed them the Johnson Space Center and the control center.

This went on to STS-135, the last flight; they sent roses to the Mission Control Center, one rose representing each member of the crew. We flew some bigger crews, seven people, and then when Space Station was being flown they even took care of Space Station as well, International Space Station. They'd always show up a couple days before reentry. They did that for over 100 flights.

ROSS-NAZZAL: It's amazing.

HEFLIN: Yes. We got them down for a launch. On their one hundredth flight, I don't remember what STS mission it was, on their one hundredth time to do this, we invited them to come down, and we brought one of the representatives from the flower company. In the viewing room behind the flight control team we presented them with a plaque to take back, and thanked them for all that they had done. I still stay in touch with the family. MacKenzie was three years old when this started, and MacKenzie is married and has a kid now.

ROSS-NAZZAL: Wow! I just think that's such a great story of the impact that NASA has on the public that you don't really see.

HEFLIN: Exactly, they're such good people. He's done a number of interviews with the local media up in the Dallas-Fort Worth area. He's a great spokesperson for the program. It's cool, really cool.

I will say we had some close calls. We've had some roses carried in during reentry of the Shuttle. It's interesting. A day or so before landing the flight control team would start asking, "Where are the roses?"

ROSS-NAZZAL: Were they concerned it would jinx the thing?

HEFLIN: Yes, that's right. We don't want to change this up.

ROSS-NAZZAL: That's funny. I wanted to ask you about several missions. I thought it was interesting how you were assigned to some that involved planetary probes to Venus, to Jupiter, to

the Sun. Was that purposeful? Did you do a lot of work with JPL [Jet Propulsion Lab, Pasadena, California]? Did you just have an interest in planetary missions?

HEFLIN: The first one was Magellan, I think. We sent [the spacecraft] to Venus. That was the first planetary [mission] if I recall. Quite frankly I think what happened was we rotated. We had a handful of flight directors. You didn't work back-to-back flights. You'd get put into the queue.

I'm pretty sure that I got the first planetary just by the rotation and getting into that [routine]. That might have been one of my leads as a lead flight director. Twenty Space Shuttle flights altogether as a flight director, and 7 of the 20 I was the lead. I might have been the lead for Magellan.

I got very close to the folks out at JPL. Got very close to them because they were controlling the spacecraft. I got very close to them in preparation for the very first planetary [flight]. That got me, I guess, into the door. Very fortunately, I did all three planetaries. I'm pretty sure I was lead for all of those flights. I became very very knowledgeable of and very familiar with the team out at JPL, probably one reason why I hung on to that assignment.

ROSS-NAZZAL: I thought it was interesting. How much did you have to know about the payload, the hardware itself? Or did you pretty much focus on the Orbiter and the crew and let JPL handle that aspect?

HEFLIN: We had a set of mission rules, flight rules for the planetaries when they were in our payload bay before we would deploy. We knew what we could do relative to Sun angles and temperatures as far as the planetary [payload] was concerned.

We were responsible for the procedures to deploy it from the Shuttle, of course, and work with the JPL team to have a process to be "go" or "no go" at certain points along the way. Any time you have a payload back there the flight control team that runs the Orbiter needs to know what you can do relative to maneuvers, relative to allowing Sun to get on the payload, allowing cold deep space to be facing the payload, how long you could do it. That's how you got familiar with it.

ROSS-NAZZAL: Did you spend any time doing integrated sims with JPL? Was that possible?

HEFLIN: Oh yes, absolutely. Did quite a few sims with them. I think all the simulations I did with them I was in the control center here. There's been a handful of payloads that we've had where we've sometimes had a representative from the Flight Director Office out at the other control center responsible for the spacecraft that we're going to deploy.

ROSS-NAZZAL: Do you feel like your knowledge of Magellan helped you build on future missions like Galileo and Ulysses?

HEFLIN: Sure. Oh yes, absolutely. Gosh, it's been a while, Jennifer, far as the booster, the rocket that we used with the payload. I don't remember all the specifics. I know we used what

we call IUS, inertial upper stage, which was an Air Force-controlled booster. We used it a lot. I think maybe on all planetaries that we did.

In fact, since you asked that, there was that team out in Sunnyvale, California—the Air Force team and the Boeing team in the back room that supported the booster for the planetary that was riding the booster after we deployed it. We had that team, we had the team at JPL, and then we had of course the team back in Houston.

ROSS-NAZZAL: Did you get a chance to go out to Sunnyvale? I know that the crews do a lot of traveling to learn about payloads.

HEFLIN: Spent a lot of time out at Sunnyvale. It became the Onizuka Air Force Station, I think, at one time. We called it the Blue Cube. There was a three- or four-story building out there, just a blockhouse basically, the Blue Cube, that had been specially built with some hardware to be able to help handle any sort of earthquake that might occur when there were people of course operating inside that thing.

For example, we deployed several tracking and data relay satellites, TDRS satellites. They used the IUS upper stage, so the TDRS was a Goddard Space Flight Center [Greenbelt, Maryland]-controlled relay satellite that we put up in geosynchronous orbit. The Flight Director Office provided what was called the MDR, mission director rep. The TDRS organization had a mission director, but a flight director in Houston would be that person's representative out in Sunnyvale during these missions. So I served as an MDR, mission director rep, four or five times in my career. I would be out in Sunnyvale, California, while somebody is running the team back there, and my responsibility there was to represent the TDRS team out there when it

came to any issues we might have with the booster that we were using or the Shuttle. It provided somebody on the scene out there to look out for the interest of the NASA-provided satellite that we were launching. Does that make sense?

ROSS-NAZZAL: Yes. Did you ever have any challenges with the IUS when you were there?

HEFLIN: Primarily only in simulations. It was really a great booster. It was. It was an interesting process, and it was fun. We had a room, the MDR's room. I'd be in the MDR's room in the chair at the head of the table, and we had maybe eight people or so in that room from various disciplines. We would have a Boeing representative, we would have another subcontractor representative, then we'd have a few Air Force people in there that were representing their team in Sunnyvale.

The MDR, me in particular when I was there, would hold court basically in this room. It was an interesting process, especially in simulations. It was called the Boeing back room. We had a room I just described and then right across the hallway was another room called the Boeing back room. Any time there was an issue with the IUS, that team would get together and come up with their solution as to how they wanted to recommend to me as the MDR, "This is how we want to proceed in light of this issue that we've got." A handful of them would come into the room and stand right there. We'd all be seated. They would present their case, then I would poll the people sitting at the table, and we'd arrive at a decision to say yea or nay. It was just an interesting process because in all this business there are some wonderful characters and people that are not only really really smart but they're really good at what they do when it comes to presenting issues and responses. It was just fun to sit there and listen to these folks and how they

were so good at being very clear in what they wanted to do. Having said this today, I wonder why there are some other places in the world today for example that can't handle business that way in a very professional manner. But it was a good time.

ROSS-NAZZAL: I did not know that. I never heard that before. That's pretty interesting.

HEFLIN: It was a very different job, but it was one that I got a big kick out of. I would occasionally have to get on the phone directly back to Goddard, where the mission director would be located, and talk to him, "Okay, here's what's going on. Hey, this is what I think we ought to do, and I'm okay with this. How do you feel? You okay?" It was a traffic cop job.

ROSS-NAZZAL: But one you were used to, working in MOD.

HEFLIN: Oh yes.

ROSS-NAZZAL: I wanted to ask you about a couple of your DOD [Department of Defense] missions because I noticed that you had a couple of them, STS-44 and [STS]-53.

HEFLIN: Forty-four, what was that, Jennifer?

ROSS-NAZZAL: I didn't write it down.

HEFLIN: That's okay. It may come to me.

ROSS-NAZZAL: I didn't write down 53 either. Just curious what it was like working a classified mission versus all the other high-profile missions that you had worked.

HEFLIN: [They were a] pain in the butt. It was just much more difficult, having to be so careful in handling paperwork and having discussions. They had to be done in a classified manner. It just took more time.

Beyond that it was still the spacecraft and normal issues that you had with an unclassified flight as well. The first one that I worked, I don't remember the mission number. I thought I worked one before 44. A team comes on after launch, and they're going to do whatever they're going to do. I was going to follow that team. I would come in about the time that the crew was getting ready to call it a day after the first day on orbit.

I was told that if they didn't do what they were going to do on the first flight day and it didn't work right, I would be briefed at that time on what is in the payload bay. To this day I still don't know. I had no idea what was back there. But I [was told that I] would be briefed prior to taking the shift there, if it was still there. Except for a handful of folks in the control center, [no one knew.] Well, we had a payload officer. We had a person responsible for the payload. That person clearly knew what was there. I really had no need to know, so a lot of that was done that way. I'm telling you I still to this day don't know what was back there, because when I came in there, the payload bay was empty. It was empty. There wasn't anything back there. So use your imagination.

ROSS-NAZZAL: How did you feel about that, being told that you're on a need-to-know basis?

HEFLIN: I wasn't worried about it. It didn't bother me.

ROSS-NAZZAL: Did you have to do press conferences for any of those missions?

HEFLIN: DOD flights, no. Press conferences, those were a hoot back in those days.

ROSS-NAZZAL: Can you talk about those and the training?

HEFLIN: Sure. My wife gets tired of me saying this every time I see it, but today, Jennifer, every time I see anybody on TV in a blue shirt and a red tie I know they've had the course.

ROSS-NAZZAL: Is that what they told you to wear?

HEFLIN: Absolutely, best color combination is a blue shirt and a red tie. The next time you watch reporters or watch people being interviewed, I want you to see how many times today you see blue shirts and red ties. As a flight director, our class had seven in it, the class of '83. Was it seven? I think it was seven of us. We all went together. In fact, we did it here at the Johnson Space Center. Folks came here, and we had a two- or three-day crash course on media, making presentations, and speaking. That was interesting.

I don't remember all the names, but I became pretty good friends with several of the space beat reporters that would show up here. For the flights that were open, not classified, I really felt obligated to do what I could to help these people do their job, all of us did. We need

allies and they need to be informed, so I always looked at doing any kind of press conference between shifts as an opportunity for me to for one thing brag about what we're doing and show them how good we are.

One man comes to mind now, Bill [William] Harwood, who is still in the business, and lives down at the Cape. I got to know Bill Harwood very close. He followed JPL activities a whole lot. So throughout the planetary missions that I was involved in I became a very good friend and associate with Bill Harwood.

There were some fun times, and there were some awkward times. Probably one of the most awkward times that I had, it was a DOD flight, except that it wasn't classified. Back in the [Strategic] Defense Initiative, this is early on to where the Air Force had this pretty large program of what can we do in space that will help defense. We had an experiment on a flight where we were putting a reflector in the side hatch window. We were going to come over one of the Hawaiian Islands, and on the ground a laser would be aimed at the Orbiter side hatch window to test out this system for whatever purpose this might be used later.

This is back in the day when we didn't have complete communication around the world. We're coming from the west. We're coming over Guam with the Shuttle; we have ground contact through Guam. We give the crew the information they need to put in the computer to have it positioned correctly so whenever it would fly overhead Maui it would be set up perfectly so that the system on the ground could attempt to reflect the laser off of that reflector in the side hatch window.

We gave the information to the crew, and they typed it in the computer. They went LOS, loss of signal. We had about, I don't know, maybe 10 minutes, maybe not that long, before we came up across Hawaii. We're just sitting there. We had AOS Hawaii, acquisition of signal

Hawaii. The crew called down and said, "We don't think this is going to work." Of course the CapCom [Capsule Communicator] asked, "What's the problem?" "Well, the hatch is pointed to deep space. We're not pointed towards the ground."

We're sitting there thinking, me and my team. If we try to maneuver this thing we'd have to use the large reaction control jets. We would use a lot of fuel trying to be able to try this. So we just blew off the experiment and scratched our head and said, "Well, we'll figure this out later." Turns out the computer needed to know the altitude of the laser. They needed that in nautical miles. What is the altitude in nautical miles? Nautical miles is an important piece of information. Somehow or other my team provided them with—it was at an altitude of I want to say 7,000, 8,000 feet. What went in the computer was the numbers; we'll just say 8,000, eight zero zero zero went into the computer, thinking that it should be in feet. The computer treated that as nautical miles, 8,000 nautical miles high. When it came to the maneuver it did what it was told. It rotated around to point the other way. It's a long story. This has to do with the media.

After that had happened I walked over there to Public Affairs over in Building 2. The young lieutenant, the public information officer in the Air Force, was pacing the floor. Boy, he was really nervous, because we blew the experiment. This is a very sensitive thing, a delicate issue, just flying this stuff. He was really really upset, and he wondered how I was going to handle it. I said, "Don't worry about it. I know what I'm going to do. You guys aren't going to look bad at all." He was worried about that. "Don't worry about it. Plus, we're going to reschedule it anyway. We decided we'll just do it the next day. We'll figure out a way to get it done."

I walked into the press conference and sat down. When it came time to talk about that, I said, "As you know we weren't able to get it done. I got some good news and bad news. The bad news of course is the fact that we didn't make it happen. We screwed it up. The good news is that the Orbiter did exactly what we told it to do." That's when I fessed up that we had screwed up the units. We put in 8,000, and it did exactly what it was supposed to do. That broke the ice, and the little lieutenant was perfectly okay after that. We rescheduled it and got it done. That's a long story.

ROSS-NAZZAL: I think it's a great story. I think that those are the kind of things that you dealt with as a flight director. Totally important.

HEFLIN: I had one reporter, Jennifer, [who] wanted to ask me a question, but as he asked it—it went like this. "Milt, I need to ask you about this. Remember back, Milt, on STS umpteenth? You did this, and you were involved in this. You guys did this way. How does that play into what you did this afternoon before you came over here? Because that's interesting."

I can't remember his name. I looked at him, looked, and I said, "Did I work that flight?" I'm serious. I couldn't remember that I did that. Of course that just destroyed his question, and the room broke up too at the very same time. I think that's one reason that I got along with these folks, is because I could have fun with them.

ROSS-NAZZAL: I imagine things changed over the years, starting in the '80s and then as you became chief of the Flight Director Office. The media changed, the type of people you were

working with, but also the format [changed], with the Internet and e-mail and all those things. Was that a challenge for you? Working with the media in very different ways?

HEFLIN: I think yes, in fact we almost completely got away from doing the change of shift briefings we used to do, probably because of what you're saying. There was much more information out there in the fledgling social media. The thing that I think I appreciated a great deal was the space beat reporters around the country. They did this for a long time. You got used to who these people were, and it was not a problem for them to get on the phone and call you. You'd talk to them and help them out any way you could. That never changed, the ones I dealt with were always very professional and just fun to work with.

ROSS-NAZZAL: Before we talk about Hubble I just had one other mission I wanted to talk about just because I thought it was a different mission. That was STS-47, which was a joint U.S.-Japanese flight. I thought that definitely was different at that point, a very international flight.

HEFLIN: Yes, it was. I'm terrible with names, but the Japanese Space Agency sent a young man over here to shadow me, who was training to be a Japanese flight director. If we need his name I can certainly get it. He came over, and we set him up in our Flight Director Office. He basically shadowed me on console and in meetings as the lead flight director. He was learning the business from our side. Nice young man and really very knowledgeable. I've certainly lost track of him, but that was the biggest difference that I saw.

Other than that, any payload that we flew, we had a position called payload officer in Mission Control. Those men and women were really good at—I thought we had a really good

system. Any payload that we flew, whether it was an American payload or an international payload, it was basically all handled the same way as far as getting people from those countries to come over here and sit down and meet with us face to face. It worked out I think very well. The payload officers that we had were very knowledgeable, and just made it easy for the flight director to trust the payload officer, to trust the team that was behind the payload officer, to work with whoever we were flying and get the job done.

ROSS-NAZZAL: I thought we would look at Hubble next. How much had you followed the Hubble fiasco? I don't know what you want to refer to it as—but after they had launched and deployed it they realized that there were some problems with it. It couldn't see very well. How closely were you following that at the time?

HEFLIN: We talked earlier about the planetaries I got hooked into. I did work the deploy flight for Hubble, was that STS-31?

ROSS-NAZZAL: I think so. With Kathy [Kathryn D.] Sullivan and Charlie [Charles F.] Bolden.

HEFLIN: Gosh, [I'm] trying to remember. Bill [William D.] Reeves was the lead flight director for that. So I was one of the other flight directors for the deploy mission. I wasn't on console when we deployed Hubble, but I think I might have followed the deploy team working there.

I already had become somewhat familiar with Hubble as that mission went on. I was really disappointed. I can remember [that]. It almost made me angry, "How did we allow this to

happen?" [We're] talking about a mirror, the guts of a telescope. How in the world did that happen? That was just embarrassing, hugely embarrassing.

ROSS-NAZZAL: Were you following the discussions about how they might fix the telescope?

HEFLIN: Not early on. Today I was trying to think when I got directly involved, and it's not crisp in my mind as to exactly when I did. It was clearly a year, year and a half out before we flew that I was assigned as a lead. I think before crew was assigned and before I was assigned there was already work going on between the Astronaut Office, the payload community here, payload officers in Houston, and the Goddard Space Flight Center, and the folks in Europe who built such things as solar arrays. All the piece parts, all the folks associated with that were already starting to look at what are we going to do.

Early on, there was enough work for a couple of EVAs [Extravehicular Activities], if I'm [remembering correctly]; something like that, not the five EVAs that we ended up with. Early on there were fewer.

The Flight Director Office, until I got assigned to it, we weren't at the point where an assignment needed to be made. That came later. Anything I heard about it was just through what I would hear in the normal tag-ups that we'd have with the Mission Operations organization weekly.

ROSS-NAZZAL: Do you think it was a plum assignment, once that came up, that people were hoping or wishing they might be appointed to?

HEFLIN: Jennifer, I was very fortunate to be assigned to that flight. The people that ended up working that flight, there's no doubt in my mind that there were a lot of other folks that would like to have worked that flight, absolutely yes.

ROSS-NAZZAL: I just wondered if there was competition for that.

HEFLIN: In our Office, the Flight Director Office, again, I don't know why I was picked, I know we were in some rotations. I'm sure it worked out in such a way that I was a candidate. Of course I worked the deploy mission. I already had a little bit of a leg up on Hubble and [working with] the people at Goddard. Thinking back on that time, I would suspect [Brock R.] Randy Stone, [God] rest his soul. [I was] very close to Randy, and Randy [was] the kind of guy, you've heard me mention before, that was in my corner an awful lot. I think he was one that probably helped get me into that assignment.

I don't know. I guess probably one of my better traits, yet it can be a [bad] trait too, is I have a way of getting things done without pissing off people.

ROSS-NAZZAL: That's an important skill to have.

HEFLIN: I know, but almost to a fault. You've got to be able to do things to where you are not considered—especially in that position, you've got to be doing things where you don't want folks to think that you're an easy person to influence to do something that maybe they would prefer. You know what I'm saying.

I had a good rapport with the planetaries and all the people out at JPL, which probably also figured into this to some degree as well. I had a track record of working very closely with many other organizations around the country leading up to that. I wasn't the only one. Most folks in the Office had it too, but I had a potful of that background.

ROSS-NAZZAL: Just going back to the media, NASA was certainly being taken to task over the failure of the Hubble. Did you feel that pressure? That so much was riding on that mission in terms of the Agency?

HEFLIN: What I have here with me, two months before we flew, I got back to my office from some meeting, it was October timeframe; we flew in December. On my desk was this piece of paper. It's a page out of the *Congressional Record*, out of the Senate Appropriations Committee. It's a page, and it just said, "Milt." It had an area where it had a box around it with all this stuff yellowed in on it. To this day I don't know how it got on my desk. I don't know who left it there. To this day I have no idea.

This was back where we had lost Mars Observer. I don't know whether it turned out to be a propulsion system problem that ended up causing it to destroy the spacecraft. I sat down here and read this. "The Committee notes, however, that the failure of the Mars Observer only increases the pressure upon NASA to successfully repair and service the Hubble Space Telescope later this year. Should this mission fail to live up to the promise that Hubble's capabilities will be fully restored as a result of this undertaking, NASA's entire flight program will suffer a substantive and financial setback that will take many years from which to recover."

So I think at that point I thought to myself we're doing something kind of important.

ROSS-NAZZAL: Kind of got the world on your shoulders there.

HEFLIN: We ended up with 14 separate independent reviews over [the years].

ROSS-NAZZAL: Fourteen?

HEFLIN: Fourteen.

ROSS-NAZZAL: Wow.

HEFLIN: Official. By my count we had 18. We had some closer to home here. They were ad hoc, but we had all these reviews.

With this piece of paper, and knowing that, and with all these reviews, I got to the point where I was cocky, because I knew we could do this. Jennifer, when we launched this mission, I was really convinced we're going to do this. I should put it this way, these reviews basically showed that there were people looking over our shoulder that agreed with what we were doing and how we were going about doing it. Early on it was a little rough, the very first one or two of these things that we had. We got to the point where we were just rocking and rolling, and we knew what we were going to be doing. I think this team went into that mission pretty doggone cocky about getting it done.

ROSS-NAZZAL: Did you ever have so much oversight on another mission? Did you ever have any independent reviews?

HEFLIN: Before this time, no. In fact, it's interesting. NASA Headquarters [Washington, DC] decided, the Office of Space Flight, don't recall what it was called back then, but they decided that they wanted to have a hand in this as well, so they assigned Randy [H.] Brinkley, who was new to the Agency, a retired Marine, as the mission director from Headquarters. We had never had a mission director for any mission that we flew, so they decided to have one for this. When I heard that, as the lead flight director, I was not happy. I was not. Didn't know Randy, hadn't met him yet. I just didn't like the idea, "Oh gosh, I'm going to have somebody who's going to be a pseudo flight director looking over my shoulders here." I was not happy.

I'm going to fast-forward. Randy Brinkley did a wonderful job. It related a lot to these review committees. He basically became the go-between between these committees and me and Mission Operations. He did a lot of work so that I wouldn't have to be worried about this stuff. He's going to worry about them, these groups, and do a lot of the behind-the-scenes work to get them information.

ROSS-NAZZAL: That was a nice little buffer so you could focus on the task at hand.

HEFLIN: Yes, but initially I didn't like the idea at all. Since that time I think we've ended up with some other mission directors along the line. I don't recall how many. The independent reviews became, I think, more and more prevalent for some of the missions that we did. It's okay. These are good people that get selected to sit on these things, and they're wanting to help.

They really do want to help. It's an overhead though that does get to be a problem. So we had 14 of these things.

ROSS-NAZZAL: That's like one every month.

HEFLIN: I think 18 counting the other 4 that we had, which were somewhat ad hoc.

ROSS-NAZZAL: I wonder if you could talk about mission planning for this mission, because it seems to me like it would have been very different from all the other flights, just like this mission director.

HEFLIN: Actually, the process that is used for any payload or any job we're going to do is done by having a payload officer in Mission Operations, a crew representative if the crew is not named, to get out early on and find out, "What are we doing? Who are we working with?" just get the lay of the land.

Planning, you have a set of documents, like mission rules. If you're going to deploy something you have deploy procedures. If you're going to repair something, you have repair procedures. Basically there's a template out there. "I'm going to need this this time; I'm going to need this this time." Then you assign people to go start working the procedures and the planning to get it done. You have a series of tag-ups with everybody involved. They go away, work stuff for a while, get back together. It just builds and builds and builds.

For Hubble, we used the talents that we had, the processes that we had used previously to design missions. Got a rendezvous in space with something, you've got to take care of how much fuel you're going to have on board. You've got to do all the same kind of stuff every time.

ROSS-NAZZAL: I thought perhaps it was different given the number of EVAs that you had, and so many different things.

HEFLIN: Initially we were going to do maybe a couple, three EVAs. They're going to be on this day. Take a day off. On this day. That sort of thing. When it ended up being five EVAs we couldn't take a day in between. All the things that we had to get done. That was much different than what we had done, but we adjusted to do what we needed to do.

ROSS-NAZZAL: Would you talk about your relationship with the crew? It's my understanding that as the lead flight director you spent a lot of time working with the commander. [Talk about] your relationship with Dick [Richard O.] Covey and seeing that this would be a successful mission.

HEFLIN: I was closer with this crew than any crew I ever worked with, for obvious reasons I guess. Just the fact that it was Hubble I was much more involved with the payload crew, the EVA crew, than I normally had been for any other flight that had an EVA. Hands-on is not right. I spent more time than I usually do attending their training sessions in the water tank. We did a lot of neutral buoyancy stuff at Marshall [Space Flight Center, Huntsville, Alabama], which had a water tank back in those days and had a mock-up of Hubble, so I spent a lot of time over there.

Of course we didn't have the Neutral Buoyancy Laboratory. We had the WETF [Weightless Environment Test Facility] over in Building 29, [which was] much smaller. Building 9, we had an air-bearing floor where we could do some work with a suited crew. So I spent much more time with this crew observing their training than I had done in the past for anything else I worked on.

Why? I think I just felt like I needed to be much more familiar with all the bits and pieces of this mission. Jennifer, as we approached five EVAs and the work that we had to get done, it dawned on me that boy, there's going to be very little time during the mission to pause and talk about stuff, or go away for a day and try to do something different. We have got to be nimble enough in order to get all this work done. Long answer here. I became very dedicated to knowing the crew, getting a feel for what they're good at. They're good at everything, but what are their strengths, and are there any weaknesses? I didn't find any, but I spent a lot of time trying to understand every task.

What I wanted to do when I got on console with my team during these EVAs, I want[ed] to beat the drum, I want us to get started. We are not going to spend a lot of time talking. We need to just go get the job done. I was hell-bent on starting these EVAs and getting through them in a very very good fashion. That's why I spent more time, I think, with this crew, just to be sure I really had a good grasp for this.

I'll use an example here. There's a tendency in real time when the situation occurs that you're going to apply a mission rule, there's a tendency to want to pause for a little bit. "Let's review the bidding here. Let's talk about this a little bit. Is this the right situation for this or not?"

I wanted to be sure that if we came into a position to where a mission rule applied that we had already discussed and cussed, and everybody agreed too. We signed the book, "This is what we're going to do if that happened to us. [If] it happens to us in real time, we're going to implement that flight rule. We're going to just do it, because if we don't we're going to waste time talking about it." Eventually probably come around to saying, "We ought to be doing this."

We had a solar array. We had a rule that if we could not wind up the solar arrays to be brought back—we had two solar arrays on Hubble—if we couldn't get one of them to completely wrap up, we're going to throw the solar array away. We're going to get rid of it.

That actually happened to us. I remember this very vividly. We were sitting there one evening towards the end of the day. We got one solar array that's all rolled up, and we're going to be able to have it stowed and bring it back. The other one wouldn't roll up. I got to do something that is really great when you're a flight director and you're in charge. I almost immediately made a decision. "Okay, folks, we're going to throw it away tomorrow. It's what the flight rule says. We're not going to spend any more time talking about it. We're not going to plan for anything else. We're going to put the crew to sleep. Tomorrow we're going to get up, and KT [Kathryn C. Thornton] is going to go out there and grab this thing and let go of it." By golly, that's exactly what we ended up doing. We didn't talk about it overnight. There was no replanning. We had the procedures in place. We just did it. I got to the point. That allowed us to keep a pace along the way.

The first EVA that we did, we had trouble closing some doors. I don't know whether you're familiar with that at all. We had some trouble [with the] access doors and getting the doors closed. Story [Musgrave] came up with this really really good idea on how we might be able to get it done. It involved a payload retention device, a strap that was a pretty powerful

thing. You could put it around something and squeeze it. Story and, I think, Jeff [Jeffrey A.] Hoffman were together on the EVA out there, two of them. Basically they needed a third person. They needed somebody else to push on this door at a certain point while the other two were someplace else doing their work. He came up with this idea. This is the first EVA. I'm thinking, "Holy cow. Here we are, we're going to stop doing this. We're going to leave the doors open a little bit overnight. We're going to replan the next day. We're going to get behind; we're not going to get all the work done." The Hubble team was worried about it, because they thought the strap is pretty powerful. Once he ratchets the strap, he could damage the telescope.

I knew Story. I knew exactly what he was wanting to do. The beauty of being the flight director in charge, we talked to the Hubble team, and I tried to reassure them. I was able to reassure them, "Hey, look. This is going to work fine. Let's go get it done right now." They weren't really comfortable [with the idea], but I got to make the decision. I got to tell the crew to go do this. We got it done. Again it was because I was hell-bent that once we started these EVAs we're going to march through these things. We're going to stay on the timeline. If we have problems, we're not going to spend a lot of time talking about what we're going to try to do next, we're going to make a decision and go get it done. It worked.

ROSS-NAZZAL: I wanted to confirm something. Randy Brinkley remembered along these same lines that you really thought it was important to get these EVAs done, so important that you decided that was what you were going to focus on, and you appointed another flight director to handle the vehicle. Can you talk about that decision?

HEFLIN: Yes, I did. Jeff [Jeffrey W.] Bantle was the other flight director in the Office. Jeff ended up being the chief of the Office for a while. In fact, I think I followed him.

This had not been done before and was somewhat awkward in a way. I had decided that we're probably not going to have any difficulties with any Orbiter systems, but if we have anything going on that is important to continue, I felt like I needed help. I don't want to be doing both these things. So I basically assigned myself as the EVA flight director and asked Jeff Bantle to come in and sit on console and be the Orbiter flight director. We'd never done that before.

I'm glad I did that because that allowed me to completely focus on that EVA. As it turns out, I don't remember a single Orbiter issue that was significant enough to be worked. But Jeff, off on another communications loop, would just do the normal housekeeping things that had to go on to make sure the Orbiter systems were buttoned up overnight when the crew went to sleep.

ROSS-NAZZAL: You mentioned Story. I wanted to ask about the frostbite incident. There was some discussion about replacing him on the crew. What are your recollections of that?

HEFLIN: My recollection of that was sitting in his kitchen one evening. We were both almost in tears. I went over to try to comfort him some. I clearly stood up for Story. I wanted us to do everything we could to try to be sure that he would be the guy to do this mission. Story is an incredible human being and very talented. I spent some time in his kitchen. He was worried, and we just spent the evening having a drink or two, and talking about some stuff. I was reassuring him. I said, "I think you need to keep healing, and I'm certainly going to do what I can to be on your side to see if you can get through this."

He had done so much up to that point getting prepared for this, and knowing so much about this telescope. This goes back to what we talked about a little bit earlier, about when he wanted to do this procedure with the strap. Story knew that he had to be careful, and that's the way he went about doing his business. He had a great deal of respect for this machine and didn't want to do anything to harm it in any way at all. That came through on everything that he did.

ROSS-NAZZAL: You had mentioned spending a lot of time out at Marshall and then the WETF, really spending a lot of time with the crew as they were training. I also understand that there were links just as there may have been with JPL—audiovisual links between what was going on at Marshall and the WETF fed into the MOCR [Mission Operations Control Room] at the time. Can you talk about the decision to do that and how that impacted simulations?

HEFLIN: It certainly helped the simulation. Any time the flight control team has the ability to be able to see a little bit of what you're doing while they're talking about it, it's a good thing. That's typically done because in real time we will have certain TV coverage that we'll at times be able to follow the crew. It's a teaching tool also.

You've got folks who can see what is going on. They may not really be able to see this going on during their actual mission. During a session like this where they can observe this, it helps reinforce their knowledge of what the EVA folks are trying to do with respect to all the other things that go on during that time.

ROSS-NAZZAL: Was it very complicated to get those links for Marshall?

HEFLIN: Was it complicated getting those links? I have no idea. I'll tell you what though. The folks in Mission Control that you never see who make all this stuff happen, it's remarkable what they can get done. Talk about a can-do bunch of people. That's interesting that you bring that up, because it's just amazing to me the dedication of the folks that are responsible for simply being sure that the people who are sitting on console running the mission have what they need to do the job. They can do lots of remarkable things.

ROSS-NAZZAL: Yes, it's pretty amazing. One of the other things that I read that was different about this mission was the fact that so many people from management were included simulations, like Jed [Jeremiah W.] Pearson and Joe [Joseph H.] Rothenberg. They got to come down and witness things, participate. Would you talk about that and what your thoughts were as lead flight director, more people, more oversight?

HEFLIN: Gosh, Joe Rothenberg, one of my favorite people of all times. In fact, a couple weeks ago we were exchanging e-mails on some stuff.

ROSS-NAZZAL: Were you?

HEFLIN: Yes. Absolutely. That's different than the review team that comes in. It's completely different. I don't think that I ever thought about the presence of more managers coming in. I never thought about that as being anything that I needed to be concerned about. Probably what I thought back in those days is I'm happy that there are people so interested in this and paying

attention to it. At times when you are a flight director or a flight controller in Mission Control sometimes you're on a stage. You are performing.

I think quite often when you're on a stage and you're performing, it's nice to have an audience and people who care about what you're doing. I always thought that if there are people who are clamoring to come see what we're doing and want to be a part of it, that's a positive thing. That is, compared to a review team. I'm not saying that they're bad. Just that it's a lot different.

I didn't look at Joe Rothenberg being here as somebody [who]'s worried about what's going on. I think he's just wanting to be sure that he understands what's happening, how it's being done, who's doing it, and support them.

ROSS-NAZZAL: Did they provide any valuable input for the mission that you ended up taking and using for that flight?

HEFLIN: I suspect Joe Rothenberg did. If there was something that he wanted to penetrate, he did it in a very crafty way, such that when it's all done, you felt good about what he had just done. I guarantee Joe Rothenberg clearly made contributions to this thing along the way. I just can't be specific about them. He was never one to come in and get in your way.

ROSS-NAZZAL: You mentioned that there was a lot of interest for this mission. It was very well publicized. I think Story wrote in his journal, "At times during the preparation the only peace I could find was in the dental chair." I just thought that was a great quote. I was wondering what your thoughts were. I understand, for instance, there was a press day here at JSC about the

mission. There clearly was a great deal of attention on the flight, and whether or not it was going to be successful.

HEFLIN: Yes, there was. I've already kind of talked about that. To me, I was happy that we got that attention. Just think about sports. Just think about doing something with a crowd that they're cheering you on, and how much that can mean to you as an athlete or as a performer. Any mission that I did where there was interest in what we were doing and people were really wanting to be a part of it and come in, that made me feel good. I was excited about being involved in it as well. I didn't see it as any kind of an issue.

ROSS-NAZZAL: That was a good analogy.

HEFLIN: I played sports in high school. Didn't do it in college. There's periods that I can still remember where I get goose bumps thinking about some of the contests I've been involved in, where we pulled out a victory, and how good that felt, knowing that there were people who were supporting you along the way. This mission was one where by golly—Jennifer, it got to where I think there were 11 things that we were to do. We did a couple more things. We actually did 13.

During the press conferences in between EVAs, I don't remember the exact numbers, but the very first EVA we had maybe three things they were doing. I walked in, I said, "We were three for three today." At the end it was really fun. I got to say, "We were 13 for 11." We crept up on that a little bit because I think maybe the fourth EVA we weren't quite done there. We crossed over at some point to where I would say, "We're not six for six, we're seven for six," or something like that.

ROSS-NAZZAL: Randy Brinkley also said in his interview something that I thought was interesting. Before this mission spacewalking was a novelty. I was curious what your thoughts were, if you would agree with that.

HEFLIN: Even before this mission, when Shuttle was being built, EVA was really really really in the background. Folks weren't excited about EVA. Novelty might not be the word, but I'm not sure I got a better word for it. Randy is probably right about that.

We recognized too that by doing this we were laying some groundwork for what was in the future obviously, building International Space Station. So that was another thought that I know we had. "Hey, if we can do this and we can be very good at it, we can build for the future."

One of the things that I'm most proud of is the fact that we ended up with—this top line up here shows how long we thought it would take before we flew, and this is what we actually took. [Demonstrates] This is where we had trouble closing the doors. [Demonstrates] We had something to do that we hadn't planned to. Here's something that we didn't have any—these right here, we didn't add anything. We thought it would take six hours and 45 minutes, it took six hours and 36 minutes. We thought this would take six and a half hours, it took six hours and 47 minutes. We thought it would take 7:05, we did 6:50. So we were really really very good at what we did.

This, I think, set the feeling here at the Johnson Space Center for spacewalks. We're thinking about building Space Station, so it looks like maybe we know what we're doing and we can go get it done.

ROSS-NAZZAL: Last time we talked, I asked about a speech. Gene [Eugene F.] Kranz has that speech right before the landing on the Moon, "Lock the doors. We've all come together, and whatever happens today, we've done this as a team; I'll support you whatever happens." You mentioned that you gave a speech. I wonder if you want to talk about that, and where that speech fell.

HEFLIN: I'll tell you the story. You're exactly right. I was cognizant of what we were about to get ready to do, very aware of Kranz's speech there before the landing, basically saying, "We came in here as a team, we're going to leave as a team."

I thought in light of what had happened to us with Mars Observer and recognizing and remembering what we got from the Appropriations Committee and their statement, I thought I needed to do something. Before the first EVA I need to do something to get people pumped up a little bit. So I came up with what I was going to do. I was going to tell the CapCom to tell the crew something.

ROSS-NAZZAL: Are these your notes?

HEFLIN: This is what I had written down. This is what I was going to say. We're all set up where the crew is in the air lock, they're getting ready to go, this is the go for the EVA. You're going to be go for EVA.

"CapCom, tell the crew it's now time to not only restore Hubble's vision but to restore the credibility of this Agency. They are go for EVA." That's what it was. Guess what. I

overslept. I got to the control center, can't remember who—I think Bob [Robert E.] Castle was the one right before me. The crew had already mentioned they might get out early. Bob couldn't wait on me. He gave them the go to do the EVA.

ROSS-NAZZAL: Oh, no.

HEFLIN: Yes.

ROSS-NAZZAL: So best-laid plans.

HEFLIN: Didn't work.

ROSS-NAZZAL: Oh, that's disappointing.

HEFLIN: Yes. Didn't work.

ROSS-NAZZAL: I guess that relates to another question. What were your work hours and workdays like when you started working on this mission? Were they any different from other missions? Or were you working extended hours because there was so much that had to be done?

HEFLIN: I was probably working extended hours leading up to the mission. But as the lead flight director, on this one, probably much more. I forgot what the timing was. I can't remember the exact timing. I don't know that I had to do much sleep shifting, not as much as I had done. I

hate sleep shifting, because you never get adjusted for things like this. We don't hang around long enough. I never did get adjusted.

It wasn't a big deal. It is interesting. I actually overslept. I'm sitting here thinking [about] when this happened. I'm driving in, and I knew the crew said they might be getting out early. I thought I probably can still make it, it's going to be close, and I didn't call the console on the phones to see what was going on. I just came on in. I thought to myself later, "How in the hell did I get any sleep in the first place, knowing what was coming up?" I was somewhat exhausted already just before the mission happened.

You probably have another question, but I just ran across something here. Having worked missions as a flight director, I was concerned about the overall Mission Control Center team collectively: engineering, support staff, all of the flight controllers, the whole team. Knowing that environment and what can happen to you in a mission, I felt compelled as the lead flight director to send a note to the entire team. This is before all the computers. I typed up a note, had it duplicated and put in every in-basket, every in-box in the control center for all the team. "This is a note from the lead flight director."

It was called "Tips from the Top." Based upon what I was familiar with in environments like this, there were some things I did not want to happen. I wrote a note, "Rigor, careful routine ops." You can screw up routine ops just by not paying attention. Keep everything within the control center. "Ignore outside requests." The HST Project I encouraged, "Ladies and gentlemen, if you would do as you did in simulations." You were trained in the simulations to do it that way.

One of the things, and this happens in all walks of life, "Don't conduct business in the hallways. Don't conduct business in the hallways. Better is evil of good. Nice things to do are

not. Be careful of downlink TV, especially when you first see Hubble during rendezvous, because shadows can really be deceiving and cause you to think you see something that you don't. Use procedures. If the signature fits, that's whatever you're seeing. Use the procedure. EVA may be early."

ROSS-NAZZAL: Oops.

HEFLIN: I should have paid attention to that one. "Do useful work. Again pay attention to nominal procedures." This is the thing I talked about. This is probably my biggest contribution to the success of this mission. I wanted to establish and keep a rhythm. "Establish and keep a rhythm." I felt like a drumbeater. I felt my job during those EVAs was to get in a rhythm and stay in a rhythm and get it done.

ROSS-NAZZAL: Did you talk at all with the crew then or was that primarily through CapCom?

HEFLIN: None of that went up. None of this went to them.

ROSS-NAZZAL: Not that, but just keeping the rhythm with the crew, were you conversing with them rather than CapCom?

HEFLIN: No, I was not, it was just through CapCom. But you could tell on board they were doing fine.

This is back in the days too—I ran across this. This is before all this wonderful stuff we got these days. This is from Dick Covey. It was typed up on board and sent down by the teleprinter. I don't know if you've ever heard of that goofy thing we used to have, teleprinter.

ROSS-NAZZAL: Yes.

HEFLIN: It was to me from Covey. This is after the EVA. We were all buttoned up, redeployed. It's late in the mission. It's getting close to landing time. He said, "Well, partner, we did it, and damn well at that. Now if I can just land this puppy on a dark night in a couple days, we'll put a wrap on the JSC team's role in restoring Hubble. I know you will probably be willing to hoist a beer for me tonight." Certainly I did. "Let me tell you though that if I had one right now I would be lifting it in the team's name." Isn't that cool?

ROSS-NAZZAL: That's really nice.

HEFLIN: That's really cool. Then he had a little P.S. He said, "P.S., thanks for preserving the day off." Early Shuttle we didn't have anything called a day off, but we began to learn it's a good idea to give the crew some time off occasionally. We must have somehow even found a way to give them a little time off. I don't know how we did that. But he said, "Thanks for preserving the day off. It really means a lot to the whole crew." That was it. That was a nice note from Covey.

ROSS-NAZZAL: Did you have any major challenges during the mission? You mentioned the strap.

HEFLIN: From a Hubble standpoint, the major challenge that we had [was one] I talked about earlier, closing these access doors. My zeal [was] to get those doors closed, so we didn't talk about it the night afterwards and have to replan the EVA. That was the most significant Hubble-related problem that we had. We had two or three other things on Hubble that we discovered that we were able to just come up with a little additional procedure to get fixed. That's why I said we were 13 for 11.

There was nothing on the Orbiter side that hung over our heads. There were always some little bits and pieces here relative to some of the environmental control system procedures or hardware, but things that we had work-arounds that we'd used before. We probably did some of those. There wasn't anything from the Orbiter standpoint that caused us to have a problem like that.

ROSS-NAZZAL: You and other members of the Hubble team ended up winning the Robert Collier Trophy.

HEFLIN: Oh yes.

ROSS-NAZZAL: Will you talk about that?

HEFLIN: What a nice thing. I'm told that that's aviation's highest award. Goes back a long ways. That was really nice that the crew and myself, I think Randy Brinkley might have been on that too. It's a very very nice thing. Got a nice replica of the Collier Trophy that I got to keep, a small one. It's at an air and space museum in Oklahoma City, my home state. It's up there now.

After the mission the European side of this, the folks that built the solar arrays and some of the other hardware, they invited the crew and their wives to come. About an 11-day, 10-day tour going around Europe to the various places that manufactured stuff for Hubble.

Story at the time was single, and Story invited me to take the place of his spouse. No, the crew invited me to attend this with them, this tour, which was really really nice. I bring it up because on this tour I can't remember what country we were in, but I got notified that I had been honored as the Astronaut of the Year.

ROSS-NAZZAL: I was going to ask about that.

HEFLIN: From *Countdown* magazine, which is no longer in business by the way. I was the Astronaut of the Year for my contributions to the Hubble repair. I learned that with the crew, and I had so much fun with that, by the way. I got the certificate somewhere. I think I got it over there as a matter of fact, so I could show it to them at the time, and said, "Look here, guys, hey, I'm Astronaut of the Year and I've never flown in space."

ROSS-NAZZAL: You did a lot for that mission. I know you did. What do you think is the legacy of STS-61, just looking back? So many years have passed. Is there something in particular you would point to?

HEFLIN: The legacy is flying up there right now, International Space Station. I think that's one of the legacies, the fact that we demonstrated that by golly, we can do all these spacewalks, and do this kind of work. EVAs came from the novelty side to the real business side of doing this. I think that's one thing.

Interesting, because we continue to learn that there are some things that we'll do that we probably shouldn't do that will cause problems. We'll never get away from that, I don't think. This was a case where I don't know specifically what I did on the side of people who worry about these wonderful instruments like the James Webb Telescope coming down the line. Hopefully the legacy of Hubble got into the folks who built James Webb and worried about all of that, so they're not going to be surprised in a very bad way like the folks for Hubble were.

I was reminded not too long ago [about] the exchange I had with Joe Rothenberg and a couple of other guys. Here at the Johnson Space Center we have the Shuttle Avionics Integrated Lab, the SAIL. We have this Orbiter on the ground, all the electronic black boxes and computers are all lashed together. We had that for Shuttle.

They built a similar thing for the Hubble Space Telescope at Goddard. They built a similar kind of thing up there. It almost got canceled; it was really difficult to get it done, but they found a way to get the money and get it done. I was a struggle to get it done.

Had they not done that for the Hubble repair job, they would not have learned that they had some fuses on board on that telescope that were not the right size electrically for what they were going to end up doing on the Hubble repair. Had they not discovered that on this ground test article that they had, there's a good chance that once we got all done with what we were doing up there, those fuses would have been blown, and they would have lost some capability

right off the bat. In this business I hope [that] will be something that will actually become a legacy, and that is where you will be sure that you're doing things on the ground that will prevent you not being able to do something with a spacecraft that's on its way to Mars.

ROSS-NAZZAL: Yes, not much you can do.

HEFLIN: That's right.

ROSS-NAZZAL: I think I'm out of questions. Is there anything else that you wanted to talk about about Hubble? Or any other anecdotes, recollections, memories? I'm sure there's a lot. Once you leave you can feel free to add.

HEFLIN: I know.

ROSS-NAZZAL: But if you don't mind, can we scan some of those and attach them?

HEFLIN: I ran out of time. I have a copy of this, you can have that. You sure can.

[End of interview]