



The Museum of Flight Oral History Collection

The Museum of Flight
Seattle, Washington

Wendy Lawrence

Interviewed by: Bruce Florsheim

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Abstract:

Astronaut Wendy Lawrence is interviewed about her military service and spaceflight career during the 1980s, 1990s, and early 2000s. She describes key assignments from her U.S. Navy service, such as her time as a helicopter pilot and her time as a physics instructor at the Naval Academy. She then discusses her experiences as a mission specialist with NASA's Space Shuttle program and shares details about her four spaceflight missions: STS-67, STS-86, STS-91, and STS-114. Topics discussed include her service history, her training and career as an astronaut, spaceflight mission objectives and logistics, her STEM and higher education advocacy, and her thoughts on the future of human spaceflight.

Biography:

Wendy Lawrence is a retired United States Navy pilot and a former NASA astronaut. She was born on July 2, 1959 at the naval hospital at Naval Air Station Jacksonville, Florida. Her father, Vice Admiral William P. Lawrence, was a naval aviator and a finalist for the Mercury space program. Her mother, Anne Lawrence, was a preschool teacher.

As a child, Lawrence was inspired by the Apollo 11 Moon landing to pursue a career as an astronaut. In 1977, a year after Congress authorized the admission of women to the service academies, Lawrence entered the Naval Academy at Annapolis, Maryland. She graduated in 1981 with a bachelor's degree in ocean engineering. She earned her naval aviator designation in 1982 and afterwards served with Helicopter Combat Support Squadron 6 (HC-6) in the Indian Ocean. In 1988, she earned a Master of Science in ocean engineering from the Massachusetts Institute of Technology (MIT) and the Woods Hole Oceanographic Institution (WHOI). Her next assignment was with Helicopter Anti-Submarine Squadron Light 30 (HSL-30), where she served as officer-in-charge of Detachment ALFA. As a Boeing-Vertol H-46 pilot, she provided logistical support for oceanographic surveying. In 1990, Lawrence returned to the Naval Academy as an instructor, teaching physics, leadership, and underwater acoustics. She also coached the novice women's crew team.

In 1992, Lawrence was selected by NASA as an astronaut candidate (ASCAN). After undergoing training at the Johnson Space Center in Texas, she embarked on her first space mission, STS-67 (March 2-18, 1995), aboard the Space Shuttle *Endeavour*. Afterwards, she served as Director of Operations for NASA at the Gagarin Cosmonaut Training Center in Star City, Russia as part of the Shuttle-Mir program. In 1997, she participated in STS-86 (September 25-October 6, 1997), a docking mission between the Space Shuttle *Atlantis* and the *Mir* space station. The following year, she served aboard the Space Shuttle *Discovery* during STS-91 (June 2-12, 1998), another Shuttle-Mir docking mission and the final mission for NASA's Phase I preparations for the International Space Station. During this mission, the Shuttle crew delivered the Alpha Magnetic Spectrometer, a module used to measure antimatter.

From July 26 to August 9, 2005, Lawrence participated in her fourth and final spaceflight mission, STS-114, again serving aboard the *Discovery*. The first spaceflight mission following the *Columbia* disaster in February 2003, STS-114's primary mission objective was to test and evaluate new safety procedures for the Space Shuttle. During this mission, Lawrence had the opportunity to serve under Commander Eileen Collins, who had made history in 1999 as the first female shuttle commander.

Lawrence retired from NASA in 2006, with a cumulative total of over 1,200 hours spent in space. She continues to be strong advocate of STEM education, particularly for young women, and works part-time at Space Camp and the Kennedy Space Center Visitor Complex. She also serves on the University of Washington Bothell Advisory Board.

Biographical information derived from interview, from additional information provided by interviewee, and from online sources.

National Air and Space Administration. "STS-86 Biographies." NASA History. Accessed December 19, 2019. <https://history.nasa.gov/SP-4225/documentation/mission-summaries/sts86/biographies/biographies.htm#lawrence>.

University of Washington Bothell. "University of Washington Bothell Advisory Board: 2019-20 Members." Accessed December 19, 2019. <https://www.uwb.edu/chancellor/advisoryboard>.

Interviewer:

Bruce Florsheim worked for The Boeing Company for over four decades, from 1967 to 2008. At the time of his retirement, he was Vice President of Program Management Operations for Boeing Commercial Airplanes. As of 2019, Florsheim is a member of The Museum of Flight Docent Corps and has served as the Docent Leadership Committee (DLC) Chair and DLC Chair Emeritus.

Restrictions:

Permission to publish material from The Museum of Flight Oral History Program must be obtained from The Museum of Flight Archives.

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Wendy Lawrence

[START OF INTERVIEW]

00:00:00

[Introduction and personal background]

BRUCE FLORSHEIM: Welcome to The Museum of Flight Oral History Program. I'm Bruce Florsheim, and this is the 30th of June 2017. And we're at The Museum of Flight in Seattle. I'm with Captain Wendy Lawrence, and I'm going to be talking to Captain Lawrence about her experiences as an astronaut, an aviator, and as an advocate for STEM education. First, just for the record, I'd like to have you tell us your full name, where you were born, and where did you grow up.

WENDY LAWRENCE: Wendy Lawrence, born at the old Naval Hospital at NAS Jacksonville. And where did I grow up? Wherever my dad was stationed.

BF: What were your parents' names and what did they do?

WL: My dad, as you might have guessed, was also in the Navy. His name was William Lawrence. And my mother, Anne, was a Navy Junior, so I get it on both sides of the family. And she was a preschool teacher and actually ran her own preschool for—and did that career for 40-some years.

00:01:15

[Childhood aspirations]

BF: All right. I want to talk a little bit about the power of a dream. What was your childhood dream? When did it start?

WL: [laughter] My story is not going to be unique when you consider my age. You talk to NASA engineers and scientists, and especially astronauts who are around my age, for us, it was all about the Apollo program. We weren't quite old enough to remember Mercury and even Gemini, but the early parts of the Apollo program caught our attention. But it was really the Apollo 11 mission. So I have a very fond spot in my heart for the entire Apollo 11 crew. I can't tell you what it was about watching Neil Armstrong and Buzz Aldrin go out for the first time and take those incredibly historic steps on the surface of the Moon, but again, like a lot of astronauts around my age, we were hooked, eyes riveted on the screen, and that's when the dream began.

BF: All right. What did you start doing to make that dream come true? Where did you go to school? What did you study?

WL: Well, as a ten-year-old, nothing, you know. [laughter] Because you really don't think about what's required at that age. But I had a little bit of a benefit, I guess you could say, because my dad, being a naval aviator, also a Navy test pilot, somebody who had flown with Alan Shepard in his first squadron and then was a test pilot with Alan Shepard and John Glenn, he was involved in the selection process for the first group of astronauts. Didn't make it due to a small medical problem, but I got to benefit from his 20/20 hindsight, I guess you could say. His advice to me was actually pretty simple. Profound, but really quite basic. He said, "Why don't you look at what the first several groups of astronauts did before they got selected by NASA and try and follow in their footsteps?"

Well, they'd all gone to college. Many of them had studied engineering. Many had been in the military and been pilots. And so my senior year of high school was the first year that women were accepted at the service academies. And so again, getting it on both sides of the family—and my mother's father graduated from there in 1930, Navy pilot. My dad was a 1951 grad. I decided to put my application in, and so I entered the Academy in the summer of 1977.

00:03:51

[Early aviation memories]

BF: After graduating from the Academy, you became a naval aviator. What's your earliest memory of airplanes, seeing them, and as a passenger flying on them?

WL: My most prominent memory was an airshow at Miramar. And I would say that I probably wasn't even ten years old. It probably was when we first moved out to California in maybe '66 or 1967, back when the Blue Angels were in F-4s, which is what my dad was flying. And I got to sit in the cockpit of one of the F-4s. And there's an old Polaroid picture somewhere at home of me in that cockpit. But watching the Blue Angels do that show in the F-4s was dazzling. So that's probably one of my first prominent memories.

And then when I was in high school—I think again it was my senior year—my dad's back-seater from his cruises in Vietnam had his own private plane, and he took me up for a flight one day. And I really liked being able to look out the window and look down at the ground. So growing up in that environment, it was pretty logical for me to also want to be a pilot. I did break family tradition in that I decided to fly helicopters.

00:05:17

[Experiences as a helicopter pilot]

BF: You were one of the first female helicopter pilots to make a long deployment in the Indian Ocean and then assigned to a helicopter in a submarine squadron. What was a typical anti-sub mission for you?

WL: Don't know. Never did one.

BF: You didn't?

WL: No, because that squadron, HSL-30, had a detachment ALFA. There was also a squadron—a sister squadron at North Island on the West Coast that had a detachment Bravo. And our job was to go out on USNS ships to do oceanographic surveying. Back in the days where there was the Defense Mapping Agency, you literally had to put small boats in the water with side-scan sonars to update all your coastal charts. Well, in order for them to get all their equipment to the beach, you needed to have a helicopter detachment on board the oceanographic surveying ships. So that was the role of both HSL-30 and HSL-31. They were the flight-readiness squadrons for the H-2, but they had—each had one specially designed H-2 carryover from the Vietnam War that was a cargo—basically a cargo model of the H-2. So I never did ASW. I was—I continued my days as—when I was an H-46 pilot doing logistics support.

BF: Did your helicopter skills help you when you became an astronaut?

WL: I think just—yes, very much so, being a pilot, particularly being a helicopter pilot, when you're one of probably four people on board. But you get the same skills just serving in the Navy, where you're part of a team that is tasked with a mission that needs to be accomplished, and you have to start that accomplishment process by first planning the mission and figuring out how you're going to do that, thinking about what might go wrong and what plan you're going to have in case you encounter that situation. How are you going to solve that problem and move forward so you can get the mission accomplished. Those are all directly transferrable to any flight you have on board a spacecraft.

00:07:28

[Instructing at the Naval Academy]

BF: In 1990 you returned to the Naval Academy as an instructor. And you have a Naval Academy crew racing shell named after you. How did that happen?

WL: I've actually had two. [laughter] So I did get to go back to the Naval Academy, and I taught physics and leadership and underwater acoustics. This was the Navy's way of having me pay back my master's degree, because they had sent me to Woods Hole and MIT to get a master's in ocean engineering. So I'm thinking, what a great deal. I get to go back to the Academy and be an instructor. And I was also the crew coach for the women's novice team and did that for two seasons, which was a heck of a lot of fun. Teaching was a lot of fun as well. And back in the mid-90s they did name a crew shell after me. Some of the rowers that I coached rode in that boat for the equivalent of the

Division II Championship and won. And I got to take the bow ball off that crew shell on my very first flight. So that bow ball has the fastest 500 meter split-time of any crew shell in the history of rowing. [laughter]

00:08:40

[Selected as an astronaut candidate]

BF: All right. Let's talk a little bit about your experiences as an astronaut. You never stopped dreaming about going into space. How did you learn you were selected as an astronaut and what were your emotions when you received that call?

WL: So this is a fun story. A lot of people don't understand that this is the way NASA does the selections. I was sitting in my office at the Naval Academy with my officemate, a former Marine Corps helicopter pilot. We had both flown H-46s. And so he was working away on his side of the desk, and I was busy working away on my side of the desk. And the phone rang, and I answered it. And on the other end was a gentleman by the name of Don Puddy. So I immediately knew once he introduced himself that this was what we called the "good phone call" because he was the director of flight crew operations at the time, so it was his job to call the people who had been selected. So he, you know, introduces himself and proceeds to ask me what I thought was an incredibly silly question, which was, "We were wondering if you're still interested in becoming an astronaut. Because if you are, we would love to have you come down here to the Johnson Space Center and join us." [unintelligible 00:09:55], why would I not—no longer be interested? Of course I'm interested.

So I choked out a yes. He said, "Oh, great to hear. Now, you can't tell anyone for 24 hours. You may not realize this, but your appointment to become an astronaut—your selection—has to get approved by Congress, and we haven't quite been able to finish that yet. So, you know, we'll have it done by tomorrow, and it will be announced. But don't tell anyone for 24 hours." And I—"Okay. Well, how about my parents?" Because I was actually—my dad had retired to Annapolis, and so while I was teaching there, I was actually living with him and my stepmother. So I'm thinking, "I got to go home and see him. I really can't keep this secret." He said, "Oh, that's—I'm sure that's fine. Yeah, you can tell your parents. I'm sure they won't tell anyone." And I hang up the phone call.

Well, my officemate has figured out that this is the phone call. I hang up the phone. He looks at me. I look at him. He keeps looking at me. He's expecting me to say something, and I'm looking at him thinking, "I can't do this." And I just got up and I left—[laughter]—and I went over to the boathouse to coach crew for the afternoon. Well, again, he knew this was the phone call. So he proceeds, after I leave, to go around and tell the rest of the physics department that I had been selected as an astronaut. Technically, an astronaut candidate.

So I'm off at practice, go home, come back into work the next day, and on every outside door to my academic building is a little poster that says, "Congratulations, Lieutenant Commander Wendy Lawrence, NASA's newest astronaut candidate." And I'm thinking, "Oh my gosh. I'm not even an astronaut candidate—ASCAN yet, and I've already screwed up. Everybody knows. The whole Naval Academy knows." And I wasn't the one to tell them, but, you know—anyway, it was all fine. And then the rest of that afternoon was interviews with TV stations in Baltimore and the local newspapers. So it was a very fun time. And I'm delighted to know that another female Naval Academy graduate, Kayla Barron from the class of 2010, got selected. She's the first female submariner to be selected as an astronaut, and only the second Navy submariner to become an astronaut.

00:12:17

[First rocket launch and astronaut training]

BF: Now, you had the opportunity to fly on four space missions, totaling 1,225 hours in space. What was it like on your first rocket launch?

WL: Oh, it's hard to put into words because you cannot describe adequately 6.5 million pounds of thrust. So I was up on the flight deck. I was Mission Specialist II, which—and then I was the flight engineer. And then another one of my classmates from the class of 1992, John Grunsfeld, was in the seat next to me as MS I, so we had actually had three first-time fliers up on the flight deck because our pilot, Bill Gregory, was also on his first mission. And so we were pretty excited. You know, we had all been waiting a long time for this moment. We had been training for about 15 months at that point just on—as a crew of STS-67.

And so the weather had been horrible. So I think in the back of our mind we were all pretty sure that we weren't going to launch that day because there was a lot of lightning in the area, a lot of rain. But it's Florida. You never know. This is why you always do the launch count because the weather changed at the last minute, and we basically had this big break in the weather. And we got the go for launch at about five, five-ish minutes before we were supposed to launch. And so we quickly kind of—we put back on our gloves because we had taken them off, thinking we're really not going to go to space today. And then before you know it, boom, the engines lit off. And the ride more than lived up to its billing, just an incredible sensation of acceleration. And so it did not disappoint.

BF: You mentioned training. What was the training like? How long did you have to train?

WL: As I mentioned before, technically when you're selected, you're an astronaut candidate. ASCAN is what you were called. And so you had to go through that initial training flow. It's very similar to life as a military aviator—student aviator. You've got to go through

your flight training, first to learn how to fly, so we basically had to learn how to become an astronaut. And, you know, then for us, our aircraft was the Space Shuttle, so we had to learn all the systems onboard the Space Shuttle. Had to learn how to fly in the T-38 jets for crew training. Had to do land survival training, water survival training, all the basic things you do, again, as an aviator, a military aviator. Do some geology training. That was a wonderful carryover from the Apollo program.

And that initial flow was about 15 months. And I got actually assigned to my first flight before I even finished my ASCAN flow. And then for that first mission, we trained for about another 15 months. A lot of time in the simulators, so—we had telescopes on that flight, so we had to learn how the telescopes operated. And again, lots of emergency procedures. That's life as an astronaut, learning how to handle all those malfunctions, all phenomenal situations, as NASA likes to call them. And so the training flow is very, very fun because no two days are really the same. Very little time spent in your office. Most of your time is spent actually practicing what you're going to do up in space.

00:15:26

[Seeing Earth from space]

BF: On that first flight, what was it like looking out the window back at Earth?

WL: Well, that was kind of fun, as—another fun story. That mission, since we were doing astronomy, we had split the crew into two shifts so we could operate the telescopes around the clock. So I happened to be on the shift that was going to launch and then immediately go to work and start a 12-hour shift. And I was the on-orbit pilot for that shift, and the commander and the pilot were on the opposite shift. So it was fun for me as a first-time flyer basically to be in charge of the orbiter during my shift. But we had a lot to do because we immediately had to go to work.

So I remember we got up into space, and we were kind of wrapping up all our kind of post-ascent procedures, early-on orbit procedures. The commander literally grabbed me and threw my face in the window and say, "Hey, you're in space. Take a look." And then he kind of pulled me away and said, "Now go downstairs and get ready for your shift." [laughter] But it's—you've seen pictures, you've done your Earth-observation training, but nothing prepares you for that first view. And for me, at that point, it had been 25 years of pursuing the dream, so there's also that emotional component of realizing that you had finally done it. You had finally made the dream come true, and you were living it.

BF: How did going into space change you?

WL: I find it fascinating that when you ask astronauts and cosmonauts alike that question, independent of one another, we tend to have a very similar answer. It's just the way that we see the Earth, particularly in the daylight part of the orbit, where the incoming light from the sun just overwhelms any of the light from the stars and so all you see is this deep, intensely deep, black void of space that surrounds the planet. Now, obviously, on a flight to—on the Space Shuttle or in—even now, on the Space Station, you're not up high enough to see all of the Earth, but up high enough that you can see the curvature of it. And you see that portion of Earth against this, again, deeply black void of space. And it just seems like this vast expanse wants to engulf the Earth and swallow it up, and it makes the Earth look small and fragile. And that's the word that we all use. It makes the Earth look fragile. It makes it look like it's not strong enough to hold off this kind of, like, Pacman void that wants to gobble it up.

And I think it just drives home this increased sense of responsibility that we have to take care of the planet. We see the world in a way that other inhabitants of Earth have not had the privilege to see. We look at the land masses. We don't see obvious borders. We see the one place that we currently know how to live on. And it really, again, drives home this sense that it's small and it's fragile, and that we, as in fellow crew members of planet Earth, must work together to take care of it. We must figure out a way to work together. And again, for us, fewer than 600 people who have had this incredible privilege, I think we also come back with this sense of we have to focus on what we have in common. If we are going to work together, we must focus on what we have in common. And that is the fact that we are all crew members on this spaceship Earth.

00:19:13

[Flight to Mir]

BF: All right. Now, your second space mission was on the Shuttle *Atlantis*, going to the Russian *Mir* space station. What was that mission like?

WL: Well, I had just spent 16 months in Russia. The first six months were as director of operations there, the job we called the DOR. So I kind of jokingly say my job was the care and feeding of the NASA astronauts who were training in Star City at the time. As part of the Shuttle-Mir program, we were having initially five NASA astronauts do long-duration missions on *Mir*. Ultimately it was a total of seven, so once I finished my stint as DOR, then I started training as a backup crew member for one of those missions. So it was fun to actually have a chance to finally see *Mir* with my own eyes, after having spent many, many months over there training in the mockups.

BF: And what was it like working with the Russians?

WL: Interesting. [laughter] Especially since I was still on active duty in the Navy, and I basically was from the Cold War era. And we had cosmonauts and astronauts who had literally stood alert against one another, stationed—Rick Searfoss, I think it was, was stationed over in Germany. And he ended up being on orbit onboard *Mir* with a Russian cosmonaut, Air Force pilot, who had stood alert against him in one of the bases in the middle part of the Russian country. And so now this was truly an instance of we were beating our swords into plowshares.

What was fascinating to me was the fact that even though we had—the military folks had this background of having been trained to go to war against one another, we chose to focus on what we had in common, which was we're space flyers. We are the individuals who get the opportunity to go to space. And so that was our common bond. We spoke a common language because of that. We understood one another. We understood the rigors of our training in order to go up into space and accomplish our missions. And so we became the glue that held the Shuttle-Mir program together. It was much more challenging for some of the managers in the program to build those bonds of trust. And so the cosmonauts and the astronauts were the ones that kind of led by example and paved that path.

00:21:48

[STS-114]

BF: All right. Now, your last space mission, STS-114, was aboard the Shuttle *Discovery*. That was the return-to-flight mission after the *Columbia* disaster. Tell us about that.

WL: A very different mission, very different training flow. I think from the very beg—well, actually, to back up, initially STS-114 was going to be a crew-rotation flight. They were going to have three Space Station crew members as part of the crew. They would take them up, let them—drop them off to start their stay onboard, and then bring home three of the stationed crew members who were done with their mission. Certainly once *Columbia* occurred, the nature of the mission had to change. And the three station crew members were taken off the crew. I was added, along with Charlie Camarda and Andy Thomas, and now a seven-person crew whose mission was to demonstrate that NASA had ways to fly this shuttle safely in space again.

And so we very clearly understood the responsibility that we had, the significance of this—that mission. But I think for us as astronauts, it was much more personal. We had known the members of the 107 crew. And for us, it was very important that the mission was also about carrying on what they thought was vitally important for not just Americans, but humans on planet Earth. The ability of humans to live and work safely in space. So we were working very hard to ensure the legacy of the 107 crew, especially for their families, and to continue their vision for the space flight program.

BF: Now, STS-114 was commanded by Eileen Collins. Was that a special flight for you?

WL: Oh, most definitely. And I get to fly somebody in—fly with someone who is in the history books, the first woman to ever command a Space Shuttle flight. And that was her second opportunity to be in command. I also got to officiate Eileen's retirement ceremony from the Air Force. And when I did that, I looked at her son and daughter, and I—in particular her daughter, and I said, "You need to understand, your mother is a very special person. You will learn about her as you get into high school and you study the history of this country. Your mother forever will have a very significant place in history, being the first woman to ever do this."

And so for me, yes, it was a great opportunity. Eileen was a great commander, a great leader, just a generally, really nice, decent person who really took care of us on that crew. Because again, it was very different than any other training flow we had been through. Typically, at the start of your training flow, you knew exactly what you were going to do during the mission from start to finish. For STS-114, we knew very little of what we were going to do because we were training while the engineers were trying to figure out how to meet the key recommendations from the accident investigation board. So there was a lot of uncertainty. There were many unknowns. And things kind of course-corrected like this along the way. [demonstrates] So I was glad that it was my fourth flight because it was much easier to deal with the, "Well, we're not sure. You may do it this way or we may do it like this or it may be like this." You know, you just developed the ability at that point to go, "Okay, I can deal with the—that I have a—I can develop that 'go with the flow' mentality, and I'll just do that for a while, until we get to the point where we really need to know what we're doing."

BF: The *Columbia* disaster was due to tiles coming loose. There was a pretty clever way of checking the tiles as you approached the International Space Station. Tell us about that.

WL: Technically, it was due to the foam coming off the tank, which unfortunately had been an issue throughout the Shuttle program. From the very first launch up until that point, foam had been coming off the tank regularly and had been impacting tiles on the underside of the orbiter, which were part of the thermal protection system. In the case of *Columbia*, the foam actually hit on the protective panels on the front of the wing, the RCC panels.

So one of the recommendations from the board was the ability to do an external inspection, to look at the entire outside of the orbiter once we were up in space orbiting the planet. So this is when it—you really realize the size of the orbiter. I mean, a hugely big spacecraft. Certainly not as big as the Station, but big enough that we simply did not have the means to use one method to look at the entire outside. Yes, we could use the robotic arm and inspection boom and that would see most of it, but not all of the tiles.

So really a good engineer at Johnson Space Center—I mean, I marveled at his deep understanding of the laws of orbital mechanics. It came to him one day that he’s like, wow, you know, there’s a certain approach trajectory that’s flown as part of the rendezvous and docking process. You know, when you look at the way the energy works and the laws of orbital mechanics works, you know, they could literally carry a little bit of that forward speed, and if you did it at this point, this distance away from station, there’s not enough of that speed that would allow you to continue on and impact station. So we could just get to this point and then have the orbiter just, in essence, rotate around 360 degrees. Do a backflip. We’ll always have crew members on station. They have cameras, big lenses. We’ll have them do a survey of all those tiles, and then send that in—the pictures, the digital pictures, down to the ground for the engineers to look for damage.

So it was called the rendezvous pitch maneuver. Very fun to do because, at a certain point in the rotation, you literally watch Space Station rise up over the tail as you were rotating around. And for those of us who had grown up with *Star Trek* and *Star Wars*, I mean, this was like a scene from a *Star Wars* movie, with two spacecraft in very close proximity to one another. So we called that our *Star Wars* moment. I know, kind of cheesy, but it really was really, really fun to do.

00:28:32

[STS-91]

BF: I skipped over your third mission. I see you’re wearing the shirt from STS-91.

WL: Yes.

BF: Anything you can tell us about that?

WL: Ninth and final docking mission to *Mir*. So we brought home Andy Thomas and concluded what NASA had called Phase I, because it was the precursor program to the International Space Station program, deemed Phase II. Really a way to get Russia and NASA working closely together in preparation for the ISS program. So we were the—again, the last orbiter to go there, brought home the last NASA crew member, and brought home a lot of—a few other things for the Russians and—also, a mission in which we had a payload in the back part of the payload bay called Alpha Magnetic Spectrometer. Don’t ask me to explain it other than “three-ton magnet designed to look for antimatter.” It was designated to be a payload, eventually, on the ISS. So AMS-02 is up on the Station, still looking for antimatter. The lead principal investigator was Dr. Samuel Ting, who’s a Nobel Laureate. He truly understands what the magnet’s being used for. On this mission, Franklin Chang-Díaz, who has a PhD in nuclear physics, he,

too, understood. The rest of us, not so much. [laughter] But my understanding is they have detected antimatter by analyzing the data.

00:30:04

[STEM advocacy]

BF: All right. Let's talk a little bit about STEM. You've continued your passion and legacy by becoming an advocate for STEM education and speaking with America's students about the opportunities and resources available to them. How do we get young people, and especially young girls, excited about STEM?

WL: It's a challenge. Because STEM, you know, it involves math. It involves science. And in the school systems, you know, there's a stigma associated with both of those courses. Kids are told that, "Hey, it's—math is hard. Science is hard. You have to be a really good student." And math is basically a foreign language that involves numbers, and so when you start to teach kids a mathematical concept, it is something new. It is something foreign to them. And because of that, it's going to be uncomfortable. And they may not immediately get it. So the point I stress to kids is that you have to understand that learning math and science, it really isn't any different than learning a foreign language involving words or a musical instrument or playing a sport. All those things involve practice. You're not going to be good at it the first time you do it. To become good requires consistent practice.

Kids in particular right now need to realize that just because you're not good at something the first time doesn't mean you will never be good at it. So there's—I think in the world of education right now, they're using the word "grit." But there's this aspect of being able to persevere, to persist, to continue to work at it, and more importantly, to pick yourself back up if you fall down and you fail and to realize failure is just an opportunity to learn.

I think another challenge kids have is trying to take what they learn in the classroom and apply it to the world they see around them. So that's a role of a museum to show the application of that knowledge, to show the things that are created, like Apollo F-1 engines, when people really understand the math behind that, the science behind that, when they've learned enough that they can take that information and use it to create new things. So hands-on opportunities that are provided by museums, afterschool activities, summer camps, to me are incredibly important. The kids need to be given an opportunity outside of the classroom to interact with what they're learning and to see what they can do with it and to see that it can be fun and exciting and rewarding. Because sometimes I just don't think that teachers have time in the school day to introduce that fun aspect. They don't have as much time as they would like to introduce that fun aspect, that excitement, to create that excitement and that sense of curiosity and wonder.

BF: Sally Ride was the first American woman astronaut. Tell us about Sally Ride Science.

WL: Well, it's a continuation of what I just said, because Sally wanted to do something to show, in particular young girls, that science and math are subjects that could be considered to be cool, that could be fun and exciting. You could have some very rewarding careers. She also realized that, for young kids, it's very difficult to become something that you don't see somebody who looks like you doing. Her quote was, "You can't be what you can't see." So she was absolutely convinced that you didn't see a lot of young girls go study math or science or engineering at college because they didn't see many women working in those fields. So she wanted to create a program where young girls, particularly middle school girls, could come to, like, a half-day festival, workshops, and see women who were working on those—in those fields, so the girls could make that connection and say, "Oh, hey, you look like me, and look at what you're doing. So if you're doing that, oh, perhaps I could do that as well."

00:34:35

[Involvement with University of Washington Bothell]

BF: All right. Now, you're currently on the advisory board at the University of Washington Bothell. What's your role there?

WL: Well, to advise. [laughter] You know, there—I think for higher education, particularly right now in Washington State, it is a challenge. I am very interested to see what they just came up with in terms of the budget. For the last many years, K-12 education has been solved on the back of higher education. By that, I mean the money's been taken from higher education and put down into the lower grades. That's, I mean, necessary, perhaps, but it makes it difficult for the higher education institutions to carry out their role of taking people right out of high school, furthering their education, and preparing them for life as an adult, life in which you need to work, that—so creating those skills that will get them employed and keep them employed. And more importantly, developing relationships with the business establishments in the local area.

So that's part of the role of the advisory board. You get people from many, many different backgrounds who bring their experiences and bring them to bears in helping the higher education institutions solve their challenges. How do we produce graduates who are going to flourish in your workplace? What skills do you need them to have in your current marketplace with this current economy? What's going to serve you best, you know? And how do we prepare this graduate to thrive in your environment and not just over the next couple of years, but for many, many years to come. And to take a sense of the landscape around them for the UW Bothell campus and say what programs should you be putting in place, again, to meet the needs of that local area? What are the challenges your students have in particular? In that college, 51% of their students are first

in family to go to college. And so that represents very unique challenges in making sure those students are given the time and the care and the attention to survive and not just survive, but to eventually thrive in that academic setting. Because some of them come in with preparation that's not quite going to enable them to do well, to thrive.

00:37:10

[Advice for aspiring astronauts]

BF: What advice do you have for those who are following in your footsteps and dream of becoming an astronaut?

WL: To walk down the path. Yeah, it's going to be hard, it's going to be long, it's going to be challenging, and there are going to be a lot of times where you don't think you can do it. But you have to be able to persist. Because making your dream come true is a process, and it, as I said before, can be a very long process. So you have to develop this mindset that it's one step at a time. And you have to be constantly thinking about what should the next several steps be.

And I go back to the—I tell kids, “This is what my dad said to me. Go do that. Go look at the people who are already doing what you want to do and see how they got there.” And that's the nice thing about this day and age, is you can go to the internet and you can research their bios. You can learn a lot about them. You can learn much more than I was able to do back in the days of having to go to the library and hope that somebody had already written a biography about a person. But do that research. And then work hard to develop those skills, to be the best that you can be, and put yourself in a position where you're ready to take advantage of the opportunities that come your way. Because there will be those incredible opportunities. I mean, the day the Navy called me up and said, “Hey, we're starting this new program at MIT and Woods Hole in ocean sciences, and we see you studied ocean engineering at the Naval Academy. Would you like to go to MIT to get your master's degree? Because if you get accepted, we'll pay for your master's program.”

And again, as somebody who was trying to become an astronaut with a background as a helicopter pilot, I knew that master's education would be critically important for me. And so how could you turn down an opportunity like that, you know? I had to put myself in a position where I could get accepted by MIT, which meant studying for the GRE exam, and studying very hard for that. But I did it, and I got accepted, and I got my master's from there. I was able to write a thesis that was published in an academic journal, which, after I got to NASA, I got feedback from some of the non-military astronauts, who said, “That was one thing that really stood out on your application, was that, as a military officer, you had been published in a peer-reviewed academic journal.” So you got to be—

so that's what I tell the kids. When those opportunities come, you need to be in a position to take advantage of them.

00:39:46

[Reflections on the future of spaceflight]

BF: Let's end up with a few questions about the future. You mentioned you grew up on the original *Star Trek*. Are we going to go where no one has gone before?

WL: I don't know. I wish I could be more positive. I don't know that the current administration will be the one to get us there. I think the private sector in this country will—country will continue to make leaps and bounds. And hopefully they can continue to plow new ground. But the reality is, it's very expensive. It will have to be an international effort. It's not something that a private company will want to take on on their own because they're not going to want to have to pay that amount of money with that amount of risk.

So I think you'll see NASA really try to continue the public-private partnerships. I'm just not convinced that the current administration we have will provide any support. I just don't see that attention span in them, so I just hope that they'll let NASA, you know, continue with what it's trying to do, and that we will see the United States Congress step up and play a much more prominent role in deciding what this country does next in its human space flight program.

BF: Would you like us to go back to the Moon?

WL: As an engineer, I just think that is a prudent approach. Because if something breaks, I want to happen—have it happen when I am three days away from this planet and not three months away on a trajectory that does not allow me to return immediately. And I like to quote fellow astronaut Don Pettit on this because I really think he said it in a way that really captures the essence of this. You're on the International Space Station right now, the crew takes its urine, they recycle it into drinking water. So the ability to do that is critically important. And as Don says, you know, "If that happens to you a month or two in your trajectory to Mars and it breaks and it cannot be repaired, you have killed your crew."

So I would rather go to the Moon and thoroughly test that system to wring it out, to operate in a, you know—the Space Station is great. It's really allowing us to use it as a test bed for that all-important life support technologies. But as you leave the protective cocoon of Earth, you get more radiation. I'd like to just have us land on the Moon and have to deal with that dust environment again, because that's going to be critical to the upkeep of your equipment, trying to figure out how to keep the dust out of it. And so, yes,

from that engineering point of view, it makes a lot of sense to me to go to the Moon and figure everything out there. And when you're confident in your technology, then you make that really challenging journey to Mars.

BF: Here at The Museum of Flight in Seattle, there's a statue honoring *Columbia* astronaut Michael Anderson. The statue's titled *Keep the Dream Alive*. How can the next generation do that?

WL: I don't think it's up to the next generation. I think it's up to our generation. We have to show the younger kids what their opportunities are. We have to create those opportunities for them, more importantly. And so that's why I think it's great that you have companies like SpaceX that are dreaming big and really pushing the boundaries, along with Blue Origin, Sierra Nevada. I think NASA was really, really smart as the Shuttle program was winding down to realize that it needed to create a marketplace for the commercial companies. And that's what NASA has done incredibly well with the ISS program, first with the commercial crew—cargo contract, and now with the commercial crew contract, and subsidizing some of the efforts by SpaceX and Boeing and Sierra Nevada as well, and Orville ATK. Without NASA's role, I don't think those companies would be very far along because, for the humans flying in space, NASA has to create that marketplace right now.

And so it's our generation that needs to keep pushing and thinking of new things that we can do in space, new technologies that we can use to lower the cost of getting things into space, to give more people an opportunity to go there, to develop that commercial space station, to figure out better propulsion systems that will get us to Mars faster, to start those efforts and then show the younger kids what they can be a part of if they get the right education to participate. So I don't think it's up to the next generation. That responsibility is on our generation. We have got to do our job correctly to make sure they have a program to be a part of.

BF: All right. Well, thank you for taking the time and letting us record this important piece of oral history from someone who has lived it. And thank you so much for all that you've done, all that you're doing, to get others to dream. I salute you.

WL: My pleasure.

00:45:17

[The Museum of Flight's Full Fuselage Trainer (FFT)]

PEDER NELSON: I actually have one question.

WL: Yes?

PN: So as a—since you’ve trained as an ASCAN, did you—do you have any memories of our Full Fuselage Trainer and what it was like in that—do you have—I mean—

WL: [laughter] I probably have a few scuff marks in there. Full Fuselage Trainer was used for a wide variety of things. Particularly with the Shuttle-Mir program, we kind of expanded the capabilities of it because, previous to that, you would go over there, and, you know, you had all your mid-deck lockers, so you’d have an opportunity to see where your things were going to be stowed, an opportunity to practice some of the procedures you needed to do once you got up into orbit to literally convert the rocket ship into the place where you were going to live and work for the next however many days your mission was. So kind of getting out of your suits, where to stow them, taking the seats down. That became much more important when you were doing the logistics missions to *Mir* and then up to the ISS because you now started taking a lot, a lot, of equipment up to the Station, all stowed in your mid-deck. And so you had to spend many—much time over in the Full Fuselage Trainer kind of working through your procedures to get all of that transferred.

Obviously, you used it for some emergency egress training as well, and that’s where I think my scuff marks are. [laughter] Because you had to learn how to climb up over—out of the overhead window and literally rappel down the side or come out the side hatch and deploy the slide and go down it, so you practiced all of that as well. But then we also used it for some rendezvous training because we, over the course of the Shuttle-Mir program, were beginning to change the configurations. We were moving airlocks from the inside to the outside, and that meant moving the dock—had a slightly different position for the docking adapter as well.

So on STS-91, we had a docking adapter that was shifted a little bit closer to the front part of the payload bay. And on that flight, myself and Charlie Precourt—he was the mission commander—we had already been to *Mir* before. So we had already gone through the rendezvous and docking approach with this older configuration, and now suddenly with this newer configuration, antennas on the docking adapter on *Mir* were now much closer to us. And I remember at one point when we were going through this exercise to see what it was going to look like, Charlie and I looked up and we both just kind of flinched—[demonstrates]—thinking that antenna really should be over here. It should not look like it’s coming right down on top of us.

So the Full Fuselage Trainer, I would say, is a great example of the entire Shuttle program in terms of versatility and adding new capabilities, adding new abil—things that we were going to do in space and then figuring out new ways that we could take advantage of the Full Fuselage Trainer to train for those activities. So it was a very diverse and useful mockup in its many, many years of service.

PN: And I heard that they would turn off the lights in the entire building sometimes to demonstrate what it was like at—when the sun was [unintelligible 00:48:47].

WL: Not during any of the training that I did. That might have been earlier in the program. It's kind of hard to turn off all the lights in Building 9 because, by the time I was there, there was so much going on in Building 9 over there. Because we were also starting to build facilities for the International Space Station, we had a station—a simulator for training with the Space Station robotic arm, and doing some of the procedures to add components to the Station. And so there was always a lot going on. Rarely did one crew kind of own the whole building. So maybe that's something they did in the first part of the Shuttle program.

BF: All right. Thank you so much.

WL: All right. You're very welcome, Bruce. Thank you.

00:49:39

[END OF INTERVIEW]