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ORAL HISTORY TRANSCRIPT

JEFFREY M. HANLEY
INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is February 3rd, 2016. This oral history session with Jeff Hanley is being conducted in Houston, Texas, for the NASA Johnson Space Center Oral History Project. Interviewer is Rebecca Wright. Mr. Hanley is currently the principal director of human exploration and spaceflight programs with the Aerospace Corporation. Prior to this role he spent more than 30 years working with NASA in the field of human spaceflight exploration. If you would, please start by providing us a brief background how you first became interested in working for NASA.

HANLEY: First, I'm very honored that you guys wanted to talk to me. That's quite a treat.

WRIGHT: It is for us too.

HANLEY: I'm one of those that always knew since he was a kid what he wanted to do, what he wanted to be. "What do you want to be, Johnny?" we get asked. I was literally a child of Apollo. I was born in January of 1961. Alan [B.] Shepard flew just a few months later. President [John F.] Kennedy's speech was May of '61 to Congress announcing the Moon goal. I suppose my first conscious awareness was Apollo 8 in terms of capturing my interest, my awe, remembering the mission, the Christmas Eve lunar orbit reading of Genesis, all of that made a tremendous impression upon me.

I was the youngest of three boys. One of my older brothers had started collecting newspaper headlines about space. I was of course very impressed with my brothers, being a little brother. So I emulated some of what they did, so I started doing the same thing. My older brothers' interest in it waned pretty quickly as they went on to other things, but it just captivated me.

I remember exactly where I was July 20th, 1969. I was at the community pool with my mother. I was eight years old. I remember being in the water, and over the loudspeakers they were announcing that [Neil A.] Armstrong and [Edwin E. "Buzz"] Aldrin had landed on the Moon. I remember that night getting the treat to stay up late when you're eight years old, watching this ghostly image of the Moon walk. When are there moments like that when the whole planet is watching, how often does that happen in our culture today? It left a tremendous impression on an eight-year-old in the ripe age where you're looking for heroes. So that's how I got interested in working for NASA.

Then of course I wanted to be an astronaut. Through grade school and middle school I followed the space program religiously, through the end of Apollo, through the Skylab Program. I clipped out and collected newspaper articles. My grandmother would send me articles. She lived in Florida in those years and she would send me clippings from the *Orlando Sentinel*, news articles from down there, because I grew up in Iowa, and they only carried space news that appeared on the major newswires, whereas it was much more part of the newspaper stuff down in Florida. I got a lot of great material from my grandmother, bless her heart.

It just grew from there, and I wanted to be an astronaut. I became a *Star Trek* [television series] fan. So I followed Captain Kirk. There's another hero in those years. My parents divorced in the late '70s, and I struggled a little bit in high school. I went to college and pursued aerospace engineering at Iowa State University for two and a half years, and then got hired down here by McDonnell Douglas. It was called McDonnell Douglas Technical Services Company.

Just on a lark, I was reading through *Aviation Week and Space Technology*, which I even at that age was religiously scouring for any and all news related to Shuttle development in those years, in the early Shuttle flights. I saw a little ad for either summer interns or co-op [cooperative education] students from colleges, and so I applied, and lo and behold, they actually hired me as a co-op student. So I came down here for a couple of co-op stints.

The second one, I didn't leave, and I transferred schools from Iowa State [University] to University of Houston. I changed majors, ended up getting my bachelor's in electrical engineering from University of Houston, while working for first McDonnell Douglas, then Rockwell Space Operations Company, RSOC, up to 1989. I was working in Mission Operations [Directorate] in the Payloads Branch as basically what was termed a technical aide, which was something lower than a co-op, for about five years while I went to night school and got my bachelor's degree in electrical engineering. So, 1989 was a huge year of change for me because I graduated from college, I got married, I bought a house, and I got hired by NASA, all in a period of about four months.

WRIGHT: We'll just call that a transformational year, wasn't it?

HANLEY: Yes, 1989, yes.

WRIGHT: In the midst of those years that you were there, [the Space Shuttle] *Challenger* [accident, STS-51L] occurred. Did that in any way shape or impact your feeling about whether or not you wanted to continue in this career that you had chosen for yourself?

HANLEY: No. Just fear. Fear that somehow it was going to come to an end, that the accident might cause our national leadership to let it all go. In 1986 I was a college student going to night school, and then during the day I was working in the Payloads Branch. I was basically what was called a back room flight controller. The first mission I ever worked was in '83, Spacelab-1, STS-9. I was a payload data engineer in the payload officer back room in the [Mission] Control Center. Actually I was OJT, on-the-job training, with a gentleman named Keith [K.] Kundel.

Keith had been a longtime Apollo flight controller. His main job during the Apollo years was to command the experiments that the crews left on the lunar surface. He was a tremendous mentoring influence on me. Here I'm this wet behind the ears young college kid and this crusty old flight controller—the day that STS-9 landed, Keith unplugged from the console and retired and went fishing. We never saw him again. I've never had contact with him since, but as an OJT flight controller he let me fly that console during that mission and taught me the ropes.

The first time I ever plugged in over there I was scared to even speak on the voice net. To hear my own voice was the very first thing I had to get used to and overcoming the fear of saying the wrong thing, not using the right jargon. Of course that operation runs on jargon; it runs on acronyms. That whole process of becoming a flight controller for somebody like me, I'm introverted, an introverted thinking type. I had to overcome an inner resistance to putting myself out there and being heard and being seen. That job was tremendously transformational for me in that way.

In those years I was going to night school. We had a product that we produced. It was called a cargo systems manual. For every payload that flew on the Shuttle we produced a manual of the relevant important information about the payload that might be needed during the mission when it flew on the Shuttle. That was what many of us junior engineers were put to work doing, basically editing, collating, putting together, generating material for producing these documents called cargo systems manuals.

They included foldout technical drawings. These would be book-width but three feet long, foldout drawings of every aspect of the payload that mattered for the mission. It's everything from the physical dimensions of the payload, drawings of how all the mechanisms worked, all the electronics. Many of the payloads would be manipulated either by the Shuttle's computers or by switches in the cockpit. We would have to draw out every circuit of every switch and every interface to the Shuttle system. We would draw all those out so that in the mission if something didn't work right we would have all that for reference.

This was actually founded in the days of Apollo. They created these systems handbook drawings for the Apollo spacecraft, whether it's the Command/Service Module or the Lunar Module. We were carrying on a legacy that had been created in the Apollo years. We did that for every payload that ever flew on the Shuttle.

What I loved about it is that it allowed me to use my creative side. I was able to actually do drawings and work out how things worked and then sit down and actually depict them on a piece of paper. That was tremendous fun for me. I relished it. I managed the development of a cargo systems manual for the Hubble Space Telescope. I was able to find some tremendous source material and I wanted to embellish upon it because I knew the Shuttle was going to go back and service the Hubble over and over again. I knew that this product would be long-lived. It wouldn't be used just for one mission and then discarded.

This document ended up being, when it was finished, about two to three inches thick. It had 68 foldout drawings of every major subsystem of the Hubble and the physical configuration. We'd have to do the servicing on the Hubble, so we'd need to know for each of the components that can be serviced how it is attached to the spacecraft, how it is plugged in. I focused on those aspects of the Hubble's design. That was probably some of the most rewarding, just personally gratifying work I ever did.

WRIGHT: A lot of foresight there when you think about all the work that was done on Hubble in the future. You had those preparations already done.

HANLEY: That document, that product, continued to be refined, embellished all through the years in the Hubble servicing up to the last Hubble servicing mission in 2008.

WRIGHT: Not everybody can say something they worked on lasted that long.

HANLEY: My focus area, the thing that I felt like I became an expert in in those years, was the Shuttle's avionic system, its computers and interface devices for the computers and the flow of information, telemetry, electronic commanding to the payloads. The Shuttle had a rich set of various ways payloads could interface with the Shuttle system. I developed over time a really strong broad understanding of all the different ways payloads could interface with the Shuttle so that as payloads started being introduced into the manifest for the Shuttle I could participate and help where I could steer them towards the more operationally effective, more appropriate ways of the payload to be able to communicate with the payload developer through the Shuttle system. That was my whole job as a payload person, to facilitate. Here's the payload hardware in the Shuttle payload bay, and the people that built the payload on the ground. My job was to help them navigate this big huge thing called the Shuttle system to be able to get their mission done.

Sometimes we, the payload controllers, were actually tasked with operating the payload for that customer, and sometimes we just facilitated the customer being able to operate it himself. It varied. Tethered Satellite [System] was a payload that is an example of one that we were asked to actually operate it. That's where I had to develop not just documents and products to understand it but actually all the material required to operate it. All the crew checklists, all the computer screens that would be used to operate the payload. I was a party to the layout of all of that. All of the computer screens on the ground to look at the information on the ground coming from the payload. All of the commanding, the different instructions that electronically could be sent up to the payload from the ground. The procedures for how do you turn the payload on, how do you make it do this, that, and the other thing. Writing all those procedures, that was part of my scope.

Between jobs like doing Hubble servicing missions, doing Tethered Satellite—there was a payload called Wake Shield [Facility] that I had a role on. I was fortunate to be able to basically do all the facets of operations for those payloads that exist. There was this idea of an operations concept. All that is is you have different teams of people on the ground, and how are those different teams going to work together and interact, and what are their roles and responsibilities? An ops [operations] concept in that vein is a way of organizing the efforts of multiple teams toward a common goal or mission.

WRIGHT: You came in and you were mentored by an Apollo seasoned veteran who then left.

HANLEY: But there were many more after that. One of the great blessings of working in that organization all through up until I left was that I had access to some amazing sources of mentoring.

WRIGHT: That's where I'd like for you to share with us. Here you are, you're young, and you were working with those veterans. Then as you started learning more how did you start to acquire more knowledge on the Shuttle? Learning from the Apollo guys, they had traditions. They had experiences that they could have done for operations, but you were using now a new vehicle. These were all new concepts, payloads and the things that you were doing. How did you take the things that they had taught you or shared with you but yet you were exploring and finding new ways of bringing these teams together? If you could talk some about how you melded those two pieces together, moving into that leadership position.

HANLEY: Sure. It was a very exciting period. When I got here during the early days of Shuttle, first time I came down was 1982. That summer of '82 STS-4 flew. This place was just amazingly teeming with activity. It was such an exciting time. In those days every Shuttle flight was closely covered by all the networks. The Public Affairs Building over on site would be just mobbed with press people all over the place, which makes a huge impression on a—what was I then, 1982, I was 21, kid from Iowa.

Very much the Apollo generation was still managing and leading these early flights of the Shuttle. Basically I'm sitting there like a sponge soaking all this up. It's not so much the technical aspects of what they taught as a way of thinking, a way of breaking down something that is very complex into bite size chunks that the human mind can get its mind around. The blessing of being associated with the payloads organization was that I had to learn many different facets of how the Shuttle worked.

Yes, I had to learn all about how payloads can plug into the Shuttle and how they get mounted in the Shuttle. But, I also had to learn how the Shuttle steers itself, the guidance and control and propulsion; how the Shuttle controls itself, the computers, the communication system in the Shuttle; how does that all work, so that I could understand then how the payloads would deal with that.

The other blessing of being in the payloads organization is that it forced me to be a generalist about learning all these different facets of aspects of the Shuttle and the way that it worked, some of which was still being made up at the time that I was in those early years. We were still making it up. The whole concept of satellite servicing didn't come about until the SolarMax [Solar Maximum] mission, which was STS-41C. It was originally STS-14 and then they changed the numbering system, which I didn't understand.

The Apollo generation, it wasn't that just one guy unplugging and going fishing. It was a whole generation of people, and they pretty much stayed with the Shuttle Program until the accident. After 51L, after *Challenger*, there was a tremendous wave of retirements and people leaving the program. I guess that was the first, I think in terms of what I notice now looking back at it, the first step change in the environment in terms of my relationship to the environment. From being this tech aide, lowest of the low on the totem pole guy, to now being somebody that's still pretty low on the totem pole, but not totally inexperienced, because I had worked a couple missions. I was working at a couple of really important things in the meantime, I was being given responsibility. I was enjoying being in that lane there. I didn't have my degree yet at that point. I was still going to night school, so I didn't get my degree until 1989.

WRIGHT: There were few moments of the day you weren't reading or studying something.

HANLEY: Few, right, yes, and commuting up to U of H every night. But when you're young you can do that kind of stuff. You can burn the candle at both ends and maybe unconsciously, but not consciously pay that much of a penalty.

WRIGHT: When this generation started to move its way out, did it change some of the dynamics of where you were working in the sense that it did allow you to have opportunities for more responsibilities?

HANLEY: Yes. To the point where toward the end of the 1980s as I said, NASA hired me in '89. It was specifically because NASA wanted me to move from the back room to the front room. In this particular role contractors could not work in the front room. You could not be a payload officer as a contractor. I had given my support to the payloads group, had been good enough to where I was able to convince my NASA section head to consider hiring me, so they did. Within just a few months I had done enough training to actually work my first mission in Mission Control in the front room.

WRIGHT: You want to talk about that? How exciting that was for you or how terrifying it was, either one or both? Because now you were in the front, not the back.

HANLEY: It's a little of both. By 1990, which was that first flight was in 1990 that I did in the front room, I was part of the team of payload officers for the Hubble deploy mission, STS-31. By then I had already worked on Hubble doing the cargo systems manual as a back room guy. I had worked in the junior role for several years on Hubble before that. One of the things that my section head wanted to hire me for was so that I could work in the front room for the Hubble mission.

I had gone through the whole training process and gotten through certification. Certification is probably the scariest part in that here you are, your certification run, simulation in the Control Center, and you've got your bosses there watching and listening to you. You've got a flight director who's grading you and the flight director is sitting right there at the console next to you. The particular flight director I had grading me that day—I still have his notes because he gave them to me—was a guy that was particularly well voiced at providing his feedback on all the things you did wrong. I had plenty, but I passed certification.

WRIGHT: You must have done something right.

HANLEY: Yes. It all turned out fine, it was a coaching moment. He said I did fine, but then he gave me a laundry list of a dozen things I should probably work on, which I did faithfully. I passed my certification and I was able to work as a payload officer for STS-31, which was the culmination of years of preparation for Hubble deployment.

WRIGHT: Not that all of them are not historic, but this one had a uniqueness with it.

HANLEY: Right. In its own right, yes, and even with the aftermath of the blurred mirror and the recovery of all that, just from a story of Hubble perspective I was blessed to be part of that. But in the histories of human spaceflight, Hubble would play a major role in validating whether or not we could build the [International] Space Station. The first Hubble servicing mission, which flew in December of 1993, right in that timeframe, 1992, '93, there was, as folks might recall, a lot of consternation about Space Station Freedom. Could we actually build Space Station Freedom the way it was being envisioned? The number of spacewalks required to build it was a very large number. That was receiving a lot of attention by congressional people.

As we got closer to the first Hubble servicing mission a lot of management attention got focused on how ambitious the Hubble servicing mission was. It took on an even broader context as a validation that we could do spacewalks day after day after day after day on the Shuttle, to prove that we could actually do that, so that when it comes time to launch the Space Station and build the Space Station using the Shuttle we could actually execute that. Hubble Servicing Mission 1 actually ended up becoming a tremendous validation for the ability to build Space Station.

WRIGHT: What do you feel like you learned at that first mission—it was your first mission and it was of course the deployment of the Hubble—through that whole interaction that you were able then to use later?

HANLEY: There was a lot of technical things I learned. There was a lot of technical things I was able to contribute. But probably the thing that I took away from it that was most important was the relationships within NASA and how to navigate those in a constructive way to build bridges across organizations, across teams, across Centers.

Hubble was built, managed out of Marshall Space Flight Center [Huntsville, Alabama]. It was to be operated by Goddard Space Flight Center [Greenbelt, Maryland]. Of course JSC was going to fly it in the Shuttle. You had these three big Centers, all of whom were very proud of what they do and who they were. There was conflict quite often. One of the lessons learned of one of the early flights that I supported, there was a communications channel through the Shuttle that the Hubble guys intended to use, but it was not very robust in its ability to provide as much contact between the ground and the Hubble as might be needed, particularly if things went wrong. If things went right, it was probably fine. But things usually don't go right, don't go quite the way we think they're going to go the first time we try them. We had never deployed a Hubble Telescope before.

I was sitting in class at school one night, electrical engineering student in my analog circuits class, and listening to my prof and thinking about what I was working on during the day, which was how Hubble was going to communicate through the Shuttle to the ground and do this mission.

I remember the moment. It dawned on me a different way to do it. It was a nonstandard way of doing it. It wasn't one of the "tried-and-true" proven ways of getting the communications through the Shuttle to the ground from the payload. But technically I couldn't figure out any reason why it wouldn't work, and if it did work, it would be a much more robust way for the data to flow from the Hubble through the Shuttle to the ground.

It required two cables about a foot long. They would basically plug into a connector panel inside the cockpit at the right place to basically jumper the data signal from one port to another. It required actually doing a test of it. In order to prove to the Marshall folks that this would work I worked with the Shuttle Program Office people to go do a test in what was called SAIL, Shuttle Avionics Integration Laboratory, in Building 16, where we actually did that. We just took these two jumpers, we took a data tape of Hubble information and played it into the Shuttle system, and we showed that yes, it'll actually work. The data will actually get through to the right places.

I had a devil of a time convincing the Marshall Project Office that this was advantageous to them. Not just for the deploy mission but for future missions. If they had relied on the communication scheme that they originally arrived at—and they used that communication scheme because they didn't want any more interfaces to the Shuttle than they absolutely had to have. It was built around the notion of the Shuttle was going to launch the Hubble and throw it out of the cargo bay on the day of launch until they realized that probably wasn't the right way to do it. They were going to stay in the cargo bay with Hubble until day two, and now they're doing more while in the vicinity of the Shuttle, and they're relying more on the Shuttle's communications.

I finally convinced them that yes, this is a good thing to do. We worked with the Shuttle Program to put these jumper cables in place, and it ended up paying tremendous dividends during the mission because we had difficulties. We went to deploy the Hubble and the solar panels would not roll out like they were supposed to, and we were very close, we had two of the astronauts in the air lock getting their space suits on to go out and crank these things out manually if they had to. That was Bruce McCandless and Kathy [Kathryn D.] Sullivan. If we had relied on that other way of communicating, they would have been out there doing a spacewalk, it turned out needlessly.

This little jumper cable, we ended up calling it the PSP [Payload Signal Processor] bypass. The PSP bypass ended up saving an EVA [extravehicular activity], because we were able to get the information from the Hubble and command it without relying on this other comm system.

This other method of communicating used a steerable antenna in the Shuttle that quite often its view of the relay satellite was blocked by the Shuttle itself. A lot of constraints that went into why that was the case. It was part of what I had to go understand and then explain to not only Shuttle Program management but to the Hubble Project guys. I had to be able to explain, "Look, if you only use this one method of communicating, the timeline for deploying the Hubble is not going to go as fast as it's planned." Subsequent missions, the Hubble servicing missions, we ended up flying it. In fact of course the Goddard guys are wonderful engineers. They actually improved it. They actually embellished it and improved the performance of it.

It was flown on every servicing mission, the PSP bypass, every servicing mission that was flown for the Hubble.

WRIGHT: You use the term you finally were able to convince them. Is there something that you said that finally the light came on that this is what they need to do?

HANLEY: That was the thing I probably learned, how to navigate, and how do I go and work with these other organizations. Here I am. I'm a JSC guy and I'm trying to convince somebody at Marshall Space Flight Center that the plan they've got isn't exactly as good as it could be. It was learning how to go build advocacy, how to go explain, how to go tell the story in a way that [they would say,] "Oh, okay, well, clearly we need to do that."

Of the three parties, whether it was Shuttle Program management or it was Hubble Project or the Hubble folks at Goddard, the Goddard folks probably got it the quickest, because they were the operations people. In operations if you don't have data, what are you doing? You got to have data coming in and the ability to command the spacecraft to have a job. My being an operations person, I had a common perspective with the Goddard team.

The Hubble Project team, who were really more focused on the hardware development and getting Hubble actually built and tested and finished and delivered, didn't have as strong of an affinity toward thinking about things operationally. I had to build a context that they would understand from their hardware development perspective. What I did was basically I came up with a more extreme way of doing it that would have been more of an impact to the Hubble, it actually would have been a hardware change to the Hubble to make it compatible with the Shuttle comm system.

I learned how to triangulate. I used that and said, "Look, we can go this far, but if you just do this patch cable thing you can get the equivalent and we've tested it and it works." Finally was able to get the Marshall team's operations guys understanding and appreciating the efficacy of it.

The thing that I was worried about is that one of the first missions I worked, actually it was the second mission I ever worked, was STS-41G. That was the second flight of the Shuttle Imaging Radar. First flight of that was STS-2. It relied on the same communications device that I wasn't trusting, and it failed during that mission [STS-41G], and was a tremendous impact to the payload. The payload objectives were greatly impacted. This steerable antenna just seized up. It wouldn't point, it wouldn't track in any direction anymore. In fact the 41G crew had to manually stow it so that we wouldn't have to jettison it. When I learned that the Hubble guys were relying on this same steerable antenna and a single failure would take it out, I never felt that was a good choice, when there were other ways to communicate through the Shuttle that were more robust.

In those years, a 20-something kid, I was a bit of a bulldog in getting my teeth into that and just not letting go of it. I felt pretty passionately about it, and then this idea comes to me in the middle of analog circuits class. "Well, OK, I guess that could work." The great thing about working at Johnson in those years was that a young kid has this idea, oh, let's go give it a shot, let's see if it'll work. Blows me away when I think of it now. I was 25, 26, 27.

STS-31-wise, it's making these three Centers work, knitting the team together. That's where I learned a good chunk of my ability to team-build. Probably was a big piece of why I was selected as a flight director later.

WRIGHT: You cut your teeth on an awfully big piece there when you consider what you tackled.

HANLEY: Related to Hubble, you mentioned *Challenger*. I was at the Cape [Canaveral, Florida] that day at a Hubble meeting. So the day that we lost *Challenger* we were only like five months away from launching the Hubble in 1986. I had been at a Ground Operations Working Group meeting that morning. In 1986 I'm 24, 25. I had just turned 25. It was late in the morning, a cold morning obviously.

We adjourned the meeting so that we could all go out and watch the launch. Being the payloads organization, we were connected with the payloads people at Kennedy [Space Center, Florida] and with the VITT [Vehicle Integration Test] Team, which was the crew office's team that basically facilitated the crew's involvement with the payloads and the Shuttle processing. I was able to latch on to one of the VITT team members and follow them up on the roof of the LCC, the Launch Control Complex.

If I'm remembering right, that morning it was the first [Space Shuttle] launch off of Pad [39]B. I had watched a previous launch, 51G I think it was, from the roof of the LCC off of Pad [39]A. One of the big memories of that was looking at Pad A, once the Shuttle engines ignite you lose sight of it, because of the cloud of exhaust, and you don't see it again until it comes up off the pad. A bat out of hell. [STS-]51L that morning, I'm pretty sure that was the first launch off of Pad B. I distinctly remember comparing my memory of the previous launch with what I was seeing that morning and how at ignition the launch pad was cocked in just such a way where you could actually still see the Shuttle completely all the way through the liftoff process. The distinct memory that I've kept through the years.

Off it goes, it's a crystal-clear morning, but it's cold. Then the explosion happens. Tremendous confusion on the roof. "What are we seeing? What are we watching?" On the roof there's these VITT team folks. There's also, as I recall, family members and friends of some of the crew. I remember PAO [Public Affairs Office] saying, "Obviously a major malfunction," over the loudspeaker. There were loudspeakers up there where we could hear the PAO calls. "Obviously a major malfunction."

We're all looking. We're looking, looking, looking. When is the Shuttle going to emerge and head back toward the Shuttle landing strip right there on the property? We keep looking, keep looking. Of course it's nowhere to be seen. Then off in the distance after a few moments you see a sparkling effect in the sky below the airburst. A sparkling effect as the debris was falling into the ocean. We're all stunned. I'm a 25-year-old kid. I don't know what to make of all this.

So all our meetings get canceled that day. I head to the airport, and bawled like a baby. The shock started to wear off. As I was sitting at the gate President [Ronald] Reagan came on [television] to make his statement and it was of course—what a great man. He so captured the moment as a leader. He carried it for us in a lot of ways, gave an acknowledgment of the gravity of what had just happened. If not for him reacting in that way I wonder—it was hard enough for all those school kids who were all watching Christa McAuliffe take off. Almost a perfect storm of impact. You could not have come up with a more damaging way of impacting young kids' impression of the space program, and of the nation in that moment. President Reagan showed what true American leadership should look like in such a moment.

It was the first time I had been confronted with a loss of people I had worked with. Tremendous confusion after that, months of soul searching. We went through this process of dragging out every requirement document that existed on the Shuttle and scouring through it and scrubbing it all, calling everything we did into question. For example before 51L we had the Shuttle flight rules, which was a big thick document of all the different rules governing the different systems of the Shuttle and a priori decisions that would be made under certain conditions. But, we hadn't captured the rationale for each of the rules. Why did each of the rules exist? Where did it come from? What constraint is it tied to? What is the technical basis of the rule?

In the downtime after 51L one of the big big changes in the ops community was every flight rule had to have with it rationale and reference to the source documentation, source material, that was the basis of the rule. We carried that on through the very end, and carried it on into the Space Station Program. The Space Station flight rule book is chock-full of more rationale than rule actually if you went and looked at it.

When you look at the analysis of what happened with 51L, we didn't follow our own rules. We got a little too cavalier with our own rules. There was a rule against launching that day, but somehow the system got, "Okay. Oh well, we'll go anyway. It's so much conservatism in that rule. We don't need to worry about it." Flight rule is probably a whole separate subject in its own right, but the other thing I've seen with flight rules is that flight rules are the beginning of wisdom, not the end.

There was one mission I worked in the last few years of my time in Mission Control. John [P.] Shannon was the flight director for the ascent phase. The computers and electronic boxes in the Shuttle, there were some in the nose up where the crew cabin was, and there were some in the back where the big engines were, the aft avionics bays. These boxes were cooled by liquid cold plates like a little refrigerant thing that would keep the boxes from getting too hot and would carry off the heat that the box generated when it was turned on.

One of these cold plates in the back of the Shuttle developed a low flow condition. It was loss of cooling to the boxes that were on that cold plate. It became apparent during launch phase. The launch went off all right. The Shuttle got to orbit, but then the flight director had to make a decision are we go to stay on orbit and do the mission or should we come home right away. The flight rules are in black and white. They say loss of cooling to those particular boxes, which were critical for landing, if you lose cooling to those you should come home right away, you should not do a normal mission. John Shannon knew that rule backwards and forwards. John was one of the finest ascent/entry people that we've had. He also knew his team, and he knew that you can't just take the rule at face value, you have to interpolate, you have to read between the lines.

He set his team to work on the problem, "Let's go work the problem." While the flow through this particular cooler wasn't what it should be, there was still a trickle of cooling through it, and the flight controllers under his team figured out a way to manage the equipment, to turn it on at just the right time and have it run. They looked at all the analysis, how hot does this thing get when you're coming in for landing, and what happens, and how much conservatism is there in all that analysis, because it's all just analysis. They were able to rationalize that in this particular case they had a plan for entry day to manage that equipment even with this low flow to make a nominal mission possible. I believe it was one of the Hubble servicing missions actually that this happened on. That's what they did.

I can't remember if it was [President Dwight D.] Eisenhower who said, "The plan is nothing, the planning is everything." But somebody famous said it, I believe it was Eisenhower with respect to D-day [June 6, 1944, Allied invasion at Normandy]. But that's what I mean by the rules are the beginning of wisdom, not the end. If you don't have time to go and put your team to work on the problem, if you've got to make a decision right now—and that's part of the art of flight director is the clock. The clock's role in the decision space. If I have time I'll go work the problem to see if I can rationalize why I don't have to blindly follow this rule.

That's what didn't happen on the morning of 51L. There weren't enough people when it was suggested that we blow past the flight rule on the temperatures of the boosters. Nobody stood up and said, "Have we worked the problem? What basis do we have to proceed and not adhere to this constraint?" There was none. It was engineering judgment on the part of people who were incentivized to launch that day. If not NASA's darkest hour, right up there with one or two top ones.

WRIGHT: During that time period before the nation returned to flight, as you mentioned you scoured things, you looked at things.

HANLEY: Thirty-three months.

WRIGHT: In the meantime though were you still working on your Hubble missions?

HANLEY: Yes.

WRIGHT: Before that gap you only had 5 months [before launch] and now you have 33 plus months.

HANLEY: NASA put that time to good use on the Hubble. Since Hubble was going to be on the ground for another three or four years basically in a clean room in California, NASA did invest a little bit more in making the Hubble more serviceable, doing labeling, and making sure that the right kind of electrical connectors that could be manipulated by a gloved hands, all the serviceability features were added to the Hubble design in the interim. NASA made good use of that time. Hubble was basically done in January of 1986. It was about to be shipped to the Cape when the accident happened.

WRIGHT: Where were you during the [STS-31] mission? Were you able to work during the deployment? Or were you off at school or part of the whole deployment effort?

HANLEY: I was a payload officer in Mission Control during the mission.

WRIGHT: So you were able to stay during the whole mission and not just parts.

HANLEY: I worked the whole mission, yes. When there were missions or sims [simulations] to do, if it interfered with classes, I just didn't go to class. By the deploy mission I had my degree, because they wouldn't let me be payload officer if I was a contractor.

WRIGHT: Talk about the whole feeling of being able to be there and see your work actually move into history. It had other aspects of this is the farthest the Shuttle had ever gone. You worked problems through.

HANLEY: It was one of the highest altitude flights that the Shuttle did. It was well over 300 nautical miles, about 330 as I recall. You could actually see the curvature of the Earth, which was very impressive. Doing the mission, having it work out as well as it did, was certainly gratifying. Our team was blessed with the honor of hanging the mission plaque in Mission Control. That's the epitome of honor in the flight control world.

Then in the weeks and months after the first images that came from the Hubble, the disappointment that the mirror was flawed. That disappointment lingered for a few months, but it quickly turned to, "How do we fix it." We knew we could go back, we knew we were going to go back, and how do we fix it.

This was April 1990 and we spent the next three years essentially, two and a half years, putting together the first Hubble servicing mission. The servicing mission's content, the objectives for Hubble, were significant enough. Fix the flaw, put in corrective optics to fix the flaw in the mirror, switch out one of the cameras, service a couple of boxes that had had infant mortality problems and had failed early in the mission, and swap out solar panels.

Another problem that cropped up in the months after deployment, as the Hubble flight controllers monitored the performance of the Hubble across the orbit, was that the solar panels had an odd response to the change between daylight and night. When it would transition from daylight into night the solar panels would waggle a little bit from the relief of thermal stresses. It goes from very hot to very cold. The waggling of the solar panels was a very subtle thing, but when you're talking about a device like the Hubble that has to point so precisely to see the things that it's intended to see, the slightest little disturbance is a big deal.

They planned around it. They still had an observation program going on, taking astronomical images well before the optics were corrected. They were still doing science with the Hubble to the extent they could. They planned around this day-night transition so that they didn't get these disturbances while they were taking pictures. But, a key objective of the first servicing mission was to replace the solar panels with new ones that didn't waggle.

What complicated things were the solar panels were a contribution of the European Space Agency. You had an international aspect to this thing that's not working quite right and it's got this impact on the rest of the observatory. The new solar panels had a mitigation feature to keep this waggle from happening. In that one mission we solved the waggle problem, we corrected the optics to get the prescription of the mirror to what it should be, and we dramatically improved the longevity of several other critical systems.

We did that across four or five spacewalks. I can't remember if it was four or five. The missions blend together by now. Of course that included jettisoning, throwing overboard, one of the solar panels, because it wouldn't roll up. This meanders, but when we got there, one of the solar panels was folded over on itself. One of its little structural members had given way. As the Shuttle was approaching—Jeff [Jeffrey A.] Hoffman was the crew member—he calls down with this bad news that one of the solar panels is bent, which was a product of this waggling problem. It was to the extreme of it actually compromised the structure of the solar panel.

Once we got the Hubble on board, I think it was the second EVA we did, we jettisoned that solar panel, which was a contingency we'd planned for, we'd trained for, but we never really thought we'd ever have to really do that. It was a dicey maneuver. The solar panel wouldn't roll up, so we had to get rid of it, because it needed to be rolled up in order for us to bring it home.

I worked at least four missions where Jeff Hoffman was a crew member, and on all four of the missions I ended up getting bad news on the payload by Jeff Hoffman calling to the ground, "We got a problem here." Two of the Hubble servicing missions and the two Tethered Satellite missions. Of course Tethered Satellite had problems on both missions that it flew. It was an Italian satellite, it was about the size of this table, so it was about I'd say four feet in diameter maybe, maybe a bit bigger. It was essentially a ball with nitrogen jets to help steer it a little bit, and it was on the end of a 12-mile-long tether that got spooled out from the cargo bay. The spool was down on a pallet in the cargo bay.

On the first mission we had a difficulty getting it deployed for one thing, it took several tries to actually start to deploy the Tethered Satellite. This is another mission where we were actually operators, we had the Marshall Project Office and engineering experts that had developed the hardware. They were part of the team. The Italian Space Agency people and their prime contractor, Alenia Spazio, were part of the team, so we had Italians. We had a whole science team that was going to basically execute all the science readings on the whole mission.

The mission was to roll out this 12-mile-long tether. It had a copper conductor down the center of it. When you pass a wire through a magnetic field you get an electric potential, that's a very basic fundamental physics thing. Take a wire, pass it through a magnetic field, it will generate a voltage.

In this case the magnetic field is the Earth's magnetic field. Using the Earth like a big bar magnet, and have this 12-mile-long piece of wire, we generated 3,000 volts of electricity. The concept was this was a way to generate electricity, just using this very long wire and at orbital velocity having it go through the Earth's magnetic field, you could actually generate power with it. That was the experiment. But just the concept of rolling out a 12-mile-long piece of wire with a satellite on the end of it from the Shuttle cargo bay in itself was tremendously difficult.

The first mission, we roll it out. It gets out 256 meters, and the spool at the bottom jams. It jammed for a silly reason. There was a hardware modification made at the Cape four months before launch that was not well documented. The hardware modification ended up creating interference with the little device—if you have a fishing reel, there's a little mechanism that goes back and forth along the spool to help the fishing line evenly wind and unwind off the spool and onto the spool, it's called a level-wind mechanism. That little mechanism jammed, so we only got 256 meters of a 20-kilometer tether deployed.

It was probably my longest shift I ever worked in Mission Control; it was an 18-hour shift, but we worked the problem. We worked through a way of essentially using manual control of the spool to reel it back in, latch down the satellite, bring it home. We bring it home. The mission for that payload was essentially a failure. After the mission there was a big investigation. What happened? They figure out what happened with this level-wind mechanism and this late change that got made that wasn't well documented.

About four years later, here we are, we're going to do it again. The first mission was in '92, so the second mission was in 1996. Again Jeff Hoffman calls down. This time we get the satellite deployed out to 19 kilometers, almost fully deployed, but then a short circuit. Now it's got almost 3,000 volts across it, and a short circuit down inside the spool and winding mechanism down in the payload bay. There was an arc and a short. It burned through the tether and the tether broke.

Away flies the tether and the satellite. Again Jeff Hoffman is calling down. The tether has broken and the satellite is flying away. Now I had just been talking to my flight director, Chuck [Charles W.] Shaw. The deployment up to that point was working perfectly. Everything was by the numbers. It was just beautiful, finally after four years, and trying it again, this thing is actually working and we're getting the reports from the science team, "It's generating all this voltage, we're seeing all this great current down the tether." The science guys are just atwitter with all the science data they're getting. Then boom, Jeff Hoffman, the tether is broken and the satellite is flying away.

That was the third time actually I got bad news from Jeff Hoffman. The bent solar panel on Hubble deploy, the tether jamming on the first tether mission, and the tether breaking on the second tether mission.

The fourth one was the second servicing mission of Hubble Telescope. The crew started to depress. They got in their space suits. They got in the air lock and they closed the hatch to the air lock and they started to depress the air lock, to vent out the air so they could open the hatch and go outside.

If you remember the picture, Hubble is sitting in the cargo bay on its platform and the solar panels on each side of it. This was STS-82. The way that we were venting the air lock, basically the expulsion of the air from the air lock basically blew the solar panels like a windmill and they just sat there and turned, and totally shocked everybody. Now we got all worried about how we were stressing them, because they were fragile. Of course it's Jeff Hoffman on the comm again giving us the bad news that the solar panels are basically windmilling. We had to come up with a way of ever so slowly venting the air lock, letting the air out very slowly so that we didn't do any harm.

Every time I see Jeff I have a good time.

WRIGHT: Did you moan every time you saw his name on a list?

HANLEY: We worked many missions together. I so enjoyed working with Jeff on all those missions and every other way I ever worked with him. It just seemed like we were both present when stuff like that happened.

WRIGHT: I have to think that between the two of you you felt that if at least you were on the team together you could figure out the problems, and figure out the resolutions to them.

HANLEY: That was the hallmark of those payload years for me. There were a couple other times I was on console as a payloads guy where things didn't go quite right. On STS-57, it was the first flight of the SPACEHAB. During ascent there was a problem with the payload bay vent doors, the doors on the side of the payload bay that would open and close to equalize pressure. As the Shuttle launched the doors would be open so that the air could escape from the cargo bay. There wouldn't be a pressure differential. They're motorized, and one of the vents had a problem of some kind.

Of course I'm watching over SPACEHAB. That's my job, to watch over the payload. We get into the first night. I'm pretty sure I was working the night shift. The crew was asleep. The team, the MMACS [Mechanical, Maintenance, Arm, and Crew Systems] officer and the INCO [Instrumentation and Communications Officer], were working under the flight director's direction at the time. They were working on troubleshooting this vent door problem that required sending commands. There was only one position in the Shuttle team that sent commands to the vehicle, and that was the INCO. The MMACS officer was the guy that owned the vent doors. So they had to work together to get some commanding done to exercise these vent doors and get the proper indications that they needed to get.

In the process of commanding there was a mistake made and the electrical buses that powered the motors of the vent doors, they're AC [alternating current], like comes out of your wall, AC current buses. They got shorted together, and they tripped the circuit protection, the circuit breakers if you will. Unfortunately the same AC buses were supplying power to my SPACEHAB. All the lights and equipment got shut off that was on the AC bus going to the SPACEHAB. So anything that was AC-powered got shut down.

In Mission Control they keep computer fault messages up on the big board, so the whole team sees any of the faults that the computer senses. It logs them up on the computer screen in big bold letters. Up scrolls a dozen payload problem messages. The controller that looked over the electrical system sat right next to me in the Control Center in those days. This was in the old Control Center in Flight Control Room #1. That's now the ISS Control Room, but we used it for nonclassified Shuttle missions in those years. I'm sitting next to the EECOM [Emergency, Environmentals, and Consumables Management], who's the position that owns the Shuttle's electrical system.

We just look at each other—his name is Quinn [L.] Carelock, and we grin about it to this day when we sit and reminisce—we just look at each other and say, "What the heck is going on? Do you know what happened?" Out come the procedures. Of course we've planned for what if this happens, what if that happens. We have malfunction procedures all over the place, we got all the documents out, those big foldout drawings I told you about, so those come out. We start trying to figure out what the heck, all these messages, what just happened. We worked the procedures. We worked the problem. We slowly recover and get the SPACEHAB back to operation again.

That was one heart-stopping moment. Another one was the last one I'll share with you before we break. On STS-49 we retrieved the Intelsat satellite. We brought up in the cargo bay with us a new kick motor, solid rocket motor sitting in the back of the cargo bay on a truss. The mission was go get the satellite, retrieve it, put it on top of the new kick motor, and punch it out again and send the satellite on its way to geosynchronous orbit so that it could do its mission. It was a satellite that had been stranded in low-Earth orbit because of a booster failure.

That's the same mission folks might recall, same mission we ended up having to do a three-person EVA to actually grab the satellite, the only three-person EVA ever done in the NASA program since the '60s. We've lived through all that. It's the day to actually kick it out of the cargo bay and send it on its way. That happens on my shift. I get to be the one to actually be there for the deployment.

We come up to time to deploy, because there's an automatic timer on the kick motor, so you want to kick it out at just the right time. The crew throws a switch. There's a series of three switches, they're called prearm, arm, and fire, because it's a pyrotechnic device that blows, and then the mechanism goes. There's an A side and a B side. We always have redundancy, particularly for critical things like this. We have redundancy, so we have an A side and a B side, it's all wired to a switch panel in the cockpit. The crew follows the procedure, prearm, arm, fire on the A side. Nothing happens, silence, nothing happens.

Oh, nuts. I turn around to my flight director and I say, "Flight, clearly we've got some kind of issue with the A side, so let's go to the B side." There's an alternate piece of the procedure. They go to that part of the procedure. B side, prearm, arm, fire. Nothing happens.

In the configuration the system is in, you can't come home that way, because the whole stack is sitting above the line of the cargo bay doors. You can't close the doors with the satellite mounted to the top of this booster. Either we'd have to get rid of the satellite again manually by EVA or jettison the whole assembly, open the latches that latched it into the cargo bay and throw the whole thing away including the cradle that the thing sat on.

Out come the procedures. We got the foldout drawings out. We're working the problem; we're talking to the right people. I hear in my headset a voice—I later learn it was a guy named Don [Donald S.] Noah who was one of the Shuttle Integration Program Office people. Real great guy. "Try A arm and B fire." There's nothing in the preflight documentation that was used to prepare for the mission that suggested that'll ever work, but we've tried A side and we've tried B side and we didn't get anything. So what can we lose?

I turn to my flight director and I explain to him I'm getting this input from the MER [Mission Evaluation Room]. "Let's give a try to A arm B fire." They radio it up. I think it was Kathy [Kathryn C.] Thornton that was doing the procedure, and she does that A arm B fire. Boom, it deploys. Such relief at that point.

Those are some examples of things that didn't go quite as planned. You get used to that, particularly the first time we do things it generally will not go like you think it will. These are highly complex things. We were systematic in the way we prepared, thinking about contingencies and writing malfunction procedures and flight rules and if this happens we'll do this and if that happens we'll do that. That's very purposeful because it's a way of thinking. It's a way of treating the subject matter to really get, not just the individual, but the group able to work together through a difficult problem.

That's why the plan is nothing, planning is everything. Our plan did not include jettisoning a solar array on the Hubble servicing mission. That wasn't in our plan. But we did talk about if that happens, here's what we'll do, we'll do this, this, and this. We would have counted that as very low likelihood that it would occur before the mission. Sure enough, it happened.

WRIGHT: Thank you. We can stop now and pick up and go again whenever you have time in your schedule. So thank you, appreciate it.

[End of interview]