

HUBBLE SPACE TELESCOPE OPERATIONAL ORAL HISTORY PROJECT

EDITED ORAL HISTORY TRANSCRIPT

EDWARD J. WEILER
INTERVIEWED BY CHRISTOPHER GAINOR
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The questions in this transcript were asked during an oral history session with Edward J. Weiler. The text has been amended for clarification and for publication on this website.

GAINOR: Okay, it's October 24th, 2016. I'm Chris Gainor and I am in Vero Beach, Florida, with Ed Weiler. Do you want to tell me about your work with Hubble [Space Telescope, HST]? At least during the operations, a little bit before, I suppose.

WEILER: Well, I'll just briefly summarize. I got involved with Hubble around 1978 when I joined NASA working for the Chief Scientist on Hubble, Nancy [Grace] Roman, who was based at [NASA] Headquarters [Washington, DC]. Nancy decided to retire literally a year after I got there, in the '79 – '80 time frame, and basically, I took over her job on Hubble, the chief Headquarters scientist.

So back in '79 – '80, Hubble had just started development. The mirror was being ground and polished, and I think the mirror was finished about 1981-1982 actually, and we of course were told that it was the greatest mirror on Earth. The greatest mirror ever made by humans, and tada, tada, tada. And it was in the can, so to speak, back in the early 80s. Little did we know the ticking time bomb that we had in the early 80s.

Let me summarize eight years, from 1982 on to 1990, there was ups and downs, and the telescope was supposed to be launched in 1983 when it was originally started, for a sum total of \$420 million. Of course, it wasn't launched in 1983. It had a seven-year launch slip. It was

basically a much tougher technological job than anybody had anticipated. And PerkinElmer took a long time on the mirror, even a longer time on the fine guidance sensors [FGS]. Those are really, really tough to make work. Lockheed did pretty well. They went pretty smoothly, because they had plenty of time, because they were always following the optical system. So they had plenty of time to do it right. And in retrospect, Lockheed did a fantastic job on the spacecraft and the serviceability of the spacecraft, and I don't think they get enough credit for the job they did. One of the reasons it's lasted 26.5 years is the great job that Lockheed did on that spacecraft system. Of course, we had to change out many things, like gyros, many, many times.

But going back to pre-launch there were many, many problems. Many threats of cancellations, many overruns. Astronomers were getting antsy. Some astronomers wanted to cancel so their favorite little telescope could be launched, or system. But we went through it and we were getting pretty close to launch in 1987, and then of course the [Space Shuttle] *Challenger* [STS-51L] tragedy happened. The shuttle went down for almost a year and a half, I think. So we went into storage, basically.

Then everything came together around April—April 10th was the original date—1990. Went down for the launch here in beautiful Florida, beautiful day. But at 31 seconds before launch, the APUs, the [auxiliary] power units, one of them gave a bad signal, and they scrubbed the launch, until the 24th. So, and we launched on the 24th and everybody was ecstatic. I don't think I've ever seen as many press at a launch, and I've been to many, many, many shuttle launches. It was just a media circus. Back in those days we had real journalists, not bloggers, so they actually came, real professional people that wrote stories. We all left Florida thinking we had launched an historic telescope that would change the view of the universe.

GAINOR: Could I just ask one question? As I understand it, the slip caused by the *Challenger* accident actually gave everybody lots of time to, I guess, improve, or even complete systems that may not have worked as well.

WEILER: Oh, absolutely, that's a good point. I was trying to rush through that period, but if your book is primarily on operations.

GAINOR: Yeah.

WEILER: Operations was not ready in 1987. That had been a real learning curve. I won't say that the slip was something we wanted, but the timing of the slip came at a very opportune time, especially for people in operations. The operations system of Hubble was so complex that even though the launch was delayed seven years—operations tended never to get enough money, because there was always the problem *du jour* on the engineering side. Whenever there was ever a problem on the engineering side (which was almost every day) operations would just get less and less money and get pushed out and pushed out. Software development, data systems, etc. So, the operations system needed a lot of catch-up time. And the *Challenger* slip gave them that. We were a lot better off in April of 1990 than we would have been in 1987. We would have been limping along in terms of trying to operate the spacecraft. And that's an absolute. Nobody can deny that. I don't care what they say.

GAINOR: Right. And I've looked a little bit. I've actually had a little better luck getting documents from the [Space Telescope Science] Institute side than from the NASA side.

WEILER: I'm not surprised.

GAINOR: But I've heard all sorts of things about what the institute was doing then, developing, what is it, SOGS [Science Operation Ground System]?

WEILER: Yes, SOGS was just a mess. It overran so much, and the institute hated it. And the institute and [NASA's] Goddard [Space Flight Center, Greenbelt, Maryland] were in constant battles over it. I try to forget all those battles. But there was [Riccardo] Giacconi's personality. When he first came on, he didn't get along with people very well. We finally worked that through, but it was a really, really, really tough time on ops. So, those extra two years really came in handy, frankly.

GAINOR: Yeah. Tell me a little bit about the relationship between Goddard, NASA, and the institute.

WEILER: Well, those are three very different entities. The relationship between the institute and Goddard, especially in the early days of Riccardo Giacconi, was abysmal. It was like Russia and the United States in the Cold War. There was almost no communications. In fact, I developed a relationship with Garth [D.] Illingworth, who was Riccardo's deputy, and we were sort of like Deep Throat on both sides. We actually talked; we were the only people at the institute and NASA to actually talk at high levels.

So, if I wanted to get a message to the institute, to try to calm the problems between Goddard, I'd go to Garth. If Garth wanted to get me a message about how to calm the Goddard issues, he'd come to me. And that was the line of communication for almost a year and a half, two years. Finally, finally we had a rapprochement with Riccardo about the time that Bob [Robert A.] Brown became project scientist. And then things went pretty well until Riccardo retired eventually from the institute. But there was always bad feelings between Goddard and the institute for a very simple reason. Goddard thought they were going to be the institute, and NASA Headquarters said, "No, we're going to compete it." And Goddard never really got over that. They had a real problem with getting over it.

And the institute and Goddard were like two fists pounding into each other. I would say, well, probably until the first Servicing Mission. I think things started working much better after the first Servicing Mission. I think spherical aberration actually was a good thing, in a sense. It brought us together.

GAINOR: You're not the first person who's made that observation.

WEILER: It brought us all together. We had a badgeless team because everybody in the world was attacking us and laughing at us and mocking us. I mean, that brings people together.

GAINOR: Now, you mention there was this three-corner thing. There was also Headquarters.

WEILER: Well, I was at Headquarters.

GAINOR: You were at Headquarters, so—

WEILER: So the institute wasn't supposed to talk to Headquarters. Goddard didn't want the institute. That's why I talked with them. Since the institute wasn't talking to Goddard, somebody at NASA had to deal with the institute. And so, that's why Garth and I developed that relationship.

Now the top at Headquarters, the people above me, hated Riccardo. Charlie [Charles] Pellerin and Riccardo were like oil and water. I mean they did not mix. And nobody above Charlie Pellerin liked the Institute.

GAINOR: Right. So, let's go back to April 25th now.

WEILER: I came back. I went to Goddard on April 25th to watch the solar arrays come out because Goddard had the big screen TV and we were going to have the press there. Kathy Sawyer and I— Kathy Sawyer was the *Washington Post* science writer, one of the greatest science writers in history. We were standing next to each other, watching the solar arrays come out. They kind of had a problem to begin with, but then they finally came out. So things looked not too bad the first couple days.

But then the problems started. Then it was the problem *du jour*. We have these glitches. Whenever the solar arrays would come into sunlight, we couldn't lock on.

GAINOR: The jitter.

WEILER: The jitter from the European solar arrays, badly designed solar arrays. The fine guidance

sensors didn't really do well locking on. As it turned out, it was probably partially due to the spherical aberration. We couldn't focus the telescope. Repeated attempts. We knew it would take a long time, but we never thought it would take so long. There were endless focus tests and none of them worked. Then they tried moving the mirror mounts, the mirror actuators, to try to force fit the mirror into a shape. I'm going fast now, but May was a real, real miserable month. Nothing seemed to go well.

So by the time early June came around, and people were starting to get a little worried (a lot worried), sometime around the first or second week of June I was in a meeting. I remember Sandy [Sandra M.] Faber whispering in my ear, she said, "As far as we can tell, Ed, we've got spherical aberration, and there ain't anything we can do about it." I really trusted her. I'd heard the rumors, but when she told me that, it was like a ton of bricks hitting me. I really felt it, and we're all in a daze at that point, just absolutely shocked. We had to tell the press, we had to tell the American people, so we had to prepare for a press conference on the 27th, I believe, of June. And I, of course, was the lucky guy who got to do the science impacts at the press conference, because a lot of my bosses had disappeared. They were in Japan, or they didn't seem to be around. Just pure coincidence, I'm sure. But I was the individual at NASA, at my lowly level, that had to tell the world what science we would do and wouldn't do. And of course, what it wouldn't do was the big part. So, that was the day that shall live in infamy. June 27th.

GAINOR: That's right.

WEILER: April 24th was Mount Everest. We were on top of the world. June 27th we were in Death Valley, the bottom of the world. And slowly we crawled up to sea level. Then, December 18,

1993, the day the first WFPC [Wide Field Planetary Camera] picture came in, we knew we had fixed it that was back to Mount Everest.

Let me say unequivocally here, the COSTAR [Corrective Optics Space Telescope Axial Replacement] did not fix the Hubble Space Telescope. The Wide Field Planetary Camera 2 fixed the Hubble Space Telescope. Ninety percent of all science after 1993 came from WFPC2.

GAINOR: The last person I interviewed was John [T.] Trauger [WFPC2 principal investigator] –

WEILER: Oh good. So, you got the same message. That is an abomination, historical abomination. I can't use strong enough words. The WFPC had nothing to do with COSTAR, and if you go back and look at the nine or ten front page stories we had in *The New York Times* after we fixed spherical aberration, they all were WFPC pictures. Because frankly, the Wide Field Camera did most of the science on Hubble.

GAINOR: And as I understand it, when you went to the famous press conference on June 27th, you already knew that there was a fix possible for WFPC.

WEILER: I knew it, but nobody believed it.

GAINOR: The other stuff was COSTAR.

WEILER: COSTAR, yeah. Again, this is Ball Brothers and Ball Aerospace and the institute did such a good job of leading the American people in one direction. We didn't know about COSTAR

then, but who cared? All we wanted was the WFPC to work. That was 80-90 percent of the search for black holes, the Hubble constant, the search for the earliest galaxies. That's all WFPC science. The Eagle Nebula – WFPC.

John Trauger whispered in my ear as I was going to the press conference, “We think we have a way to fix it.”

I said, “Come on, John.”

He said, “Well, we've got these little nickel-sized mirrors, four of them, four relay mirrors, the prescription on the main mirror is one thing. If we duplicate that prescription and in the negative sense on the other mirror, it's just like putting your glasses on. This is the opposite prescription of the curve of my eye. My eye is not the right curve. This is not the right curve. But it's the opposite curve. When I put them on, everything's in focus.” That's exactly what the WFPC2 did to fix Hubble.

And I said, “Well, that sounds pretty easy, John. I'll mention it to the press. But I tell you, they're going to think we're just making this up.” And they did. They didn't believe us. But at the press conference I said, “We have a fix, and we'll do it on cost and schedule by December 1993.” Nobody believed us. We did it.

GAINOR: Yeah.

WEILER: That's the amazing thing. That's the miracle in space, as the [PBS] NOVA show, “About the Miracle in Space Mission,” called it.

GAINOR: Right, and I think one of those shows didn't even mention WFPC.

WEILER: That's correct. The 25th anniversary show. That NOVA show didn't even mention that. The *National Geographic* did a great job. Got it right. I wrote a letter to NOVA, saying, "Hey, you're supposed to be the top scientific organizations on Earth. You have made a grievous error." And they said, "Well, we don't think so. We'll look into it." I swear to God, Chris, three weeks later, they sent me an apology. And if you get the disc of the thing now, it's been corrected.

GAINOR: Oh! Okay.

WEILER: God! They were very embarrassed, because they were led down the garden path by the institute and Ball Aerospace, who still permeates this bull crap.

GAINOR: Do you want to tell me a little bit about what was going on, on your end between June 27th [1990] and December 18th [1993]?

WEILER: As I say, everything got better, but slowly because we were the laughingstock of the country. Cartoons came out, cartoons that have a picture of Mr. Magoo, and the caption was, "The real inventor of the Hubble Space Telescope." Real nasty cartoons. It was tough. I was pushing my kids (I had little kids at that time), I was pushing my son or my daughter around in a stroller around the block, and I'd have neighbors come up to me and say, "Gee, I really feel for you, having to work on a national disaster." I mean, that really builds your confidence up when your neighbors tell you that.

GAINOR: I heard that that time was really hard on some, on a number of people.

WEILER: Oh yeah. A lot of people disappeared from Hubble and weren't seen very much.

GAINOR: How about you?

WEILER: I stayed around. Well, I was chief scientist. I had to. I feel like I'm a natural leader, and we had to have a cohesive team, so I went to every meeting, every meeting that we had, every progress report. So I was front and center. I did all the prep. I did all the press conferences in the first three or four months. And Chris, there was a daily press conference, after June 27th. A daily press conference, and we had hundreds of reporters on the phone—old fashioned telecom—beating up on us. Finally that slowed down to once every two days, then it slowed down to once a week.

GAINOR: And you had Congress, too.

WEILER: Congressional testimonies, so I was in the thick of it. That's all I did was Hubble. I did nothing. I mean, I had other jobs at Headquarters, but I lived and breathed Hubble. To this day, I think it's one of the reasons my marriage failed, eventually, because I was never home. Every afternoon, long after dinner time, I was at a press conference, telecom at Goddard. So, I was the voice of Hubble from '90 to '93. And Hubble wasn't something you wanted to be the voice of.

GAINOR: Yeah.

WEILER: I don't remember it as a very happy time. It was a challenging time. We were all dedicated. We were a badgeless team, whether you were from Lockheed, or PerkinElmer, or Goddard or the institute, because everybody else was against you. You had to come together. And we came together. To this day. And I've worked on a lot of teams.

Another disaster I had to fix was the Mars Program, after the two Mars failures in 1998. The boss, the administrator said, "Ed, I want you to take this program over, and I want to know in 24 hours, what are you going to do about it, to fix it?" So, I called him up the next morning, I said, "Dan [Daniel S. Goldin], I got a solution for you."

He said, "What?"

I said, "Cancel the whole program and start over." And that's exactly what we did and we developed a new program with seven launches. By the way, the end of that story is that we've launched all seven successfully. So I have some experience in leadership, you know, in that kind of thing.

Anyway, so lots and lots of meetings, lots of arguments, lots of meetings where literally I walked out the door in anger at people who weren't trying as hard as I thought they should. Getting the WFPC ready was tough, because JPL [Jet Propulsion Laboratory, Pasadena, California] really didn't have their detectors ready, and I had a lot of fights with JPL. Those are some of those we walked out on and literally went to the airport and got on a plane, to send a message, you know, get your act together. But to JPL's credit, they got it ready on time for launch.

It was interesting. First of all, we had never done EVAs [extravehicular activities] like that. Not only were we trying to fix a telescope that we couldn't touch on the ground, because it was in space, but we're doing it by EVAs. And they've done an EVA once on Solar Max [Maximum satellite], one [repair] mission, an EVA there, but never five, eight-hour EVAs. It was

just never done. It was the first time ever. And we're trying to fix a telescope in space. We got to the launch, I remember, and we all would have agreed that if we could get 50 percent of our goals done, we would have considered it a 1,000 percent success. If we could get just half of it done. If you would have told us, two nights before launch in December 1993, that we were going to do 100 percent of everything and get it all perfect, I would have bet a lot of money and big odds that that could never happen. But apparently planning paid off.

The astronauts were superb. Everything went like clockwork. Sure, there were burps, like doors that wouldn't close. Story [Musgrave] came up with a thing called a come-along to close them. It was just amazing. And sitting at Johnson [Space Center, Houston, Texas] behind a console watching this, the only way I could describe it to people, and I've described it many times, is, even to this day, I look back on it and it was like a dream. We knew we were experiencing it in real time, but it still was like a dream. This can't be happening, wake me up. It can't be going this well. It can't be going this well. But it did.

GAINOR: It seemed like there were a lot of extraordinary measures before the mission, like having a mission director, and I've heard from other people, it seemed Goldin was ordering another review every 10 minutes.

WEILER: Yeah, but again, you said it right. It seemed like from outside. But for us, at the working level in the actual meetings, and I'm not talking really low level—I was there, the project manager was there—at that level, we said, "Okay, we'll take care of that review. We'll do it." But it was like, so what? We've done a hundred already. It was like water off a duck's back for us. We just got used to it. We got used to the fact that we were under a microscope, and we just grinned and

bore it. Yeah, we could have complained; we could have slowed down. We were motivated. This army was moving, no matter what. Nobody was going to get in the way.

GAINOR: I've heard a lot about this part of it, but where do people like Cepi [Frank J. Cepollina] fit into all that?

WEILER: Cepi was on the project side, the Goddard side, so he was the one organizing the EVAs and making sure the equipment, all the tools—Cepi was especially on the tools. The tools had to be just right. He worked on the tools, making sure the things fit. His job was to make sure that the new WFPC would fit in the hole. Basically he was responsible for all the EVA and the ORU [Orbital Replacement Unit] hardware. And he did a superb job, clearly. An absolutely superb job, because again, it had never been done before. So Cepi deserves a world of credit on the technical side.

GAINOR: So we're into '94 and there's a couple things I want to ask about the period.

WEILER: Well, let me tell you more about the WFPC2, which again, is not a well-known part of history. I've got this document, but ironically, December 18, 1983, exactly 10 years to the day of the first image from the WFPC coming down, at the institute. I signed my name on a white paper, about 10 or 12-page white paper, on why we shouldn't cancel the maintenance refurbishment program and why we should put more money into it, especially from the science side, because why does it make sense to have a telescope if you don't have science instruments. And one of the prime conclusions of this white paper (again, this is 1983) was the Wide Field Camera 1 was going to be

so important, so important, the prime instrument, the be all and end all, and we should start building a backup camera immediately, the WFPC2. A clone. It was called the clone. My boss almost fired me for that. But somehow (I had no idea) Congress got word of this idea, and I think it was John [N.] Bahcall who was testifying, my good buddy. And suggested this to Congress, and you know, Congress liked it, and when Jim [James C.] Welch the project director was up testifying one day, the congressman said, “Oh, you will be funding this important WFPC2 clone, Mr. Welch, won’t you?”

“Oh, of course, we’ve decided. That’s a go.”

GAINOR: Who was your boss at the time?

WEILER: Jim Welch.

GAINOR: Oh, okay. I’d like to see that white paper.

WEILER: If you remind me, I’ll look on my computer, remind me, I will print you out a copy of it.

GAINOR: Okay.

WEILER: Before it went to Congress, I gave this white paper to the science working group, and they blessed it. John Bahcall was a member of the working group. They thought it was a great idea. The bottom line is the WFPC clone was already being built. I wish I could say I was so prescient that I knew we’d need it, but thank God, that thing was being built in 1990 because, yeah,

we needed it. And the true irony is 10 years to the day, the first image from WFPC2 clone came down.

GAINOR: That's amazing. Now I wonder, I almost suspect whether you knew, even without spherical aberration, you might have needed it, WFPC2 at that time, just simply because of all the improvements to CCD [Charge-coupled device] technology.

WEILER: You're absolutely right because there were a lot of improvements to WFPC2. Oh, we still would have launched even if there weren't spherical aberration, it would have been on the first servicing mission.

GAINOR: There's two things that I've started to think about the mid-90s, after it is going. One is deciding what instruments are going into Hubble, now or at that time, and how that's decided.

WEILER: Oh, that's easy.

GAINOR: We'll deal with that first, but the other one, just so you can think about it a little bit, is that I hear a lot of noise from that time, and you would have been involved in that I suppose, that you were constantly fighting the battle of the budget all the time. But let's start with the instruments.

WEILER: And my job, over this whole period, was the protector of the science budget. Actually, if you look at the job description of chief scientist of Hubble, it is protect the science integrity of

the mission. And to me that means the whole picture, the whole thing. On the instruments, that's easy. For the next generation after the camera, we knew that the two spectrographs, the high resolutions, GHRS [Goddard High Resolution Spectrograph] and the FOS [Faint Object Spectrograph], they were ancient technology. They were digicons. Digicons are kind of like old fashion tube TVs. Compared to that thing you're looking at over there. Single string.

You wanted array detectors which would increase the sensitivity by factors of 10 or 100, so it was a no-brainer that we needed an advanced spectrograph. And it was also a no-brainer that we launched without an infrared instrument. So, that got us to two very easy choices. We had to solicit a spectrograph with a two-dimensional detector and an infrared instrument. That wasn't even a discussion. Everybody just agreed with that right away. We just knew that. If anybody tells you different, they don't know anything.

We knew we launched Hubble without an infrared instrument, even though it has infrared capability. That was not an oversight; there were only five instrument slots. So, we knew that one of the first instruments that would have to go up would be an infrared instrument. And that became very aware because detector technology was just skyrocketing during this period. Even when we launched in 1990, we knew that we've got to launch spectrographs and array detectors. That's a no-brainer.

So my job was putting out the Announcement of Opportunity [AO], or what you think of as an RFP [request for proposal]. That was my job. So, I wrote it and put it out, and we were soliciting instruments for launch in 1997. Now, throughout that period, '94, '95, '96, despite the fact that Hubble was just filling the newspapers with stories and front-page news, of course the idiots at Headquarters were trying to cut budgets. So, it was a constant fight to get that AO out. But I finally won all those battles. I was fighting all the time to keep that budget safe. But we

finally got the AO out, and we finally got two instruments selected, and we finally launched the two instruments.

GAINOR: As I understand it, there were budget battles.

WEILER: Oh yeah.

GAINOR: Throughout government, right?

WEILER: Yeah. Oh yeah. And they probably appeared one way to somebody one or two or three levels below where I was, but I was in the middle of it. And yeah, we do this all the time. It's what we do in Washington. To me, it was just another day at work. I mean, we won. There were times when I was depressed, and wasn't going our way, but I knew that Hubble, even in the mid-90s, I knew this is just not your grandfather's telescope. This thing is rewriting the textbooks. The people love it.

Even in the mid-90s, you get on an airplane (this was before the Mars rovers), if a person sat next to you and knew anything about NASA, not the space station, not the space shuttle, Hubble. Everybody knew Hubble. You ask them for an astronaut's name, forget it. That's just the way it was. So I knew, especially with my good friend, Senator [Barbara] Mikulski, in charge of appropriations, I knew Babs from the time she was just a young senator, before spherical aberration. We lived through Hubble together. I was just the young little scientist who got to show her the first pictures that came down from the fixed Hubble. She was the first person from Congress who saw these pictures, and I was the one who showed them to her. A real honor.

GAINOR: I know certainly from that time forward, she was a very steadfast friend of Hubble, and her imminent departure is not being looked at with anticipation.

WEILER: Two months from now. No.

GAINOR: What about during the period 1990-93?

WEILER: Well, she did say techno-turkey around the time of spherical aberration. But, once we got working and started reporting our progress, she slowly came back onboard and was a real advocate for the first servicing mission, probably with her fingers crossed, because she didn't want to be burned again. But she was a tough. She's a tough lady. I have a lot of respect for her. If the other 99 senators were of the same ilk as she is, today, I'd still be working at NASA. I retired early because I couldn't stand what was going on in Congress. I grew up with people like Mikulski and people who could work on both sides of the aisle and get things done. Today's Congress is just a bunch of people who are ideologues, they care more about who's for abortion, who's not for abortion, who's for this, who's for that. Nobody cares about the country it seems. They just care about their own beliefs. And that just turns me off. That's not Mikulski. And that wasn't Senator [Bob] Dole. Senator Dole was a Republican. He was the same way. He could work on both sides.

By the way, the story on the Advanced Camera [for Surveys] and the other instruments was the same. We decided what we needed, jointly. The scientists got together and said, "What kind of instrument do we need?" Once they made that decision, it was my job to put out the Announcement of Opportunity. And every instrument was a fight. The budget was always a fight.

But we got the Advanced Camera in '99, and we got the COS [Cosmic Origins Spectrograph] in whenever it was.

GAINOR: When the scientists got together, what forum was it?

WEILER: Usually the science working group. The science working group, or the institute has various groups too. It was great. There wasn't a lot of controversy. It was always clear cut, what we needed.

GAINOR: Right. Do you want to tell me a little bit about the decision to split Servicing Mission 3, into two?

WEILER: I'm trying to remember. That had something to do with Y2K, too, didn't it?

GAINOR: It does, yeah.

WEILER: I'm drawing a blank.

GAINOR: Because 3A barely got back on the ground before Y2K.

WEILER: I probably am not the best person—I have a lot of blank spots during that period for some reason.

GAINOR: Well, you were doing different things.

WEILER: I was associate administrator at that time.

GAINOR: And you were Director of Goddard at one stage.

WEILER: That was 2004. In 1999, I was associate administrator. Hubble was still under me, but I had the whole science program. Everything. Planetary, solar, Earth science, everything. So, I don't remember exactly—I do remember Y2K was a big deal. I remember they thought we couldn't do everything we needed to do in one servicing mission. It would be too risky. I do know this for sure: the real reason wasn't Y2K. The real reason was it was so chock-full it was thought it'd be better to break it up into two.

GAINOR: Okay. Another thing that I'm still trying to figure out about what happened, the control for Hubble was run out of Goddard, and then around the turn of the century, it went over to the institute. It eventually came back, but I'm still trying to figure out—

WEILER: It did come back?

GAINOR: Yes. It did come back. Yes.

WEILER: Really?

GAINOR: Yeah. Well, of course, of course the institute will be running JWST [James Webb Space Telescope].

WEILER: Oh yeah, that's why, yeah. Well, the institute and Goddard were at odds until after spherical aberration and after fixing it together as a team, the Goddard and the institute slowly discovered that they were more powerful together than they were alone, separately, if you know what I mean.

GAINOR: Yeah.

WEILER: So, moving the operations to the institute was an example of that. That would never have happened in 1991 or 1989. That would never have happened. But it was thought to be more efficient, and it was done. I don't think it was very controversial at the time. Now, it may have been for some of the lower-level people, whose jobs were affected, but the upper level, the upper echelons, I don't think it was very controversial.

GAINOR: Then we get to Servicing Mission 4. And I have heard so many stories about what happened.

WEILER: It's very clear in my mind. Servicing Mission 4 was never a given, but some of the crazies in the science community wanted even more, already arguing for Servicing Mission 5, before we even got Servicing Mission 4 approved. And then the [Space Shuttle] *Columbia* [STS-107] blows up landing. And these people still talked about Servicing Mission 5. I remember

taking a position with the community, and it wasn't very popular. I said, "Guys, we just lost seven astronauts. There's every possibility we will never have another servicing mission. So arguing for Servicing Mission 5 is the wrong argument. You ought to be worried about Servicing Mission 4." And sure enough, Chris, two or three months later, Sean O'Keefe cancelled Servicing Mission 4. My boss. And of course I supported it 100 percent because he was my boss.

GAINOR: Right.

WEILER: Officially, I supported him. But anybody who thinks that I was—I don't work for NASA anymore—anybody who thinks that I wasn't working under the table and around my boss to get that mission back on the manifest, doesn't understand me personally. Let's put it this way, when that boss left and Mike [Michael D.] Griffin came on board, it didn't take too many months before that mission was back on the manifest. And Senator Mikulski and I were sitting next to each other at Goddard Space Flight Center with Mike when he announced it. Now, did I appear to some scientists as being against Servicing Mission 4? Absolutely! And maybe they just didn't understand the bigger picture.

GAINOR: Well, what was going on there?

WEILER: Sometimes, sometimes you lose a skirmish, you lose a few battles to win the war.

GAINOR: What was going on under the table?

WEILER: That story will never be told. Let's put it this way. Information being passed to make sure it got to Congress, real information, you know, real issues.

GAINOR: One of the little mysteries, shall we say, for want of a better term, is the news. Kathy Sawyer broke the story.

WEILER: What story?

GAINOR: That SM4 had been cancelled.

WEILER: Well, it was no big secret. It was announced publicly at a press conference.

GAINOR: If you look at what happened—

WEILER: It was about mid-January.

GAINOR: Yeah.

WEILER: The agency knew, I mean O'Keefe knew that he was going to cancel it two or three or four days earlier. I don't know when the story broke. Did it break early?

GAINOR: Yes. As I understand it, the plan was to announce it when the budget came down, which at that time was usually the first couple of days of February, and in the middle of January, President

[George W.] Bush came to NASA and announced his blueprint.

WEILER: His vision. You're right.

GAINOR: His vision. And then the next day's *Washington Post* has a big story about everything that happened at Headquarters and everything else. Then you turned inside, and about the middle of the story, it says, "And by the way, SM4 has been cancelled."

WEILER: Oh yeah.

GAINOR: And then O'Keefe or somebody had read this and said, well I better get my butt out to Goddard the next day.

WEILER: That's exactly what happened.

GAINOR: That day.

WEILER: Somebody leaked to Kathy Sawyer what O'Keefe was planning to do, and when that story came out, O'Keefe had to drag a whole bunch of us, John [M.] Grunsfeld and me had to go to Goddard and face the people and the institute and say why this was a great idea. And gee, I just have no idea how that story leaked to Kathy Sawyer. But you're right. It did leak to Kathy Sawyer, and those things happen around Washington. O'Keefe wanted to keep it a secret until February 1st.

GAINOR: Right. And as I understand it, you had known about this for some weeks at that time.

WEILER: About one or two weeks. So, did John Grunsfeld. The OMB [Office of Management and Budget] budget is tightly held at Headquarters, usually. O'Keefe had made the decision around January 1st because they were having secret budget meetings, to which I and Grunsfeld weren't invited because I think he knew how I would react. We became aware of it about a week before the story broke. But the decision was made sometime in the Christmas timeframe. Steve [Steven J.] Isakowitz was part of this. And I blame him still to this day for being one of the guys to suggest it to him, but I can't prove it. But it did leak. That stuff happens.

GAINOR: Yeah. Okay.

WEILER: And then I forget how long it was, was it around June? Then O'Keefe got kicked out around—I'm trying to remember when—no, I think it was longer than that, because O'Keefe furloughed me to Goddard to get rid of me, I guess. You know, my reward for landing on Mars, twice, Spirit and Opportunity [rovers], was getting kicked out of Headquarters and sent to Goddard. Why do you think that happened, anyway? Admittedly, I was center director, and frankly it was the best move I ever made because I really enjoyed being center director, and you could work a lot more under the table at Goddard than you can at Headquarters. O'Keefe sent me to Goddard to push the robotic mission, as opposed to the shuttle mission. And how ironic it was that it only took a year and a half to get the shuttle mission back in.

GAINOR: So, I take it you didn't get along too well with O'Keefe.

WEILER: I had no respect whatsoever for him. He is not technical. He should never have been an administrator. I think he was the worst administrator we ever had at NASA.

GAINOR: Hmm.

WEILER: He was an MBA. Whereas Dan Goldin was an engineer. Mike Griffin was a PhD engineer. That's what an administrator ought to be now, not an MBA. No offense to MBAs, they're important people, but not to run a technical agency. He had no appreciation for the science or the engineering. Now, there are certain bloggers who think he's God's gift to heaven, but who cares?

GAINOR: I want to go over this a little bit, because you know there was the work that [former NASA Chief Historian] Steven [J.] Dick did. He did a little report on this that was published in a book.

WEILER: I may or may not have seen it.

GAINOR: So if I understand it, O'Keefe made a decision around Thanksgiving.

WEILER: I'm not sure it was that early, or I think it was more like just before Christmas, but that time frame.

GAINOR: And I was left with the impression that you found out in December sometime and that Grunsfeld found out about it in early January.

WEILER: Now, John and I, I know this for a fact, I remember. I just had a vision. John and I found out about it at the same exact meeting on the 9th floor, in the Administrator's Conference Room, when they were talking about the budget. And this is the first time that I, as the AA, or John as the chief scientist, were aware of these secret budgets that they were going to work. And whether that was in late December or early January, I'm not sure. But John and I were hit by this at the same, exact moment. And we both had the same reaction, like, "You've got to be—" and we said this to O'Keefe. We both said, "You've got to be out of your mind. Every little school kid in the world is going to be writing post cards and letters to you."

And it was like, "So what?" That was the reaction. And John and I both had that same reaction. But we also, on our own, in private discussions afterwards, realized that we had two options: keep pushing it and be eliminated, or make it look like we supported it and then work our own agenda, separately. We both chose the latter, thank goodness. Because O'Keefe could have gotten monkeys to do our jobs and would have said, "Yes, sir!" which is the kind of people he liked anyway.

GAINOR: And then O'Keefe, I think he announced in December that he was going.

WEILER: The following December?

GAINOR: December of 2004.

WEILER: That makes sense because I was at Goddard as a center director. He kicked me out of Headquarters in August of 2004. And he hung around until February until Mike Griffin came on board and brought them all out.

GAINOR: So the reasons for his departure are still the stuff of controversy.

WEILER: Well—

GAINOR: There's speculation.

WEILER: I don't want to comment on that, because it's personal, but the guy had some issues. Let's put it that way.

GAINOR: I mentioned I saw Steve Beckwith, recently.

WEILER: Steve and I used to be like this. We were "bitter" enemies, but I don't think Steve ever understood the game I was playing. Apparently, I was acting too well. I must have played the part very well. Because once we realized that we were really on the same side, I think it was okay. But it took a while.

GAINOR: I kind of heard about all the great efforts he made. Some of them under the table, to save

Hubble. So I'm trying to get an idea of what you did to save Hubble.

WEILER: He did a lot of good things, with the Congress and Mikulski and all that too. But despite all that, you've got to have the agency to want to do it. So, eventually, no matter what the outside was saying, until NASA is committed to do it, which was Griffin, it didn't make any difference. You saw nothing happen until Griffin came on.

GAINOR: Right.

WEILER: The agency was poised to go do it. The agency was—we were pushing. Let's go do studies on two shuttles on the launch pad. Let's go do studies on repair kits for the shuttle tiles. Griffin had a very different decision to make in June.

GAINOR: And there's the robotics stuff.

WEILER: Well, the robotics stuff. I'm not an employee, so it doesn't matter anymore. Some of us, like John Grunsfeld and I and Steve, never—this is what Steve didn't understand. We supported the robotic mission. We were against SM4 because that's what our boss told them to do. But we supported the robotic mission for another reason. It kept the money flowing and it kept Cepi's team alive. If we didn't support it, that team would have died, and then it wouldn't have mattered. And I don't think some of the people at the institute ever understood that. We weren't so stupid to think that we were going to repair Hubble with robots, but it kept the money flowing. Again. You give an inch here, an inch here, and then you take a light year.

Washington is a strange place. It takes a while to learn how to work in Washington. The most important thing was keeping Cepi's people alive. I don't care if O'Keefe gave us money for him to do finger painting in Goddard, as long as it kept his people employed. We had to have him there for yet another fight. And as it turned out, it worked out exactly as we had hoped. Because while he was working on these crazy robots, which he really believed in, to his credit, he took it seriously. We were working with the shuttle people, and the shuttle people were working on repair kits, and ways to get two shuttles on the launch pad, so that when Griffin had the decision to make, it was a reasonable decision. He had backups and backups and backups.

GAINOR: Yeah, because he came in, Griffin came in and he took his time. But it was pretty easy to see which way the wind was blowing.

WEILER: Yeah, because Steve and the institute have done a good job getting the political support, but there are still people within Goddard and Headquarters, below O'Keefe's level, who were building up to the point where Griffin could come in, a new guy could come in and make that right decision. Griffin could not have made that decision if Cepi's people had all gone away. If the shuttle people hadn't worked up the EVA repair kits for the tiles, if the shuttle people hadn't worked the options of having two shuttles on the launch pad. That was all in place for Griffin. All the dominos were in place when Griffin came in. And Steve and the institute did a good job making sure the dominos were in on the Mikulski side, on the Congress side, and on the science community side. So it was again, without them knowing, it was really a team effort.

GAINOR: Okay. So we had Servicing Mission 4—

WEILER: And not 5. Because 5 was still a bad idea. At some point, we do have to move on. I love my Hubble, but, at some point, you've got to build bigger telescopes. Astronomers always want bigger optics.

GAINOR: That's right. One of the things I'm trying to talk about is how astronomy has changed during the past 26 years and where Hubble fits into it.

WEILER: The Hubble, you can't—and this is not an overstatement—you can't open any astronomy textbook, and not see Hubble pictures all over the place, and Hubble data all over the place. It is the key – I want to say it's the Mercedes Benz of cars, I mean. That's not an adequate description. It's the end all and be all of optical/UV astronomy. I mean, you know, it's the watermark, the high watermark, because nothing comes close. Ground-based telescopes say, "We can do it good as Hubble." Yeah, one little tiny portion of the sky on a particular night, but nobody has – if they were so good, why aren't they in all the textbooks? That's the question I always have for people who, at the tennis courts say, "Ooh, I heard this ground-based telescope is as good as Hubble." I said, "Go open the astronomy textbooks and see how many of their pictures you see in the textbook."

GAINOR: Yeah.

WEILER: The Hubble just can't be beat, you know. And the fact that the Congress has funded it for 27 years says something, right? How has it changed astronomy? Geez, that's another 26-hour

discussion. I know when we launched Hubble, we didn't know whether the universe was 10 billion years or 20 billion years old. A factor of two. You might say, why do you care what age it is? Well, as a human being, you go to your doctor and you say, "Well, I'm either 30 or I'm 60 years old." He or she has to make a diagnosis.

How do they make a diagnosis if they don't know if you're 50, 30, 40? Age is an important thing for a human, and for the universe, it determines a lot of factors. So Hubble determined to fix that controversy between 10 and 20 to 13.6. I mean, when we launched Hubble, my textbook when I was in grad school said the first galaxies and stars probably formed about 2 billion years after the Big Bang because, of course, it had to take at least 2 billion years for this enormous, amorphous hydrogen expanding from the Big Bang to start coagulating into clumps and then form stars and then to form galaxies. That process had to take billions of years, right? That's what our textbooks said. We watched Hubble. We look back to 700 million years after the Big Bang, and lo and behold, we saw galaxies and stars.

How could this be? How can galaxies of stars be forming, even before 700 million years? A very strange answer. The universe didn't read our textbooks. Heaven forbid humans are wrong. We didn't know all there was to know. And by what factor? So, that's a mystery that led to that single observation, the Hubble Deep Field, led to the JWST being proposed and funded. That is the cornerstone of the James Webb Space Telescope, to find out how the hell did all that matter start coming together so quickly, and why, and when? How did we begin? Kind of a basic question. So that kind of changed astronomy.

GAINOR: I'm also thinking about how astronomy is done.

WEILER: Well, I was a ground-based astronomer when I started working on Hubble. You get your seven nights of ground-based telescope. You might get seven nights of clear weather, you might get seven nights of cloudy weather, and then you'd have to wait another year. If you got your data, you'd bring it home, you crunch it on a big calculating machine. Then you'd go into the stacks of the library to figure out who wrote articles back to the 1800s, and the whole process of writing one paper might take you a year. Astronomy today? You get your observations on your computer; you do a web search to find out who wrote papers. You can put out a paper every month, and the data's there, and you can analyze it with high-tech computers. It's a whole different world. I would have trouble doing astronomy today. Just too fast paced, you know? Not going to a library? Heaven forbid. What a thought.

GAINOR: Yeah, and it used to be, at least on the face of it, usually almost a solitary thing.

WEILER: And another thing too, is people were labeled. I do optical astronomy. I do x-ray astronomy. In fact, even I got a little taste of that when I was in my first or second year at Princeton [University]. I did some multiwavelength [astronomy], which were really unheard of back in those days, the late 70s, where I'd get Copernicus data, which was UV data, and I'd had some radio collaborators who'd get radio data on the same target at the same time. I had some x-ray people who got x-ray data, and we published on paper with a multispectral. That today is commonplace. When we did it in the late 70s, it was unheard of because, frankly, it took a lot of work. Because there was no email in those days. You did everything by phone. Or heaven forbid, face to face. Something our 20-somethings don't understand.

GAINOR: [laughs]

WEILER: There was no texting.

GAINOR: Right, right.

WEILER: Astronomy is done a very different way. Is it better? Probably, but you know, some of the romance is gone.

GAINOR: And the people who are doing astronomy are a little different. I have one section I'm working on, where you're talking about how astronomy, you have a lot more women in it.

WEILER: Oh yeah.

GAINOR: And I came across a talk you gave, where you started off by talking about, "I was hired by Nancy Roman," and you sort of led from there.

WEILER: I used that little joke. My claim to fame at NASA is I was the first male Chief of Astronomy. Literally.

GAINOR: Hah!

WEILER: I was the first male head of astronomy. I was the first Chief Scientist of Hubble who

was male. Astronomy is actually unique, even when I was starting out in astronomy. For some reason more women go into astronomy than any hard science. You'll find more women astronomers than physicists or chemists, and yet astronomy is as hard as physics because it's mostly physics anyway. But for some reason we draw a lot of women. And there've always been a lot of women. I'm used to having women around me all the time in astronomy, at meetings and whatever. That's not the case in physics or chemistry.

GAINOR: Yeah. And, when you look at that, and how Hubble was involved, there's the Baltimore Charter thing, which was at the institute, which was fully supported by NASA. Did you have to push that a little bit yourself?

WEILER: The independence of the institute?

GAINOR: Not the independence, but encourage women, or to be involved in things like Hubble. Affirmative action.

WEILER: I don't know if I had to push it, but I've always been an affirmative action. My organization at Headquarters used to be called the UN [United Nations] by some people because there was one point in time where I had seven division directors, the minority was white. I had three women division directors, a Hispanic and an African American, and two white guys, I think. I didn't select a woman because I wanted to select a woman. I just made sure that good minority people—whether they're women, Blacks or Hispanics—applied, so that I had the option of selecting them. If they were the best.

GAINOR: Right.

WEILER: And that's just the way I've always done it. I had two or three deputies. I had four deputies at Goddard: two of them were women, two of them were men. You know, center directors.

GAINOR: I'll ask you, maybe with your center director's hat on, but we all know about all the scientists over at the institute and everything else. And I came into this—I knew something about Hubble, but not a huge amount, and it was kind of a revelation to hang out in Building 34 and see all these scientists. That's the most amazing building I'll probably ever have the pleasure of working in.

WEILER: There are more Earth Science PhDs in Building 34, 33, and 32 than any place on Earth. And that's not an overstatement. People who don't believe in climate change, I'd like to see them explain a late season category 4 hurricane that goes up the coast, hits every port city all the way to North Carolina from Miami. Unheard of. And have two category 4 hurricanes in the same ocean, almost in the same place, at the same time. People forget about that other hurricane. I forget the name, Nora? I guess it was hurricane Nora. Yeah. Matthew and Nora. Nobody noticed Nora because Matthew was right up the coast. But just another 500 miles to the right was this other monster.

GAINOR: Right.

WEILER: Go find that in historical climate records. But don't worry, nothing's changing.

GAINOR: If you, if you had my job for a minute, how would you describe the contribution of scientists at Goddard to Hubble?

WEILER: Well, let me answer that in a different way, okay?

GAINOR: Yeah.

WEILER: Why do we have public scientists; why do we have scientists at NASA centers? Do we pay federal salaries to scientists at Goddard or [NASA's] Ames Research Center, California], or wherever, to do science? And I say partially. The real reasons we pay scientists at Goddard, or at Ames, or at [NASA's] Marshall [Space Flight Center, Huntsville, Alabama], whatever, is to enable U.S. scientists to do better science in their role as project scientists. It's a bigger hat role. You can do science at a university. You don't have to be at Goddard to do science.

But what you can do at a university is lead a science team that's going to make Hubble better, that's going to fix Hubble, that's going to suggest an instrument to go on Hubble, to find ways to use the instruments better for all humankind. That's the job of a Goddard scientist. To enable science by other people. Am I being clear?

GAINOR: Yeah, yeah.

WEILER: It's to stand up for science, okay? As a project scientist. Like a Dave [David S.] Leckrone. Dave Leckrone's job wasn't to do science. It was to lead the science working group of university scientists, and somebody had to whisper to John Bahcall, "Hey John, you're testifying at Congress. Can you be sure they know about this clone?"

GAINOR: Yeah. How did you get along with Dave?

WEILER: It was love/hate. Dave and I, we were very close from 1980 probably into the final years of Hubble. But then, for some reason, we went our separate paths and we never met.

GAINOR: Just while we're on this, we talked about Hubble, the institute directors. Couple of the other ones, like Bob Williams.

WEILER: Bob and I got along famously. We had no problem at all. He came to me with his idea of a Hubble Deep Field. I said, "Bob, that's exactly what we ought to be doing. I support you 100 percent. If you want any back cover, or mortar shells thrown for you, I'll cover you." Bob and I got along fine. Steve and I got along fine until he thought I was going to kill Hubble when that fell apart. Riccardo and I were bitter enemies until he realized we both had the same goal in mind and our egos were getting in the way. Once we finally realized that toward the end Riccardo and I were fine. Let me put it this way. I had a lot better relationships with institute directors than the Goddard people did.

GAINOR: [laughs]

WEILER: In fact, most of the times, I was put in the position of being the go-between.

GAINOR: Right. Any comment on any of the project managers, or anything like that?

WEILER: Joe [Joseph R.] Rothenberg, I have to give credit for being one of the best project managers; he was a project manager for the first servicing mission, so I've got to point him out, just because he did a great job. Just managing Cepi was a job in itself. Keeping Cepi under control. John [H.] Campbell was very good. I can't think of a bad project manager. Frank [A.] Carr was good in the early days. I've been through them all. You know Jim [James B.] Odom was a great project manager at Marshall.

GAINOR: And when did you leave NASA?

WEILER: September 30, 2011.

GAINOR: Right at the end of the fiscal year, right?

WEILER: Because I was convinced that the next year, that Congress was going to do something to the retirement system of civil servants and I didn't want to be part of that because I didn't trust Congress. Civil servants are always the scapegoats for anything. And I just wanted to get the hell out and lock in things before they had a chance to screw me. I waited until the last day of the fiscal year because I was hoping they wouldn't try to do an *ex post facto* law. Which I think is illegal,

but man, one never—

GAINOR: Strange things happen. Now, I guess we're kind of winding down, but is there anything that you think should be said that we haven't talked about?

WEILER: We did the institute pretty well. Yeah, again, I don't know what other people are telling you, but my vision, remember, on Hubble I've always been either at the mid-level, when I first started out, to the top level looking down, and depending on how you're getting stories coming up, things look very differently when you're looking down, upward. For instance, a lot of people who never really understood the politics of Headquarters, Congress, and the institute probably never really understood that ultimately, I was never in favor of cancelling Servicing Mission 4. I had to appear to be in order to continue the fight the next day. Because I could have made everybody feel good by saying, "Screw you Sean O'Keefe, here's my badge." He would have replaced me with some milk sop, who just be saluting.

Instead I was there to cheer Mike Griffin the day we got Servicing Mission 4 back. That was true of John Grunsfeld too. John saluted. John and I kind of had a pact. We will support Sean O'Keefe, our boss, but that's not going to stop us making sure the right thing is done, eventually. And the right thing was done eventually. That was one of my biggest concerns on Hubble that a lot of people on Hubble, who used to be my friends or good colleagues, moved away from me because they thought me or John didn't support them in their time of need. I like to remind everybody to look at the way it turned out, not the way we got there. Look at the way it turned out. Did we get what we wanted? Yes.

So, it's the old saying, you've got to lose some battles to win the war. You can't win them

all. Sometimes retreat is good.

GAINOR: [laughs] A strategic retreat.

WEILER: A strategic retreat. So we covered the institute, and it's not worth going into, but there were a lot of software packages that the institute and Goddard fought over like crazy in the early days. Because the institute had the attitude, to be fair, they were a little arrogant. We can do it better than Goddard. Those dumb civil servants. It took a while to get over, but it worked itself out. A lot of this stuff is personality. And a lot of it is what I told you early. There was a real feeling of abandonment by Goddard, that they weren't selected to be the institute. They absolutely expected to be the institute. And having that moved out of Goddard was a slap that—there are probably still people today, 60, 70, 80-year-olds who are still working there, who still feel resentment over that.

It was a deep-seated thing, and nobody should underestimate how deep seated that was. I saw it still when I came to be center director in 2004. I still ran into some GS-14s and 15s who just would say off-hand comments, “Ah, the institute – arrr, arrr, arrr.” For no good reason than that they still didn't like the decision that was made 20 years earlier. Some people just can't get over it. So I think we covered most of the good stuff. Have Robert Smith in, if you have the time to cover it.

GAINOR: Well, alright. Thank you very much.

[End of recording]