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RICHARD L. NAFZGER
INTERVIEWED BY SANDRA JOHNSON
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JOHNSON: Today is June 12th, 2013. This oral history interview is being conducted with Richard Nafzger at Goddard Space Flight Center in Greenbelt, Maryland, for the NASA Headquarters Oral History project. The interviewer is Sandra Johnson, assisted by Rebecca Wright. I want to thank you again for being here today and agreeing to talk to us.

NAFZGER: You're welcome.

JOHNSON: I'd like to start today and just talk about what led you to seek a career with NASA back in 1968?

NAFZGER: Sure. In 1967, I was teaching math and science in a high school in Florida, and we had gone through one county strike of teachers, so there was a short layoff, and then it looked like the entire state was going to go out on strike for the first state-wide teachers' strike in the nation. It didn't look promising, what was going to happen. At the same time, I had grown up working in television and radio part-time—my father was the Chief Engineer of a CBS outlet, WBNS TV and Radio, in Columbus, Ohio—so I'd done a lot of work in the engineering side of it in Ohio, in TV and radio. That, coupled with what was going on in the teaching profession, I had received a call from a friend of mine that I'd gone to school with, who had taken a job with

NASA in the employment area, and he said that NASA was looking for a lot of new hires for the Apollo Project, and was I interested?

I said, "Well, I don't know."

He said, "Well, you'll probably make double what you make now," and so I got more interested. Of course, I was making $5,000 [per year], so they were going to pay me $9,000, if they hire me.

He said he would have someone give me a call, and I received a call shortly thereafter from a Mr. Ray Hibbs, who worked in the Manned Flight Engineering at Goddard, which was newly-formed, and he interviewed me on the phone and said, "We'd love to have you," and he essentially hired me on the phone. I took the job, so I was headed in to work on some sort of what I knew was manned spaceflight television. I didn't know exactly what my job would be, so it sounded exciting to go to Washington, D.C. and work for NASA, but I can't say that I had a career plan. I had no career plan other than to get out of Florida and make more money somewhere else.

When I came up here and checked in and met my new boss, he then told me I would be handling what was called Apollo slow-scan television, and that was nothing like the broadcast television that I was used to. It was a totally different format, and a format on which you couldn't watch on a regular TV—it had to be converted if you watched it.

Quickly, I started going to the Goddard library. Goddard wasn't all built at the time; we didn't have a building at Goddard. We were on University Boulevard, down near Riggs Road, about probably 10 miles west of here at Goddard, where we're at now. I would go over there—they had a library—and start learning about what it is that I was now in charge of because I had no clue. It was kind of frightening. I was about 25, 26 years old, and there were ground sites

and I was going to handle television processing of some sort. We went from there, and so my career developed, from day one on, and it wasn't a career path that I had chosen prior to coming to NASA.

JOHNSON: In those first days when you were here and you were reading about what you were going to do, what were your assignments at that point, or what did they tell you? Were you going to be here or were you going to the ground sites?

NAFZGER: Initially, what they told me was—this was January, February of 1968, so we were already getting ready to launch Apollo 7. That was the first flight that would carry TV, so I quickly was indoctrinated on what we had to do to scan, convert, or convert this abnormal television downlink signal in order to view it, and then to release it to the public. At that point, I was learning how you write engineering instructions and how a tracking site works and where the tracking sites are that we would be using, such as down at the Cape [Canaveral, Florida], called Merritt Island Launch Area, MILA, Corpus Christi, Texas, and then of course there was the [NASA] Johnson Space Center [Houston, Texas] that controlled everything during the mission. I would be going to the sites, and as we expanded from Apollo 7 to Apollo 8 to Apollo 9 and headed towards the Moon, there were more sites involved.

We had what we called Earth-orbit sites, and those were sites that had 30 foot dish antennas that would track—not all of them would do television, but some would do television. And then when we went to the Moon, we had to use 85-foot and 210-foot large antennas to hopefully get a signal from the Moon. Everything was evolving: what kind of TV would be on each mission, would it even be on the mission?

It was hotly-debated that there would be any television. In fact, Apollo 7, the first [Apollo manned] mission, we had worked awfully hard—and in those days, we didn't have as many rules. This was a national effort and because of that, we had no restrictions on travel. If I said there was something wrong at the Madrid [Spain] site, they'd say, "Fine, get a ticket and go." We had plenty of funding, and because it was a national project, we did what we had to do.

To go from 1968 to Apollo 8 circling the Moon in December of that year, and going to the Moon six months later, in July of '69, that's a crash program. We had to learn and do things along the way. The reason I'm mentioning this is we would come in at 7:00 a.m., anytime 6:00 to 7:00 a.m., and probably leave at 8:00 or 9:00 at night, and never realize what time it was because we were having a ball. I was having a lot of fun, but probably what drove me was fright of whether I was doing it right. It was scary knowing what the final product would be.

There was always a debate whether they'd carry television. So I guess to answer your question, your question was really what led me to this career at NASA, well, once I got here and got assigned to TV, my career was set unless I said, "I don't want to do it." No one else was doing it, so it was a unique career where, "We don't have anyone to do ground television processing, you're going to be the man, this is now your new career unless you choose to say, 'I don't want to do it.'" That's how my career started. Turned out, it was a wonderful career, but not because I was wonderful, but being able to work at that program.

JOHNSON: Talk about that debate on whether to have television or not on the flights.

NAFZGER: The debate on television, which was a lot behind the scenes, we were so busy, we didn't hear a lot of it. We would hear it maybe right before a launch that they might not turn it

on or they might not carry it. It's pretty deflating when you're working that many hours and getting things ready to be able to try to have TV, that all of a sudden someone says you might not have it.

I know Wally [Walter M.] Schirra on Apollo 7 was very violently, I guess you would call it, against it. In fact, one event that was passed on to me was during one of the tests on the pad where they suit up and get in the spacecraft, he actually tore his spacesuit on the TV mount. He didn't want TV looking over his shoulder, even though it could only be turned on by the astronauts. He didn't like the idea. In those days, every ounce was accounted for, so when we would put a pound on, if it was over the limit, a pound had to come off, and so they even had a time in the Apollo Program where they had to take off some survival rations in order to make room for the weight of the camera.

The camera was not considered by those in the program, astronauts and others, to be a benefit or science. It was there simply for public affairs. In reality, that was true at the time, it was there for public affairs, but they didn't see it as a necessity for the program, and it certainly wasn't a launch-criteria project or launch-criteria element, which meant that if someone determined that the camera failed two minutes before launch, they're not going to hold the launch. For Apollo 11, even, if that camera had failed, they weren't going to wait another day and fix it. There would be no camera.

What happened was we launched, we got the camera on board, but when we got in orbit, Wally Schirra refused to turn it on. He said, "I'm too busy, I'm not turning it on." We were really upset. You know, not mad, but just deflated. We were young guys that were working to do what we had to, to get TV down through Corpus Christi and the Merritt Island tracking site,

and two or three orbits later—I went to Houston on all these missions—I was told that there was a private conversation, audio, up to the spacecraft.

These guys were all military, so they were essentially given, what I understood, the order, "You're going to turn it on." They turned it on, and then all of a sudden, they started seemingly enjoying it because they heard that the American public was thrilled, and they would hold up signs saying, "Keep the cards and letters coming." It seemed like TV was now all of a sudden a big thing and it was accepted as the first TV from space. As it went on, though, there were still arguments still going on, on whether to carry the camera. That was the story of the first one.

We still didn't know, even through Apollo 11, whether we were going to have a camera on board. That argument went to the highest level of NASA. I think it was Chris [Christopher C.] Kraft, and I forget the other one, there was one of the heads of NASA at the time, they had a heated argument. I wasn't a part of it, I wasn't in those meetings, but one of the guys I worked with in a later project, Stan [Stanley] Lebar of Westinghouse, was in it. I guess Kraft and someone else said "Wait a minute," he said, "this is a taxpayers' mission. They're paying for it and they have a right to see it, and we're going to carry the camera." That won out over, "There's no scientific value to this." It was, "The taxpayers have a right to see what they pay for." Of course, history was made by doing it.

JOHNSON: Let's talk about the slow-scan, and why slow-scan was used instead of broadcast-quality television.

NAFZGER: Sure. When we originally started the Apollo Program, the goal is to get TV from the Moon, even though Apollo 7, 8, and 9 were Earth-orbit type missions. Apollo 10 went to the

Moon and back but didn't land. Even though the previous missions were mainly Earth-orbital, the mission and goal to get to the Moon and have TV gave rise to the problem of how much power and how much what we call bandwidth will it take to get broadcast television? We didn't have today's high-definition, obviously. We do on the [International] Space Station and Shuttle, now, so we've evolved quite a ways. At that time, broadcast was what we call 4 megahertz of bandwidth, head-scan rates, etc., that required this big bandwidth. The more bandwidth you have, the more power you need, so when a television station transmits, there's a lot of power going out there to get it to the home sets. For getting today's cable, or when you add an antenna on your roof, there's a lot of power being used to transmit that to TV.

What we looked at was, well, what kind of power can we get from the Lunar Module [LM] on the Moon, and what kind of bandwidth's available in our downlink streams of data to put TV in it? There wasn't any broadcast 4 megahertz available—it wasn't built for TV. Our receivers were built for data and voice, so the widest we could come up with was 500 kilohertz, and that's 1/8 of what a broadcast signal is. Not to get too technical, but the way to get TV that you can see when you don't have the bandwidth is to change from what we called 60 Hz, or 60 pictures a second, down to 10. Instead of having 525 lines, which was the old broadcast, it was 320 lines. When everything lowers, the scan rate and the horizontal and vertical rates of these signals, you need less bandwidth, so we condensed it into 500 kilohertz.

What that meant was that that signal's not going to be the quality, but it's going to be a signal you can see. You see it on these special monitors that are looking at 10 frames a second, flickering, etc., etc. The next question was, "We have to get this to the public, and we're not going to take pictures off the screen—how are we going to do it?"

I contracted with RCA in Camden [New Jersey] to build the scan converter for the ground sites. This scan converter's job was to take that downlink signal and view it on a small, special, slow-scan monitor, and look at it with a broadcast camera through a prism, and then take that signal and repeat it five more times, so you would get 60 instead of 10, and then play it out through this equipment called processing amplifiers and stabilizers. At that point, the format becomes a broadcast signal. You're not getting 4 megahertz of good video, but you're getting it in a format that can play on a home TV set, and that's why, if you look at any of the old Apollo missions—Apollo 11 is the only time we used it on the Moon—it looks blurry or ghostly because you're repeating each image six times in a row before you go to the next image. If someone moves quick, it looks like a ghost because it's not a picture every 1/60 of a second; it's the same picture six times in a row. It looked very ghostly and blurry sometimes, when they'd move quick, because that conversion had to take place.

JOHNSON: The conversion was at the ground sites?

NAFZGER: Yes, the conversion, in particular on the Apollo 7 and 8, was prototype stuff, and we built them to see how they work, and we had a Corpus Christi and the Cape Kennedy [now named Cape Canaveral] MILA sites. When we went to the actual Apollo setup, we were going to use 85-foot sites, mainly, in Madrid, Honeysuckle Creek, Australia, and Goldstone, California. Goldstone also had access to a 210-foot dish, deep space antenna. Honeysuckle and Madrid each had 85, but in Australia, I'd say about four or five months, maybe six months before launch, we contracted with Parkes Radio Astronomy to use their 210-foot dish north of Sydney [Australia]. We got scared that 85-foot dishes were still going to be noisy with this signal. This signal also,

by the way, when it came from the camera, the slow-scan, it went to a 2.5-3 foot little dish built on the Lunar Module. The antenna was small, and the power's 10 watts. Here we are on the Moon, transmitting 10 watts, trying to get a picture all the way down. The bigger the antenna, the more you can receive at low signal strength.

We got this Parkes antenna, and we had Honeysuckle, and we had a team of guys in Sydney—that's kind of in the middle—and the Parkes signal would come down and get microwaved. In fact, we didn't covert at Parkes because the microwave wouldn't handle the bandwidth of broadcast television, so we had to send the slow-scan on microwave and convert it at Sydney, Australia. Honeysuckle could convert, and they had a microwave that could handle it, so we would take the best picture at Sydney and put it out to Intelsat [communication satellites].

Same thing at Goldstone, they just downlinked it and then fed it to what we called "Ma Bell," or AT&T. Then, Madrid, which didn't play a big part in it, they would relay it by microwave and go to—it was Intelsat, or I can't remember who it was. These would all come down into either Andover, Maine, or Jamestown, California, and off of Intelsat, and then they would be relayed by ground, AT&T/Ma Bell, into Houston. Houston would then release it to the rest of the world, and it'd go back out. That was the path that could break anywhere.

JOHNSON: Yes, it definitely could break anywhere. The converters themselves, you said that you contracted with RCA?

NAFZGER: Yes.

JOHNSON: Were they not in existence before then?

NAFZGER: No, a lot of us referred to it as the Rube Goldberg device because it had so many commercial parts slammed together to make this work. There was some of what they called amateur radio that did slow-scan, a type of slow-scan TV, but no converters. This was the first converter that I know of ever built for this purpose. It was designed and built in conjunction with RCA, and there just weren't any converters out there for any purpose to do this before because the broadcast signal didn't need conversion. The world on broadcast TV was built so that whatever we used was visible to homes, and we sold TV sets based on that format. When we take a slow-scan, it meant that it'd be special if you wanted to show it on a regular TV set.

JOHNSON: You mentioned there were a lot of opportunities for problems. Did you ever have any problems with those converters or any of those signals?

NAFZGER: Yes, we had some big problems. The converter design was fine. I remember specifically when I was in Sydney, and prior to mission, probably three months, maybe—I can't remember the exact dates—probably three months before the July '69 mission, that's how close we were when we were actually setting up to operate for a mission that was going to launch. Many missions, you'd be ready a year ahead and be testing all the time. We were on the fly. We had this converter, and we were operating out of downtown Sydney, in Australia, called the Overseas Telecommunication Commission.

Australia was a unique place; they loved Americans, which was nice, but they were also a different societal-type operation than us, so you had to be very careful that you didn't offend

anyone by doing something before the right people met you. We were very strictly controlled on what we could do when, and who we had to see before we could go to the next step, even to get in that building. Once we got set up, we installed a converter and the Navy brought in a power converter. The Australians use different power than we do. They use 50 hertz cycle—at that time, called cycle—we use 60. Their wiring—not, again, to get too technical—what a red wire and a black wire means in the U.S. to an electrician is the opposite in Australia.

This big converter, to take this Australian power of 50 hertz and make it 60 so we could run our converter that takes slow-scan and makes it broadcast, we're converting everywhere, that converter—which was called Big Bertha; it was tons of equipment that came into the basement of this building—was hooked up to our converter, and everything was powered up. We were running successful tests.

I remember it was a weekend, and for some reason, we weren't allowed to work there. I don't know if it was because it was Sunday or a Saturday, or we had a day off. Whatever it was, we were off and came in the next Monday morning. We came in, and I was in charge, and they said, "Dick, turn on the converter." I turned it on and that smoke came flying out of it. Relays were flapping all over the place. I turned it off, but it was too late. It blew up about $100,000 worth of equipment. We're three months before launch and we're trying to figure out what happened.

Eventually, what we found was a technician came in on the weekend. He was down in the basement, looking at this big converter, and he said, "Oh, these Americans have wired this backwards—their red wires." Instead of giving us 110 volts, he gave us 240 by changing the wires. We never took action against him—they did—it was a shame, it was an honest mistake,

but he didn't ask questions and he switched the wires without telling anyone. That's what blew up our converter.

We had emergency shipments from Camden, New Jersey, from RCA. They had technicians flown over at the last minute. It was a crash program to get the converter back up. As you know, we got it all back up, working. The only other thing that happened—along the way, you always have tests that have a problem or you have interference or whatever, and you're always working to clean it up—that was the only major problem.

Right before launch, when they buttoned up the Cape, buttoned up the total launch vehicle, I got a call. There's two reasons why the camera, being small, didn't have a bigger antenna. Later in the missions, we had an antenna they would take out of the LM and put it on the ground and deploy it, and it'd be a five- or six-foot dish. We wanted to see Neil [A.] Armstrong's first step on the Moon, so you can't go down and put up an antenna and go back up, and take the first step on the Moon! That's why the little antenna on the LM was going to be used.

The camera had to see him, so how are you going to see him? They had what they called the MESA [Modular Equipment Stowage Assembly] Palette on the side, and when they landed, they'd pull a rope and it flops out. It flops out, and inside, there's some stuff, but also it's a camera mounted on the door, essentially, pointed at the stairs for Neil Armstrong. This camera, later, is to be taken off of the MESA Palette and put on a tripod. That's where you saw all the EVA [extravehicular activity] and the lunar activity because they took it off there and mounted it—which meant it had a handle.

To put this in the MESA to watch Neil Armstrong, you couldn't mount it with the handle up. You mounted it upside down, so the top of it was on the shelf, and therefore, you would be

able to mount it there, and then you took it up, you turned it over, and put it on the staff that it was mounted on the surface. They didn't realize, or didn't think about it, until the last minute, that, "Wait a minute—when this thing opens up, the camera's upside down, it's going to look like he's walking off the Moon—it's upside down. We can't get into the spacecraft. You've got to change all your scan and conversion at the ground sites so that left is right, right is left, up is down, down is up." This isn't technically a very difficult thing to do. You'd have to have a switch so that when he comes down, it's one way, and when you take the camera and mount it, you flip it back the other way. You also have to have it all perfectly aligned, so that each way you flip it, it doesn't throw this thing off or half the picture's missing.

It was a last-minute emergency switch, and lo and behold, when we started Apollo 11, they decided to come out early. This was to take place mainly over Australia. In fact, even the first step was on Australia, but the whole thing was coming to Australia. The astronauts got antsy and wanted to get out of the spacecraft early, so now Goldstone was the first site. They wanted the first step at their first site for TV downlink, and I remember, I was sitting at Houston [Mission] Control Center, and they said, "Turn on the camera," and, "Well, we don't have anything yet," and we're all holding our breath, you know?

What happened was because it wasn't supposed to be at Goldstone, operating television was kind of an art, this converter. You had to know how to set up things on the fly to make the picture look right. Because it wasn't a well-established program like telemetry or voice or tracking, these people trained for years to do their job, we had to train people and pick them and find out which guys might work out better. They didn't have TV backgrounds, so you were picking guys so the best guy would be on during the support—well, they went out early, and the

best guy wasn't there. He had the switch in the wrong place, so when it first came on, it was upside-down.

They corrected it, and within six minutes, it transferred, because of the Earth's rotation, to Australia, who had their best guys on. That's where the first step occurred, but that switch was in play and obviously showed it to be in play because it was in the wrong position at Goldstone when they first came out of the spacecraft. When Neil started his descent, he was upside-down. It all worked out eventually, but it was kind of hairy. I remember sitting in the Control Center, and of course, the goal of Apollo was to go to the Moon and safely return—that was it—and when they landed safely and everybody was celebrating, that was the goal and we were all caught up in that. I wasn't thinking a whole lot about the TV yet.

One of the managers walked in and said, "Well, we landed. Now there's 600 million people wanting to see TV and it better work." That's when it dawned on me, a 26 year old sitting there, saying, "I'm the guy, now they're going to blame if it doesn't work." You're 250,000 miles to the ground, you're back to Intelsat, you're down, you're through all the equipment at the site, you're through AT&T, you're through people you don't even know, and this has got to be live. This isn't like a commercial that you can play over—it's got to be live. It was kind of scary when we first started, what we were going to get. It worked out as good as we could have hoped for, I guess.

JOHNSON: The quality of the picture, from what I've read, what you saw in Mission Control was different than what we saw at home on our televisions.

NAFZGER: Let me explain, that probably not so much what we saw in Mission Control; what we saw at the tracking sites was the raw downlink slow-scan, which would be much higher-quality than the converted signal. What we saw at Houston would probably be what you would call the best converted picture because once we sent it out to Intelsat again or to the commercial carrier, depending on how he's doing, he may preserve it as well or not.

What we saw at Houston was pretty similar to what the world saw. It wasn't edited; it was passed through. The only reason it went through Houston was if there was a problem, someone had to cut it. If there was a fire on board or something blew up, you always have to be able to turn it off to the public if there's an emergency, just as we do with Shuttle or any other project. But nothing was edited. When they talk about the quality of it, people are generally referring to the fact that the slow-scan, if you could have seen it, was probably, I'd say, three to five times higher quality than what you could get when you converted it.

JOHNSON: Were you always in Houston during those Apollo flights?

NAFZGER: Yes.

JOHNSON: So you were always at Mission Control?

NAFZGER: I would be at tracking sites and Goddard throughout between missions, and I would go to Houston every month. Even without the mission, I would be there a couple of weeks every month, getting ready. Then, every mission, I would go to Houston so that I would be in contact

with all the tracking sites at the same time and be at this, I guess, the center of operations, so that if there was a problem, I would be there to talk to the people at Houston.

JOHNSON: You also did testing at the Electronics Systems Test Laboratory.

NAFZGER: The ESTL, yes. The ESTL at Houston was just a tremendous place for me because they had all the spacecraft equipment. Again, when they decided to go to the Moon, we didn't have all the equipment we needed and we couldn't run test signals from the Moon to us to see how strong they would be. We had to simulate everything, and ESTL was the only place we could actually simulate the lunar signals with actual spacecraft equipment. I spent tons of time at ESTL, working with Jack [W.] Seyl and others that ran that facility, not only looking at the downlink signal, but what we had to do was a lot of our ground site equipment other than the converter—even in later missions, when it wasn't slow-scan—was to process that downlink. It was commercial equipment that we would either modify or we would buy commercial equipment. This was after slow-scan. Prior to and during Apollo 11 was the only time slow-scan was used. Then, it went to color-sequential, and then eventually, when it got to Shuttle and in Space Station, it's high-definition.

What we did was we took commercial equipment, sequential-color TV came into play in Apollo 12. It was on the Command Module in Apollo 11. This is instead of, I mentioned before, a 500 kilohertz signal, this was 3 megahertz. Still wasn't 4, but it was 6 times what we had before—which was somewhat interesting because now we had a signal that was 3 megahertz wide, 6 times what we were able to do before, but in the middle of it were two telemetry signals, voice and data. Right in the middle of our picture. It's like saying you just stuck two sticks up

in the middle of the picture and blocked part of the picture. We had to get rid of it, so they built what they called cancellation devices that would actually take the signal and reverse it on itself and just canceled each other out in the middle of the picture. It worked very successfully. All that testing went on at the ESTL lab, and we would bring commercial equipment down there.

We would go to RCA or we would go to what was called Grass Valley [Group], or JVC or IVC and buy what we called processing amplifiers. Actually, it was like the battle of champions. We'd bring five companies in with their equipment and we would take a signal from the spacecraft equipment, simulate it, bring it down weaker and weaker and weaker, until we called it a loss of signal [LOS], and see how these pieces of equipment would process it because they were built for broadcast. The best signal we ever got from space would never meet the standards of a broadcast signal, so none of these devices are designed to handle—what we considered our best TV was terrible for them.

What we're talking about is an engineering noise content, where you start seeing noise in the picture. We couldn't get near this cleanliness that you can when you have a big transmitter and do all these things, so we had to look at what equipment would still handle things for us and how we could modify it to still lock on to a signal. It wasn't just lunar that we were worried about; it was even Earth-orbit. When we do Earth-orbit, you come over a site—say it's White Sands, New Mexico—when it's Earth-orbit, you have what you call AOS, acquisition of signal. You go 8 or 10 minutes, and then you have LOS. The better the equipment, the longer you can hold on to this thing before the next site picks it up.

That's where we did all the testing, all the simulation, and learned what we needed to learn as they had tremendous support at ESTL at Houston. I couldn't have done it without them, they were terrific, just terrific guys to work with, too. I was kind of the guy in charge and

learning, and they accepted me for that. It wasn't us against them. There was a lot of competition between JSC and Goddard—always has been—on, "We don't need you," and, "We can do it all from here." It was kind of like, "Do we need a separate tracking network run by Goddard versus let Houston run it all? We do the spacecraft, we can do this." And yes, it was true, they could do it if they were given the job to do it, but that wasn't it. We had the tracking network. We had to work together, but there was always this competition.

I remember going to Houston for meetings and reviews, and they were challenges. At my age, most of the guys were in their 40s—I'd say anywhere from 35 to 50 years old—and I was 25, and you come in there and you are going to go through a beating in these meetings. They were going to question you up and down. I went to law school later and got a law degree, but it was probably my first training to be a lawyer, was to have to be cross-examined by Ed [Edward I.] Fendell and some of the people at Houston.

JOHNSON: Apollo 8 was the first time the people on Earth actually got a good view of what the Earth looked like from space, and also those close-up views of the Moon. Of course, it was still the black and white, the slow-scan. Can you talk about those first images and when they came through, and your relief?

NAFZGER: I remember the night because it was Christmas Eve. I remember the astronaut started—I guess there were some stories I heard recently about who was going to read what from the Bible—we didn't have any controversy going on about should they read from the Bible or not, but we didn't really know what they were going to do. As it turns out, I don't think they did for sure, either. It just kind of came together: I remember before we saw the Earth, they were

trying to point that camera and get a view of the Moon and the Earth together, and so it took some manipulation because they don't have a good viewfinder on a camera. They're holding the camera up and the Earth's telling them what they're seeing. They have a monitor, but it's pretty hard to do. Once they got the view and started reading, and it was Christmas Eve, it was pretty impressive, and I think most of the television audience was quite impressed with that. Later on, you see color photos that were taken out the window of that view, coming around the Moon. That's what I remember. It wasn't anything special or difficult to do for the TV part of it, but it was spectacular as to the effect of it.

JOHNSON: Just further away, to get that signal back.

NAFZGER: Yes, again, we were having to work with signals at a lunar distance. This was from the Command Module. I think we had a little more power there than we did—same camera, but it wasn't from the Lunar Module—I think we used 85-foot dishes, as I recall, on that, so it worked out all right, but it wasn't going to be the same on the Moon from the LM, from the Lunar Module.

JOHNSON: You were mentioning the color—Apollo 10 was the first time that color cameras were used?

NAFZGER: Right, sequential-color.

JOHNSON: Sequential-color, so then on Apollo 11, they had the color in the Command Module, but they didn't use that on the surface of the Moon. Was that a power issue, or was it the weight?

NAFZGER: Both. Weight and power. The development of the sequential-color wasn't ready for the timeline of Apollo 11 regardless. Probably if it had been delayed six months, it probably would have gone with color; they might have gone with it and tried it. You have to remember, once we used color, like I earlier said when I was talking about sequential-color, it was six times the bandwidth. Once you do that, you use that same little transmitter, you're going to have a weaker and weaker signal.

The other problem was, the link from the Moon would not pass 3 megahertz. It was a link and a receiver meant for data, and so we didn't have it available. The whole career in television at NASA, television wasn't part of the program. It was almost like an afterthought, "We ought to have television, let's try television, let's do this, let's do that." It was pretty piecemeal throughout, even when we went to Space Station and the Shuttle, it took them a long time to start accepting that television wasn't just for the public anymore. You can use this to look at science, you can use this to work on EVAs, and all of a sudden, television became a tool and a science item. It took them years before NASA would start saying, "Television's not just public affairs." That's what made it more of a program item is because it was now being used as part of the mission-required tools.

JOHNSON: Apollo 12, of course, they had a problem with the camera on the surface. Can you talk about that just for a second?

NAFZGER: I have friends who know Alan [L.] Bean, and he's still apologizing. From what I hear, he's a real nice guy and he feels terrible about it. That was simply a case of a camera that—these cameras are not to be pointed at the Sun. When he was moving the tripod or whatever, the camera got pointed at the Sun. We had really good video going on, and all of a sudden, we see this bright glare, and then we see part of the picture in the top, but not in the bottom, and we knew right away—this was called a Vidicon [camera]—and it's burning up particles on this Vidicon. The blind leading the blind, we have people—it wasn't my job; I don't do the spacecraft camera, I only take the signal when it comes down—they're on the ground and saying, "Move this and do this," and he said, "Wait a minute, maybe if I hit this on the side," and as he hit it on the side, thinking something's loose or something, I don't know what he was thinking, you could see actually pieces of the Vidicon falling.

The image was probably not those pieces, but you could see it was crumbling in front of your eyes. It was pretty wiped out when he first pointed it at the Sun, but that's how sensitive it was. This thing had to go from pitch-black to bright and adjust, and if you just went whack in the Sun, it was going to do—I didn't know it would do that. It was surprising that they didn't have automatic aim controls to the point that it would just shut it down and tell you to get it out of the Sun, but these cameras were designed for lunar surfaces.

The camera itself, it was kind of interesting. These cameras, when you saw a picture of the Lunar Module and say you see a shadow from the Lunar Module, and here's a camera on the tripod, Apollo 11, or any Apollo mission on the Moon, when that camera sits in the Sun, it's 250 degrees Fahrenheit. If you move it in the shade, just move it over in the shade, it's minus 200-

250 degrees. These Vidicons, these tubes and these internal electronics of these cameras had to be able to cycle through those huge temperatures in a short time.

They had gold padding on them. I remember getting some test gold leaf—I still have it at home, it might be worth money now—these are wrapped in Sun reflectant and insulated, but it had to go through tremendous temperature and light changes as it is. As time evolved, they protected the camera from sunlight bursts and fatalities such as this camera. I think they blame Alan Bean for hitting the camera, but the real problem was it was pointed at the Sun and the camera didn't have the protection against a quick look at such a bright object.

JOHNSON: I know that like with the still photography, the astronauts went through training on how to take photos. As the missions went on, they learned more and more. The same thing for the television cameras?

NAFZGER: Yes, I wasn't involved in that but I worked with, again, Westinghouse, who built the camera on the Moon and built a lot of the cameras, Stan Lebar. They went through complete training sessions on how to hold the camera, how to point it. That wasn't an unknown, that you don't point at the Sun. I can't blame a guy that's walking on the Moon in a spacesuit making a mistake.

JOHNSON: Yes, he's a little excited.

NAFZGER: You've got a lot of things to think about besides is the camera pointing up at the Sun.

JOHNSON: I know that the technology was evolving in the cameras because they did find these problems, that the cameras evolved as well?

NAFZGER: Oh, yes. We stayed sequential-color for quite a while. It was working. That required a conversion also, but it was no longer called a scan converter. This was really extracting what you call red, blue, and green signals and putting them back together in a composite that gave you essentially 3 megahertz of broadcast color. It was a conversion done at Houston. This was all done at Houston. We would feed the sequential color signal—and by sequential, what I mean is these cameras had a spinning disk in front of the tube, and it had a red, green, and blue filter. Every 60th of a cycle, it would be all blue or all red or all green. Those are the basic colors that make up color TV.

When the signal came down electronically you would just see what we call 3 megahertz broadcast signal. If you broke it down every 60th of a second, it would be all red, blue, or green. When I got to Houston, they extracted what was the red, what was the blue, what was the green, added what they call a color burst, which was what controlled color and put it back together and sent it out live. That was now broadcast television. It was 3 megahertz, which was what we call good quality for what we had when we had slow-scan, but it still wasn't broadcast. It was still two-thirds of the way towards having a full broadcast camera. It wasn't until we got—and I may be wrong—but it wasn't till we got to Shuttle, I think, that we really had broadcast-rate downlinks.

JOHNSON: Of course, Apollo 13, the accident happened.

NAFZGER: Right, Apollo 13 was, I don't know—it's funny, people ask me about that and I don't recall much except worrying about whether they were going to get home. I can't remember a thing about TV support, other than I remember them putting the camera out, looking at the damage, and seeing where the explosion occurred. I could kind of tell—I couldn't tell what they were talking about to the extent they could see it, but that's the only video.

JOHNSON: They used the TV video to view the damage?

NAFZGER: Yes, but I think at an angle. What they saw is, I think, they took a spacewalk eventually or something, once they got into the rescue mode. Maybe not, but they were able to see the damage and determine it was an oxygen spare tank. We were in the dark during all that. We were there, but it was like, "Everyone stay in place and we'll work on it." In fact, I think I came back to Goddard while they were still in the rescue mode then because TV was not being used, power was being conserved.

JOHNSON: In the end of the Apollo missions, Apollo 15 and 16, there were ground-controlled cameras?

NAFZGER: Yes, that was probably a breakthrough also. We had what we called a "ground-controlled television assembly," GCTA, which we humorously named "the Gotcha." This was the housing that would go, the camera would mount in it. In fact, Apollo 15 did two things: it had a ground-controlled television assembly, which meant you could remotely move the camera up, down, left, and right, zoom in and out, and they also put a rover. It was the first rover on the

Moon, and this camera, when it wasn't on a tripod, mounted on the front of the rover like a headlight. They could stop the rover, and then the ground would control where it would look. I remember two things—one is that that's what enabled us to then watch a launch from the Moon, that was put on a tripod at that point. Ed Fendell was famous for all this because he was the controller that would send the signal, and if there was a countdown to launch, he had to send the tilt up. You're going to launch, so you're going to tilt the camera up and you're going to pan it.

You got a predetermined path that you think the LM is taking so that you can follow it, but you have to start your signals 2.5 seconds before they do the actual launch on the Moon because the signal won't get there. If you were in a studio and you told the operator, "Move the camera up," it's instant. We've got 2.5 seconds before that thing is told to move up, and he's launching. You have to make sure the signal gets there when he hits or mixes the fuel on the LM. That was the trick, to do everything 2.5 seconds before it was needed. That's what enabled him.

The other thing was when we were on the Moon on Apollo 15 and we had this ground-controlled assembly, I remember, we were talking—I don't know if it was in the Control Room or where it was—what happened is there was a dish on the rover, and they would stop and then re-point the dish to the Earth to lock up and then turn on the camera. What we said was, "Well, even though we're not going to air this to the public, let's keep the camera on while you're moving and see if we can keep locked up on the signal for a while".

We did it for, as I recall, and I wish I had the tape, it was, I think, about 30 seconds before the antenna was no longer pointed right because they were moving—because it wasn't automatically going to point at the Earth, you had to manually do it. During that 30 seconds, they're moving along, I would guess, five miles an hour? Maybe slower. With the camera

mounted right down, probably two feet off the ground, looking at the lunar surface and horizon, it looked like they were going 100 miles an hour. It was amazing. It looked like a racecar headed across the lunar surface. It was really slow, but it didn't look slow. I thought that was really neat, but it was not something we could do for the public because we couldn't guarantee it was going to stay locked at all. The ground-controlled assembly enabled them now to see the astronauts doing things that before, when you put the camera up there, unless they're in the field of view or go remove the camera and then go back and do something.

The other thing that happened during the ground-controlled systems is the astronauts knew, of course, that they didn't have to go move the camera. If they were going to go over to their right, they would say, "We're going to move over to the rock about 30 meters to our right." Of course, then the ground would send a signal to start the camera moving before they did. The astronauts, some of them—I can't remember which ones—they had a sense of humor and they're on the Moon. They said, "We're going to go over to the rock on the right," and the minute they said that, they'd run to the left. All of a sudden, the camera goes the wrong way, and they can't find them, and they don't know where they're at. They would have to search and find them, and it was half funny and half not so funny because we don't know if something happened. They were hiding behind rocks because, "You couldn't find us—there was no cameraman to find us!" You had to know which way to point. I guess that was part of their fun.

JOHNSON: I guess you have to find your fun where you can.

NAFZGER: Knowing you may never come back, you might as well have fun while you're there.

JOHNSON: Yes, and there are some of those iconic images—of course, Pete [Charles] Conrad singing, and all those different things that we all remember. I think they did have a lot of fun while they were there. While we're on Apollo, let's talk about the recovery of the Apollo video that you've been involved in here in the recent years.

NAFZGER: You mean the search for the missing tapes?

JOHNSON: The search for the missing tapes, right.

NAFZGER: I also was involved a little bit in some tapes that were actual recovery tapes of the Apollo 11 capsule, the U.S.S. *Hornet*.

JOHNSON: That would be great, we'd love to hear about that, too.

NAFZGER: There's not a whole lot of story, but during the search, what happened was that long story short, it came up that someone had looked, in Australia, at some of the slow-scan pictures of the TV set with the slow-scan and said, "Oh, my gosh, that's so good compared to what we've ever seen—where are those tapes that had the slow-scan," because lo and behold, this was 1969 and it's now 2006, and it's almost 40 years later, and the world is digital. We can take tapes and digitize them. We can convert them.

In '69, that wasn't even a thought, so when we recorded the downlinked TV, what people don't remember when I went through all these press conferences about where are the tapes, digitize the tapes, the goal of the mission was to transmit live TV from the Moon, and that was

done. That was the only goal: get it down, convert it, send it to Houston, send it to the world, you're done. It's an historic moment, and it was accomplished.

The video itself, slow-scan, was converted, but let's say the converter broke during the downlink. It was taped so that we could play it back through the converter if we had to. It wouldn't be live anymore, but it would be still video from the Moon. That's why we recorded it, and it was recorded on a big reel that was used for telemetry and data. In order to get—I mentioned that little 500 kilohertz of video, that's much wider than the data they ever had—so to get that on one of these 14 tracks on this tape, that tape had to spin at 120 inches a second, which meant it only took about 10 minutes to fill up a tape 15 inches wide. For every 15 minutes of video on the Moon—we did a 3-hour EVA—you had tons of tapes being made at every site, prime and backup recorders, and on and on. It was one track out of 14 other tracks that had telemetry data, voice data, biomedical data, tracking data, so mainly, those recorders weren't for TV, but we found a track we could use, and that's where we put it. When they saw the pictures, they said, "Well, where are those tapes?"

These tapes were all shipped in, and they were shipped in to Goddard, and then they were transferred, eventually, to the national archives storage facility in Suitland, Maryland, [Washington] National Records Center. We said, "Well, if we could find those, we can now digitize them and come up with four or five times better quality TV than anyone's ever seen." We started looking for the tapes. I was authorized by Headquarters to go ahead, they'd contacted Headquarters and then they called me. We went to the National Records Center and started looking.

What happened was we found some Apollo 9 tapes in the National Records, and National Records Center in Suitland is part of the National Archives [and Records Administration], but

it's not the National Archives. What that means is we had hundreds of thousands of articles. I found JSC stuff in there, all kinds of stuff that nobody knows is there, even though it's categorized and labeled and there's a record of it. Unless someone is actively looking for or reviewing it, it's mission tapes, all kinds of audio and video—but we found some Apollo 9. These tapes that came in from the sites, all around the world, our tracking sites, there were probably 400,000 of these things. We found Apollo 9—no video, but tapes—we said, "We've got the right place." And we couldn't find Apollo 11, and that's what we wanted, the slow-scan. That's the only time it was recorded.

What happens is these tapes come in and sit in the National Records Center, and they might sit there for 20 years, and they get reviewed maybe every 10 years, and then what they do is they go back to the people who had the data on there—scientists, mission experts—and say, "Look, we've got these tapes, we've got 500 of these tapes with the so-and-so data on there, do you still need this data?" Most of them didn't need it because they already got it live. This was a backup tape. Or they used the tape, extracted it, and sent the tape back.

Once they say, "We no longer need it," the tapes can be either destroyed or they can be what they call degaussed, recycled, and sent back out for further use if they're in good shape. They had a whole recycling center, that basically Goddard would take tapes, erase them, then run test signals on them and measure what we call bit-air rates to make sure they had the quality to do mission. We were looking, at the time, in late '70s, early '80s, Landsat [Program] needed tapes and the Shuttle Program needed tapes.

As I tracked this down, I found that what happened was we were buying millions of dollars' worth of new tapes and they didn't meet spec [specification], they came in and got rejected. Now, we had the Landsat and we had Shuttle about to launch, and we were short in the

network to be able to record data, which was a crisis. They started hauling tapes out of the National Records Center and reusing them. Nobody at the time was saying, "Wait a minute, there might be some tapes," they didn't come to me and say, "Are there any tapes with TV on them?"

I wish they had, but nobody was tracking this slow-scan TV because it was thought of as just another piece of data on a data tape. Again, as I said, the mission objective was to get live TV to the world, and they did. No one had the foresight to say, "But we could do something with this." Long story short, we were able to pretty well definitize what happened, which was these tapes were degaussed, recertified, sent in the network, and that data was lost. That's what happened. If someone had said in '69, "We're going to record this as a backup, and if we don't need the backup, we're going to keep the tapes anyways because we think 40 years later, we'll be able to use them," then we'd have done it.

In retrospect, the other side of it would be, "You know, there's something called TV, even if it's not broadcast, on one of these tracks." If they'd said that to me, I'd have said, "Don't destroy that." I'd want it even if I couldn't use it on broadcast—I would want it because it's TV. It just wasn't like that, that way.

It was unfortunate, but the tapes weren't lost, they were intentionally reused. If someone had said, "Track 14 is slow-scan TV," the people recycling it would have probably said, "So what?" They wouldn't know that that's something they should question. It was simply, "Is there any reason that we need this anymore?" Again, the mission didn't have TV as a prime objective, and secondly, when we did put TV on, we met the objective of live TV to the world. It's unfortunate, but that's what happened.

What we did as the second level was we went out and searched all the broadcast tapes from CBS New York, ABC New York, went to all the positions that had the first feeds and got what we thought was the best broadcast quality. Then, we worked with a company in Hollywood [California] and we removed noise and removed smearing, we removed all kinds of artifacts in the tapes and came up with what was called the re-done Apollo 11 video. That's what we have now. It's probably twice as good in many areas than it ever was, but it'll never be as good as the slow-scan could have been.

JOHNSON: How long a process was that, once you started looking?

NAFZGER: It took me about three years, from 2006, I believe, to 2009, when we finished the project and had the reconverted or enhanced tapes done. Then, they had the Emmy Awards and decided they ought to—I think what happened was that when we did all that tape stuff, searching the tapes and then upgrading the quality and playing it, and got a lot press, and then they had some press conferences, you know, to question me, "Did we go to the Moon?" We had a lot of those nuts out there. All that publicity, I think, triggered the Academy saying, "You know, the radio and television arts and sciences part of the Academy has never awarded an Emmy to NASA for historic TV."

All of a sudden, the 40th anniversary came around, all this stuff was being publicized, and all of a sudden, it's announced that NASA's getting an Emmy. Then, Headquarters calls me and says, "We want you and Buzz Aldrin to accept on behalf of us." I felt almost ashamed to do it. At first, I thought, "Okay, whatever," then I realized it was a big deal. My wife went to Hollywood with me and walked on the red carpet and all that, so it was pretty exciting stuff for

her more than me because I had to make a speech. That's the last thing I wanted to do, but it all worked out really great, yes. I've got a big Emmy sitting in my dining room.

JOHNSON: Really? That's exciting.

NAFZGER: Yes, and there's one at Headquarters in the lobby—you could have seen it there. You'd see my picture with Buzz Aldrin, and June Lockhart was the Master of Ceremonies at this part of the Emmy Awards.

JOHNSON: From *Lost in Space* [television show]?

NAFZGER: Yes, they use her all the time. A wonderful woman, just so friendly. Really great. Went drinking with her afterwards. It was terrific.

JOHNSON: You mentioned that you were involved in some of the recovery on the *Hornet*? The video?

NAFZGER: I wasn't involved in the recovery, but during the search. When I was looking for the tapes, we would get calls from people saying, "I think I have your tape," you know, "my dad worked for NASA and I found this thing in the basement." We got calls left and right, and other people saying, "Well, we have a tape, but you can't have it unless you give us a lot of money." None of them had what we wanted, so we humored them a while, and then said, "Sorry."

I got a call, this was a fellow that was the Second in Command on the U.S.S. *Hornet*, which was the recovery ship for the Apollo 11 capsule for the return to Earth. He was over in Chesapeake Beach, on Chesapeake Bay, he lived over there. He had tapes from on-board, and that's when the Apollo 11 capsule was picked up, was brought to the U.S.S. *Hornet*, they were put in, what do you call those? I'm trying to remember the name of it, the little vans you pull that you live in when you go on vacation [Airstream travel trailers], the famous ones?

JOHNSON: Yes, for when they were in isolation [Mobile Quarantine Facility].

NAFZGER: Yes, so they put them in this isolation, and that's when [President Richard M.] Nixon came on board to visit them and say hi, and all this. All this was recorded for ABC. ABC was the news coverage, and they recorded it on board. He was explaining, he wanted to give these to NASA, donate them before he died. He was an older guy. He says, "I want NASA to have these."

I said, "Even after reading about what they call our lost tapes, you want us to have your tapes?"

He says, "Oh, yes." He wanted to give them to us and what happened on board was when all that took place, some of it was live, but a lot of it wasn't. They had two tapes they made, two recorders recording all this stuff. One tape was given to the guy and they put it on a helicopter from the U.S.S. *Hornet* and flew it to Hawaii, to bring it back to the U.S. to play to the public. The other tapes stayed on the U.S.S. *Hornet* in case the helicopter crashed. That was the reason, "The helicopter might crash, we need a second."

It didn't crash, and these tapes were given to him, and he's had them for years. It shows a lot of footage of the actual recovery and the *Hornet* streaming to the capsule. Pretty exciting stuff, actually. He was telling us about some of the stories and some of the things that occurred, that when they first started the recovery process, when they landed, they didn't know what germs could be brought back. That's why they were in isolation, right? When the frog-men or recovery men would come in, the first thing you did was there was a tube that came around the capsule to keep it floating. They completely sprayed it all with Betadine—I don't know if you recall Betadine, it was like Merthiolate, it was a disinfectant—and they spray everything with that.

It turned out this stuff was slippery as hell, and they couldn't get up on the Command Module ring because they keep slipping off, so they had to come up with some other disinfectant or they couldn't recover the astronauts. That was one thing you learn, and you can see the red around the capsule. That was one of the problems they had. It was just interesting footage, and some of it's probably never been seen. NASA Headquarters, you might want to check into it, has this. I don't know where they put it.

JOHNSON: Has it been digitized, do you know?

NAFZGER: I don't believe it has. Some of the historians down there should be aware of where this is. This is something someone ought to take a look at and utilize because it shows a lot of recovery stuff that I doubt if most people ever saw. It's fascinating stuff, even Nixon and everything Nixon did wasn't on TV, so it shows all the Nixon going around the ship and acting important.

JOHNSON: It's the raw footage.

WRIGHT: I'm sure the *Hornet* people would like to have a copy, too.

NAFZGER: They might, now. He had it digitized on the DVD, this guy that gave it to me. He had DVDs of it, but NASA didn't, unless he included that. I can't recall, now. Maybe I have one—I'll have to look before I die, and see what I have at home.

JOHNSON: During this search, in finding different tapes—like you said, you found Apollo 9 and some different things—what about playback for these things? Did you still have the equipment to look at what you were finding?

NAFZGER: One of the big pluses at the time was the fact that one of my technicians had been there as long as I had. He came maybe a little after me, but the recorders in his lab that were used from Apollo, he had preserved those for 40-some years, and they were in total operating condition. They'll still play tapes that we used in the network for data and stuff, so we had actual Apollo 11-type recorders that had been preserved and in-use, ready to go, if we got the tape. We had everything we needed to convert.

JOHNSON: Let's talk about some of the other programs. Skylab?

NAFZGER: Skylab was, of course, the first lab we had, and we did a lot of support of Skylab out of Rosman, North Carolina. We had a Rosman tracking site down there, an 85-foot dish up in the mountains of North Carolina, near Asheville. There wasn't anything I can really recall special, other than we did our normal support, and it was kind of like, Space Station or Shuttle after it's been up a while, it was just ongoing support. I can't recall, unless someone reminds me of something that happened, anything specific in that project, other than support from Rosman was a new area of support.

JOHNSON: Like you said, they were there 24 hours a day for extended periods.

NAFZGER: Right, right, absolutely.

JOHNSON: Did you stay in Houston the whole time?

NAFZGER: No. On those missions, on Skylab, I was mainly at Goddard, and we would directly go to Rosman or one of the tracking sites for work, ongoing work, but mainly at Goddard once it was ongoing.

JOHNSON: Apollo-Soyuz [Test Project] was the first time Americans saw a Russian launch, and did you coordinate with the Russians in the television coverage? How did that work?

NAFZGER: I didn't handle launch TV. That was handled out of Houston. However, they coordinated showing the launch of the Russians at the time. I handled the television from

Apollo-Soyuz, and that was unique. Our coverage used ATS [Applications Technology] Satellite, at the time, and our tracking sites weren't able to cover that. What happened was we set up to use a tracking site north of Madrid—we have a tracking site out of Madrid, northeast or due west of Madrid, but we couldn't use it.

They gave us a location called Buitrago, Spain. It's a Spanish tracking site mainly for submarine support, worldwide submarine support, but it could handle the ATS feed and the Apollo-Soyuz downlinks. What we did was we had me and one other fellow, each with about 10 people, two shifts, 12 on, 12 off, fly over to Spain, and go up to this Buitrago. That's where we'd do Apollo-Soyuz TV support. When we flew in there to Madrid, they called us to the American embassy, and the first thing we were told was that the Basques in the North—[Francisco] Franco was in power, and they had regular police that directed traffic, and they had what they called the *la Guardia Civil*. These were two military policemen all over the place. One had a long-range rifle and one had a submachine gun, and they would have motorcycles or horses, and they would commandeer cars or do whatever they wanted; it was military rule.

We were called to the embassy and told that there had been a threat on our lives, and that they were going to kill an American this weekend, and so they were warning us to take stickers off of anything that said NASA, and to stay out of town, and don't be overly visible. They assigned *la Guardia Civil* to guard us. That was our introduction to Apollo-Soyuz support. We were young enough that we thought, "This is neat!" I know that the NASA rep [representative] tore all the stickers off his car and got out of town. What we did was we had rented a villa—and it was roughly called a villa because where we were, it's brick and mud—but it was a place that would house 10, 12 people. I had an apartment in Madrid because my wife was with me. First thing we did was throw a big party at the villa.

Before I get to the Apollo-Soyuz support, this was the human part of it, was that when we went out to the tracking site, *la Guardia Civil* were behind trees, in the bushes, in the building. They knew where we were all the time, they followed us. We didn't know they were following us, but they knew everywhere we went, whether it was downtown Madrid, didn't matter. These guys with long-range rifles, submachine guns.

I remember one time we were in Spain, what happened was noon was the big meal, so we took over part of the building in Buitrago that they let us have, and then every day at noon, they would bring us this six-course dinner with wine. Then, one of the higher-ups at NASA found out we were having wine and said, "No more, no more, you can't have that," so they cut out the wine. When we would have a successful completion of something, we would have bubbly wine. I remember we had our little engineering room they gave us, and someone said, "Hey, you know, that downlink went great, let's celebrate," and they popped the cork. When that cork popped, next thing I heard was click-click, and two guys with guns at the door. I mean, they were everywhere and we didn't think about that at the time.

We later did what was called an AIDSAT mission out of Spain that went around to Pakistan and Libya, and they wouldn't let us fly over Libya, and Pakistan. [Benazir] Bhutto got assassinated two months after we left, and we didn't even know half the dangers over there when we went because we were just over there doing things.

Long story short, Apollo-Soyuz, we supported 12 on, 12 off, out of this Buitrago site. The downlinks would come and we would record them, and then immediately at a given time, would uplink them back through ATS-6 to Houston, who would then either use them or play them to the world. There's a story, I can't tell all of it right now because they're debating what we're going to do with it, but it was Apollo-Soyuz and I got a call about midnight one time,

about, "You got to get out here, what happened on the downlink?" I didn't know what they meant, and they said, "Well, just come out here." It was about a 50-mile drive in the Burgos Highway, and it was just a danger in itself. We had times where we went between two semis to avoid a wreck.

This is just a world of crazies over there. Fifty-mile backups on the weekend were common, people all leaving Madrid, for the weekend, to the hills. Fifty miles of backups! I mean, it's crazy, and you see these little metal cars with loaves of bread sticking out all the windows, and families of 8 or 10, and it was like a movie.

I go out there and I said, "Well, we got a downlink," and they were docking with the Russians at night, practicing. They were practicing, and most of the video is flashing strobe lights—you can't see, it's dark, except the light's flashing, and then you hear the commander and others start to say things. What they said was not fit for transmit back to Houston, and what they said had to do with the Russians.

If you can imagine this, what was on the tape that they asked us to play back was audio that would be heard by the press. It was an open link. The next day, the Russians are docking, coming in and shaking hands, our good buddies. If they'd have heard what we heard, it would have been all over the newspapers. We didn't send it, and they said, "No, you've got to transmit."

"Well, we can't do that."

"Well, what's on it?"

"We can't tell you."

We couldn't say anything on the loops and they said, "Okay, erase it."

I said, "Okay," so before they erased it, we made our own copies.

But then they called back and said, "Don't erase it, we're sending a courier." A courier came to take the tapes and fly them back to Houston. We never heard another word. They said they never got them—I don't know what happened to them. There were copies, and I thought I had the copy at Goddard for a long time, couldn't find it.

I said, "Oh, somebody cleaned out the penthouse storage area and threw these old tapes out," or whatever, and lo and behold I've come across a guy who had the tape. It wasn't me, a guy that worked for me.

I now know where the tape is, I'm debating with Mark Hess on what we do with converting this tape on an old machine back so we all know what was said and what happened during that docking session. That was interesting, the *la Guardia Civil* were interesting, and the Apollo-Soyuz. I know one thing we found with the Russians, be it Apollo-Soyuz or the [Shuttle] MIR [Russian space station] project, whenever we had a problem and needed to get information on the MIR or the Soyuz, it became a military issue. It was worse than pulling teeth. They wouldn't tell us a lot about what they had on those spacecraft that we needed to know to better be able to receive it because what happened was I became in charge, other than video, of what's called VHF Emergency Voice. This is tracking sites at White Sands and Wallops Island [Virginia] and the Cape that are there specifically for emergency transmissions to and from the Soyuz spacecraft, and at the time, the MIR. That's because we have U.S. astronauts involved.

If the Space Station has a problem today and they have to get out of there, even before the Shuttle stopped, the Soyuz is the escape of choice. Once they get out of there, if they're over the U.S., who are they going to communicate with? It's a Soyuz spacecraft, so we have VHF, special emergency. I remember, when we set that up, the MIR had a fire. Wallops Island was the first place they called, saying, "We've got a fire on board." It was pretty interesting to have

all this Apollo-Soyuz and MIR-type Russian support, but it was very difficult, if you had a problem, saying, "Well, how are you configured? Are your antennas on the fore or aft side because we're having trouble locking on?"

It was like, "Well, we'll discuss it with the military and we'll let you know," and then it was, "Well, we're flying over Russia, we can't tell you anymore." We're trying to support not only the Russians but the U.S. astronauts, and it was difficult. JSC was one that had to try to get the information out of them to show the configurations, and they were very reluctant to tell us much about what they did because it was run by the military and still is, I think.

JOHNSON: That's interesting. That also reminds me of, like you said, you visited—especially early on—these other sites in Australia. Then, of course, you're talking about Spain. Were there any other cultural differences that you noticed that you'd like to talk about? Maybe some of the other sites?

NAFZGER: Again, the Australians had a very inflexible hierarchy in society. If you were from NASA, you were almost like an astronaut to them. "I want you to come out to my country club." "This is my friend from NASA." It was very particular who would invite you out or who was allowed to invite you out, or who you had to talk to. Spain wasn't that way at all. The Spanish, it was mainly just a language barrier for those of us who spoke broken Spanish and picked it up, didn't take Spanish, so it was a little more difficult to communicate. The Spanish people were simpler, much simpler. Maybe we were a little hyper because we had timelines and we were trying to do things on the run that had to be done quick. Spanish seemed to be almost, on

occasion, overly laid-back, not understanding the importance, that this has to be done by tomorrow, not next month, but their support was terrific. There was no complaint there.

Other than that, I would say that we enjoyed being in Spain. Their culture was interesting, but they have a lot of upper and lower class. They had hardly any middle class at the time, so you were either well-to-do or you were using the center water tap for your water. It was fascinating, being in the atmosphere we were, living in Madrid in a nice hotel, but five miles away, seeing people that had to share one pump of water.

The only other thing I remember that stuck with me is I kept telling my wife when she was there one time with me, "When you're walking down the sidewalk, the people will walk into you—they'll never move." I found that Spain, for some odd reason, that if you're walking down the right side of the sidewalk and someone's coming the other way, they'll come the same side you are. It was kind of like, "I don't understand this culture—maybe it's like driving on the left, I'm on the wrong side of the sidewalk?" I guess to make it a fair statement of the Spanish, they did everything we asked them, and they worked hard. The people at the tracking site, there were some guys that they would have key guys that were the experts, and they kept everything going for us over there. With Franco there, it was a highly politically-charged area, so it was quite different than our Australian visits.

JOHNSON: You sent us a list of different programs you've worked on—Landsat?

NAFZGER: Landsat, I just simply supported it. I threw that in there because it was just something I supported. Landsat imagery was Earth-orbit and had television-type images and

recordings, and so, there wasn't anything unique. It was unique to the scientists, but not to me, so it was just ongoing support of a project that had video-type signals.

JOHNSON: As these programs—and of course with Shuttle and then when the TDRSS [Tracking and Data Relay Satellite System] was launched, and then the coverage became easier. It wasn't, like you had mentioned before, you'd have that few minutes between AOS and LOS.

NAFZGER: Yes, that's a good point, that when we launched the TDRSS satellite, now what happened was we were able to relay from the spacecraft to TDRSS, and TDRSS down to White Sands, New Mexico, as a central hub, and we were able to have about 80 percent of an orbit continuously covered, even though it was Earth orbit, where before it was 8 to 10 minutes for each site. You would pass a site and lose it and then be two, or three, or four, or even five minutes before the next site picked it up; now you had 80 percent, or an hour and a half, of continuous coverage every pass, until you went to the back side. TDRSS allowed us now to have continuous support of Shuttle, which was really important, and Space Station, where you only have small drops, and when you're able to have live data, and that data's recorded and dumped when they come out of the blocked area. They can downlink some of that stuff in places like Russia, if the support calls for it, but for U.S. coverage, yeah, the TDRSS made a big change in how we did Earth-orbit coverage.

JOHNSON: Did you stay in Goddard for most of those coverages of the Shuttle flights?

NAFZGER: Yes. We support most of the TDRSS service out of White Sands, New Mexico. Actually, there's two sites there at the same location, so I spent a lot of time out there. The mission, like I said, when you get to Skylab or a mission that's just there all the time, then it seems that yes, there's a Control Center at Houston, but it's not a singularly short-term event, so unless someone calls for you to go to Houston for some reason, we support from our location. That's the way it worked from then on. When it got through the Apollo Program, Apollo-Soyuz, when it got to Skylab and Shuttle and Station, you didn't need to go to Houston to support it, other than to run tests and get ready.

JOHNSON: As you mentioned before, as far as the acceptance of TV, once you got to Shuttle and ISS, or Shuttle-MIR, NASA started accepting the fact that it could be used for scientific purposes?

NAFZGER: It became more and more a tool for engineering and science than it did public affairs, unless there was a specific event they wanted to be public affairs. Before, the only time you saw TV was if there was something for the public. We have television coming down right now, as we speak, and most people never see the stuff from Space Station unless it's a spinning spoon or something. Politically, I would say they could do better to get the American people involved. The bottom line is that they're using TV all the time for science experiments, you name it, and it's now just a tool up there. EVAs are a tool, but that's probably more of the time they use it also for public affairs because everyone's interested in EVA because it's different. That's what we found over the years—at least, I found—if you don't do something different and exciting, you're not going to have the public caring what you're doing. You went to the Moon in Apollo

11 and 12, and 13 didn't make it? Well, 14, 15, 16, and 17, the interest went way down. It was mainly, "How many rocks are you going to bring back?"

It's the nature of the program. You didn't go up there to entertain people, but on the other hand, NASA's highly dependent on public support and getting Congress to support what the public says they want them to support, and it takes going to Mars, exploring, excitement. I was lucky enough to be around in 1967-68, and fell into something that was an historic event, through no deed of my own. I was in the right place at the right time, and everybody wanted this thing to work. I would have to say that in going back to talking about what we did in the Apollo days, this was world-wide. It was not just NASA and the United States. When I went to Spain, when I went to Australia and Hawaii, or Mexico, or Germany, these people were all wanting—it was like a big team, in the true sense of the word. It wasn't the U.S. and NASA showing how powerful they are; it was, "We need everybody in that whole link, and everybody to work together."

It was one of those unique times where it didn't take a whole lot of encouragement or inducement for people to want to participate and make this work, and it didn't take a whole lot for people to want to watch it—the public like you and me—although I didn't realize that until many years after Apollo 11. When they told me there was a lot of people-watching, it didn't mean a thing to me. In fact, when Apollo 11 landed and that mission was over, we were already working on 12 and 13, and we just went, bang, bang, bang, bang, bang.

I've told many people, it probably wasn't until the 25th and even 40th anniversary, it became more and more apparent to me how historical this event really was. I knew it was historical, but how many people watched it and what it meant, since we never went back again,

became more and more important in the eyes of many. Probably even the Emmy awards are based on, "Hey, look at what we did and we've never done it again," and that was the story.

You get a different perspective, as you get old and look back at what you did. At the time, it wasn't like, "Oh, look what we did." We were happy we were successful, but it was no more than you being successful with your interviews. You did your interviews and someone said you did a great job, and now you're off to your next interview. That's how we treated Apollo at the time. We didn't have a historic perspective, and that's probably one of the reasons that we don't have those tapes! No one had a historic perspective. They had a perspective of, "What's the next mission? Let's get going."

JOHNSON: Yes, and we've heard that from other guys in Mission Control, that when it was happening they were doing their job, they were paying attention to what they were doing, they had no idea the world was celebrating.

NAFZGER: Yes. If I had to say I want to blame someone, I would say there should have been a total public affairs involvement to the point of saying, "Anything that has any video associated with this Apollo, we want set aside." That's all it would have taken. Didn't happen. We have a lot of pictures and stuff. They—years later, even—cleaned out storage areas to make space without any perspective on what you're throwing away. Part of our Apollo 11 tape search I spent months looking for documents that were sitting in a room down the hall from me until they threw them all out. "We don't need those anymore." It gave me an interesting perspective.

I was asked to speak at one of these archiving conventions, and I never went because it seemed too complicated to me because I'd done all this searching and it didn't work out time-

wise, either. But I had a whole different perspective of what it means to be an archivist and what it means to preserve things that may be historically significant, but at the time you don't know it. You have to take a look at what needs to be stored for periods of time and then evaluated as to its significance. Just as you're recording people like me—I called it the "Project to Get it on Tape Before They Die Project."

WRIGHT: It's harder afterwards.

JOHNSON: Yeah, it is harder afterwards!

NAFZGER: Interview these guys before they die because you won't hear it again. It's the same as that, that if you don't put it down or you don't hear some of these stories, you don't hear the information. Whether anyone listens to it again, you don't know, but it's there. You preserved it, and that was the key, preserving something that people can either listen to or read later that they would have never known if they hadn't. In my mind, the tape search—as an engineer, I didn't get involved in that stuff—but as a tape-searcher, I became involved with the National Archives and the National Records Center, and what they do and how they store things. It's pretty fascinating. Pretty difficult, too.

JOHNSON: It is fascinating. With the volume.

NAFZGER: The volume, and Apollo, as you know, '68, '69 was Apollo 11, the records then were three-by-five cards. I went through thousands of three-by-five cards because they're trying to

computerize it all, but it's manually transferring data from three-by-five cards onto computers, and so it's not there. It's almost impossible—you get clues and then search areas. It's amazing. Just the little bit I did was just mind-boggling, trying to put it together and search it, and I had people helping me. It was very, very difficult to track down leads and what meant what, even on the documents we stored, it's very cryptic what was stored. There's no detailed description, that "This is a recording of Astronaut Deke Slayton speaking to," you know, it's "Apollo 12 Audio," and maybe a code number and what date it went in.

JOHNSON: Kind of gives you an appreciation for an archivist's job, trying to figure out where everything is. Was there anything about your career through Shuttle that you'd like to talk about, or is there any significant events?

NAFZGER: I would just say that Shuttle brought a lot more advanced television. It brought a lot of efforts at Goddard that we hadn't done before, where we now became a key remote site for NASA TV, and a lot of Shuttle support. I was able to get Goddard TV to be the main hub to support White Sands and other sites for television support—engineering—if there were problems with launch. Shuttle also gave rise to a new area of support, which was called "external tank television," at the Cape. After they had the [Space Shuttle] *Challenger* [STS-51L] explosion, they put a camera on the main tank, looking towards the wings, to look at ice or things or ice particles falling off or tiles falling off.

We put sites in at the Cape and at Wallops Island on the East Coast, so that we could transmit during launch. It was battery-operated, and once they turn it on, if they delay launch too long, the battery can go down and you don't get it, but it always had enough life that we were

able to get the downlink from the small camera that was downlinking TV to our sites during the first three and a half to four minutes.

Well, I take it back—I think we could go through Wallops and we went up the coast, maybe up to 10 minutes or so before we lost it, because the tank would fall off. Interestingly enough, what happens during launch is we would then have a visibility—there are other cameras they put on that aren't downlinked live; they're cameras that record and dumped later—I'm trying to put this together, so I'm kind of freewheeling, but you have two solid rocket boosters on the side of the main tank. These solid rocket boosters are jettisoned and come down and get recovered. They had cameras and recorders in them, so there's video on each one of those that comes back, looking at different parts of the Shuttle during launch for damage.

The main tank burns up, so when that video's done, it drops off and burns up in the atmosphere, and you don't see it again. We were able to put in the systems to take live TV for this period of time, and when it would get to, say, Wallops, where Wallops would take over the track on a launch out to the Atlantic Ocean, when that solid rocket booster would fall off, the duty of Wallops was to track the Shuttle.

What happened was we were still seeing TV as the booster's falling away. It's interesting TV, but the antenna's still looking at Shuttle, so as they get further and further apart, if we tracked the booster, we could track it for minutes and watch it fall and burn up, but we had to track the Shuttle, so we lose lock, we lose the signal because they're splitting apart from each other.

That was an interesting project. I remember working with some [NASA] Marshall [Space Flight Center, Huntsville, Alabama] folks, and they kept saying, "You don't need to," they were buying some of the hardware for this. I'm not sure how that all came to be, but

Marshall was involved in hardware and they were asking me, "Why do you need two recorders and two of this and two of that?" Another site was called Ponce de León, that's a little portable site north of the Cape, where MILA is, that would do some of our launch during a thruster where it would block MILA from seeing it because the burn of the spacecraft, we had another angle from a small Navy site.

What was interesting to me was how TV gets developed. They were asking me why I wanted to spend all this money to buy two of everything, and I said, "Look at it this way: when we launch, when you do a TV show," for these folks that worked in broadcast TV, "they tape things and if it doesn't go right, they'll tape it over and they'll get it right. If it's a live show, then it's live, but they tape it for historical reasons and in case there's an outage or something." I said, "If there's a real outage, they can redo the show on tape. Whatever they want to do. But when you do a launch of Shuttle, it's one time. When it goes, it goes, and if that piece of equipment that you told me to buy, 'don't buy two of them,' had a problem, then we didn't see the tiles fall off. We didn't see the TV. You don't say, 'Let's do it over again.' It's gone!"

A lot of people had trouble, that came into the program later, understanding the differences on what you have to do cost-wise, to buy all this equipment for backup, because you only get one shot at all this stuff. It's a one-shot deal. It's not, "Let's redo it, it didn't go well." You can take this tape we're doing and say, "Let's go over this section again, it didn't sound right." But once that rocket's gone, it's gone, so we were living by, "It has to work when it goes up, otherwise it's a failure and you can't redo it—forget it." We wanted to see anything we could see on those tapes or live.

JOHNSON: There was a lot of the video coverage of the Shuttle, especially after [Space Shuttle] *Columbia* [STS-107], with the cameras so that they can inspect it.

NAFZGER: Right, yes, that was one thing that probably stuck out with Shuttle, was the tragedies we had were probably as meaningful as the successes we had. Especially the *Challenger*. Not to get in the politics of it, but we were all really upset about why we felt *Challenger* happened, and what was known and launched regardless of all the risks. That was a terrible thing. The *Columbia*, I think, just took everyone by surprise. That was a terrible thing—they both were terrible, when you find out the facts of what happened after the explosions—being spread out over land like that. I know a lot of you Houston folks had to go out there, part of teams that searched for parts. Those things stand out a lot, I think, in the minds of everyone that supports the network because it's like our network is trying to support this vehicle with all these people in it, and bang, it's gone. That one caught us, I think, more by surprise than the *Challenger*.

JOHNSON: I would think that because you were dealing with video footage from the beginning and it had to be determined whether you could put it out there for the rest of the world to see, your office worked closely with public affairs all the way through?

NAFZGER: What happens on Shuttle and that is anything that untowardly happens is just they lock down everything. Just lock down the room, nothing can be moved, and everything is gone over with a fine-tooth comb that might be relevant to finding out what happened. That's pretty much a common procedure, that if there's a shutdown due to a problem with the spacecraft,

every control room is locked down to determine where the information is that we need to determine either what we need to do to fix something or what caused the tragedy.

JOHNSON: You also mentioned that you worked with the closed-circuit television [CCTV] at Goddard?

NAFZGER: Yes, Goddard has a pretty extensive closed-circuit system. So does JSC and Marshall. I'd been working with them on the side, before I retired, kind of overseeing—not running it—what they did in closed-circuit. They have several hundred channels of video. That function of the closed-circuit TV folks here at Goddard also accomplished being the primary site for all NASA TV uplinks, and to support the tracking sites once we went to TDRSS. It was a combination of manned-flight support, onsite Goddard TV, interface to networks that we have specials, and it was interesting thing that was more like broadcast TV work than my manned-spaceflight strictly downlinked stuff was.

I got my hand in there and it developed into quite an outfit here that if I was around and you had time, I'd take you around and show it to you. It's an impressive outfit, and Houston has a similar one. We probably do more different things because we're a NASA TV primary uplink with Headquarters. Closed-circuit TV, they probably do more than we do onsite, but overall, with all these things together being mission support, uplink for NASA TV, and on Center CCTV, there's a group of 10 or 12 people that keep very busy.

JOHNSON: You mentioned you got your law degree—were you still working at NASA when you decided to do that?

NAFZGER: Yes. I don't know—do you want to hear about that?

JOHNSON: Sure.

NAFZGER: When I was working on the Apollo Program, for some reason, I thought—I had a brother-in-law who's a lawyer at the time. He still is, but he's retiring. We used to drink beer and argue a lot, and then he would always say, "Well, I'm a lawyer, you don't know what you're talking about." We'd be at some law argument. I never knew for sure why, but one day I said, "I think I'll take the bar exam [Law School Admission Test, LSAT?] up in Baltimore [Maryland], just to see." I took it—I don't know why I took it—that's the only reason I could figure, maybe it's because I wanted to argue with him on the same grounds. I took the bar exam, and then I was able to get in to either [University of] Maryland or University of Baltimore, night school. Maryland, I had to wait a year to get in, but Baltimore had an opening right away, and it was cheaper. It was night school.

I was working full-time at NASA, so I took a couple of courses, and I guess I liked them, so I took a couple more, and I just started taking courses. I didn't even go there with the idea of getting a law degree; I just went there to see what it was like. Once I started, I remember I was carrying law books on airplanes to Houston. I would be there on an Apollo meeting and also studying law. People would always laugh at me because I was doing all this law work.

I'll never forget it because I had a kid during that time. I remember one time, I had my first law exam when my wife was due to give birth, and she insisted that I go to the law exam

because she said, "I'll be in labor eight hours down in Prince George's [Hospital] here at Baltimore, you'll be down here."

I took the law exam, I got out, had a splitting headache, I think, because I was so concerned, and I called the hospital. I wanted to know if she was still in labor, or what. I'll never forget it because whoever answers, probably some protocol they have, they said, "Well, yes, Mrs. Nafzger gave birth."

I said, "How's the baby?"

"We can't discuss that; you'll have to come down here." She just meant that "We're not allowed to discuss it." I took as, "What the hell happened," and so I'm racing down there to the hospital. I remember going in the hospital and going up to the maternity ward, and walking in when some woman was breastfeeding and she's screaming and they're telling me to get out of there, and I said, "I want to know about my baby!" Everybody was fine, but so, I went to law school. She always told me to go, and it's true.

She passed away by cancer in 1984, but during that time, she had all of the work of these two kids and I'm traveling around the world and studying for law and doing all this stuff, so I thought she had the hardest job. I mean, there's no question in my mind. She had to do more to let me do this than I was doing because I could just focus on what I was doing. Even though it was law, education, and NASA, having kids, you probably all know, it's 24/7. She did more than her fair share.

I kept going and I finished law school one summer and said, "Okay, I guess I'll take a bar exam."

They said, "Well, you can't, you finished too early." They had a rule from the Court of Appeals that if you go to night school, you have to go longer because the whole idea was that,

"We know you're working so we don't want you taking too many courses," and they didn't have summer school at the time, but I took summer school. They said, "You can take the bar exam now if you first petition the Court of Appeals of Maryland and have them specially allow you to take it."

I said, "No, I'll just audit a course." I took the bar exam, and of course, they only pass, like, 51 percent of the people in Maryland on the first try. I always remember that because there was a guy at Goddard that everyone thought was a raving idiot, but he passed the bar exam! When I go to take the bar exam, all the other guys say, "He passed it! You've got to be able to pass it or you're an idiot!" You know? I knew Maryland only passed 51 percent. It was one of the lowest pass rates in the nation, and it's done politically. "How many lawyers are we going to let in?" You could go up to Pennsylvania and it was 98 percent. The idea was, you just graduated an accredited law school. Why shouldn't you be passing the bar exam?

I took the exam, then I was in Spain supporting what was called an AIDSAT mission. This was another mission out of Spain, and it was coming due weeks and weeks after when I should hear from the bar examiners. They send you a note, it says you pass/fail, you don't know until you hear. I told my wife, "If you hear, call my boss and he'll call me in Spain."

I get a call over there one night, and I get the call at the tracking site, and he says, "Dick, this is Ray, your boss. Your wife called me and you got a letter from the bar examiners. I don't know what to tell you, I don't know how to tell you this."

I said, "I passed it, didn't I? You would never do that to me!"

I had passed it, and whether I passed by the skin of my teeth or not, I don't know. I get out of law school now and I'm working at NASA full-time, I got two kids, I got a little house, I got a mortgage. I look around, just for the interest of interviewing with people—in fact, one's a

well-known Congressman now; at the time, he was just a lawyer—but I couldn't get a starting job that would pay enough to pay the mortgage and take care of my family, so I just started doing law on my own. Divorces and stuff like that, and I did it 36 years on the side. Represented a lot of people and a lot of buildings at Goddard Space Center. I could tell you stories about people at Goddard!

Anywhere from criminal cases to divorce and you name it. I always threatened, I said, "You know, when I die, you got to be there for the will reading, because they can't disbar me after I reveal all this." I did a lot of representation here at Goddard, and I took a lot of vacation time to be in court. I remarried, and every wife I've had has had to put up with—"We're going on vacation?" "No, I've got a court case." "Vacation?" "No, we've got a mission." Yes, I guess I enjoyed working, so after 36 years of law and 43 years of NASA engineering, I said, "You know, somewhere, you got to retire because I really don't want to be found in a chair somewhere," you know, "He's not moving!" I just said when Shuttle came to an end, manned-flight was going to be Russians on it, I said, "This seems like an appropriate time because I've done manned-flight my whole life."

In 2010, I said, "I'm out of here." NASA's a great place to work and you could work until you die. I can't speak for everybody, but if you look at the polls of how many people like where they work, NASA's always one of the tops, if not the top. I don't know how it is for your job as contractors, but if you do your job and you're responsible and don't have a crummy boss, NASA's pretty lenient and treats you as a professional. You do your job, and we're happy.

JOHNSON: Exactly right. Is there anything you wanted to ask, Rebecca?

WRIGHT: I just wanted to ask one question, and it's about technology. All the years that you've worked, is there a tipping point in the technology that your field really changed, that you felt like really made a difference?

NAFZGER: I think going to digital TV was a big, significant difference. Seeing how that changed ability to handle—all the parameters of how we had to handle what was called analog data and TV changed with digital. There was a mental chasm of how you handled—when it went digital, all of a sudden, we had a lot of people that knew only digital data handling television and other things because your home TV is digital now. The final picture TV is still TV that has color and brightness and contrast and settings that are important, so it got very difficult for people to relate to television as being anything different from just getting data on the Internet.

That was a struggle, getting them to realize we still have to do certain processing and certain things to it after it's removed from its digital stream. It also made it easier to do things because you can use different bit rates and data rates, to use multiple cameras and multiple streams of data. Going digital was one big thing. Of course, when we went from slow-scan to sequential to broadcast. As far as technology, I think it's mainly the transition to digital that was the biggest thing over the years, yes.

JOHNSON: There's so much more now. I know with still photography, going from film to digital, the number of photos taken just grew by thousands and thousands, and so I'm assuming the TV too because it's easier to store and everything else.

NAFZGER: It's easier to store, but to tell you the truth, that's even an issue. When I was out at the Emmys, the Radio and Television Society asked me to be on a panel to talk about storage digital because digital formats change. It's like saying I had an old video recorder that I can't play back tapes—it's the same in the digital world. If you're going to keep something 20 or 30 years, that format that went on that disk is no longer used. They're looking at how do we best preserve digital data, given that there's more information? How do we preserve it where we still are capable of extracting it whenever we want to?

JOHNSON: That's a constant upgrade.

NAFZGER: It's a constant, yes. Every time someone comes out with a new device or a new format, that means trouble for the old formats because now you have old devices that have to be preserved. I don't know any way around it, and there's never going to be a universal standard for everyone in the world to use at all times.

JOHNSON: Right, because technology keeps going forward, no matter what.

NAFZGER: You've pretty well milked me for what I can [remember]. Hey, you get old, you don't remember anything. It's harder.

JOHNSON: No, it was good. I think we got a lot of good information, and we certainly appreciate you coming and talking to us, sharing with us.

NAFZGER: I can't say that I was excited to do it, other than I think that when people ask me—not that I was so important; I'm a little niche in a lot of things that happened. I'm sure you've talked to a lot of important people higher up, but when people ask you, "We want to interview you," they're asking because they want information that I have, and it's almost like a duty to do it. This was pleasant, this was fine. Television interviews can be really tedious. Like that Japanese interview went five hours, and it was just difficult. I remember saying, even doing photo pictures of the Moon and stuff, the *Washington Post* one time took, I think, three hours to get one picture to put in the newspaper. I was standing in front of an image of the Moon, and I said, "This is tiring! I'd rather be playing golf."

JOHNSON: We'll let you pursue that now! Thank you again.

NAFZGER: You're welcome.

[pause]

Are you on?

JOHNSON: Yes, we're on.

NAFZGER: You asked me about *The Dish* movie, and I remember I got a call one time and said, "Hey, have you heard about *The Dish* movie?"

I said, "No."

They said, "Well, you got to see it—it's a movie about Americans over in Australia for Apollo 11."

I said, "Well, I was over there for Apollo 11 getting prepared." There was another fellow, Bob [Robert] Taylor, who handled antennas that went to Parkes a lot. I went and watched the movie and said, "This is what we did!" It was really about the American presence in Australia during Apollo 11 and prior to it, setting up for this antenna. A lot had to do with the Parkes site, this big, 210-foot antenna that we spoke over earlier that we had essentially rented out for the mission. The more I saw it, the more I said, "That's exactly what we did." They talked about the processing of the TV and all this.

I had somehow got in contact with the producers who said, "Well, here, we're going to send you tickets to this." They had a big celebration for *The Dish* with NASA, but they didn't bother to call me. Headquarters, they just grabbed whatever they could. They had a downtown Washington party about *The Dish*, and yet they didn't contact any of us who were the subject of the movie! I thought that was kind of rotten, but not surprising.

A lot of them don't even know it—they wouldn't know who was there unless someone said, "Do you know who those people were?" Or they could have asked. It was a cute movie, and there are always technical things that are manipulated to make the movie interesting, but no, nothing in that movie was irrelevant to what happened. It was a good movie, and it's a family movie, of all things!

JOHNSON: It was, it was, it was a good feeling.

NAFZGER: But if you were there with us after-hours, it would not be a family movie! That's all I can tell you about Australia. It's a fun place when we had free time.

JOHNSON: I thought it was interesting because it did explain how the Australians felt about how proud they were, that they were bringing that video through.

NAFZGER: They were so proud. One other thing about the Australians is it was like from the motherland, even though they're Australian, they have this English Queen backing, and what we would do when we went over there, we would take *Playboy* magazines. In those days, *Playboy* was the ultimate—we didn't call it a porn magazine, but it was an adult magazine.

WRIGHT: Gentleman's magazine.

NAFZGER: Right, but what happened was you weren't allowed to bring *Playboy*. When you would go into airport customs, you would clearly display this *Playboy* magazine innocently, like you don't know what you're doing. They would confiscate it and give you a big certificate that said, "By order of the Queen," and it would go on to say, "We've confiscated your *Playboy* magazine." They didn't allow those in Australia. No one could sell them or buy them, so we would bring them over to get the certificate that we had the *Playboy* confiscated. That was a big thing to us.

JOHNSON: You were proud of those certificates?

NAFZGER: Yes, yes, "By order of the Queen, I'm hereby confiscating goods that are not allowed within the country, i.e. namely one *Playboy* issue 14."

WRIGHT: A badge of honor.

NAFZGER: Oh, yes, yes. *The Dish* was a good movie, and it was in all respects valid, as far as I'm concerned.

JOHNSON: I appreciate you adding that, thank you.

[End of interview]