

# NASA HEADQUARTER HISTORY OFFICE ORAL HISTORY PROJECT ORAL HISTORY TRANSCRIPT

RONALD C. WOODS  
INTERVIEWED BY REBECCA WRIGHT  
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*The questions in this transcript were asked during an oral history session with Ronald C. Woods, who has amended the answers for clarification purposes. As a result, this transcript does not exactly match the audio recording.*

WRIGHT: Today is June 26, 2008. This interview with Ron Woods is being conducted in Washington, DC, for the NASA Headquarters History Office. Mr. Woods is in Washington this week to participate in the NASA Program at the Smithsonian Folklife Festival on the National Mall. Interviewer is Rebecca Wright, assisted by Jennifer Ross-Nazzal. Thanks again for coming over and talking with us today. Let's begin with you sharing with us briefly about your background and how you got involved in the spacesuit business.

WOODS: Well, right now I work in the GFE [Government Furnished Equipment] Office at KSC [Kennedy Space Center, Florida] as the JSC [Johnson Space Center] Resident Office representative for all the hardware that is flown in the crew module, air lock, and also items in the payload bay such as the cameras, foot restraints and tools.

Prior to this job, I worked at JSC and KSC as a NASA suit technician for the early Shuttle flights. Prior to that, I worked for ILC [ILC Dover, Inc.] at JSC and KSC as a suit technician. I worked for ILC for eleven and a half years. We did maintenance and pre-flight testing on the Apollo, Skylab, and ASTP [Apollo-Soyuz Test Project] space suits. You could

volunteer and work with a specific crew as a suit and insertion technician, a three mission rotation if you were lucky.

I was very fortunate that I got to work on [Apollo] 8, 11, 15—all three Skylab missions—and also Apollo-Soyuz as an ILC technician, and then as a NASA technician for [Space Shuttle] missions 1 through 5.

I never had my life planned out after the military. As I got close to the end of my three years in the Army, I received a call from my mother who lived in Houston at the time, stating that a NASA contractor (Brown & Root-Northrop) was looking for Survival Technicians. One of the requirements was that you had to know how to use various types of sewing machines, so my job in the Army as a parachute rigger was perfect. I took a few days off and went to JSC for an interview.

The personnel manager at Brown & Root-Northrop sent me on site for an additional interview with the supervisor over the Survival Lab. He asked me to make a box with a lid out of fabric. He left me at this table, I drew out a sketch on the fabric and sewed the box together, then showed it to him. To my surprise, he says, "Wow, that's pretty nice. Good sewing." He said, "Come back and see me when you get out."

I got out of the service early on a Thursday morning, flew to Houston, went to NASA that afternoon, and was hired on as a survival technician. On Friday I got my badge and started with a great bunch of guys, learning about NASA survival equipment.

The survival lab was located in Building 7, Crew Systems Division where they built all various kinds of survival equipment for the Apollo program. This was after the Apollo [1] fire [1967], and they were working with fireproof material, so everything was changing. It was an interesting time, new designs, new material and a time to learn from engineers that experienced

the Mercury and Gemini programs. I got in on the ground floor of working with the newest survival gear. Also, Brown & Root-Northrop had a contract with NASA to provide suit subjects for all kinds of testing related to the every changing spacesuits. Suit subjects got time off in the late afternoon to exercise, to keep in shape for the suit testing we supported. We were used in place of the astronauts for testing that didn't require their technical evaluations. We performed in the suit for mobility studies, cycle testing of suit components, or did stress on a treadmill with sensors installed to collect data.

Suited work is a lot of fun, but I never considered it work. When you first get your foot in a spacesuit, you're hooked. Working as test subject, I met a lot of the suit technicians, suit engineers, and their supervisors. They knew that I could use different sewing machines and had a knowledge of manufacturing/fabrication of soft goods. So this was an opportunity to change jobs and become a suit technician. I didn't have any of the experience working with the suits, as some of the other technicians did that had previous military suit experience.

We worked at night performing maintenance on Class III training suits with a supervisor and quality [assurance] looking over our shoulder all the time. It was an excellent way of training, breaking down hardware to its lowest component level (wrist rings, neck rings) and sewing on suit components (using machines and hand stitching). After months of this type of training, you would get certification to work on Class II and Class I flight hardware. We worked on suits for underwater tests (to simulate Zero G), altitude chamber testing (to simulate the vacuum of space) and supported the Zero G aircraft (weightlessness).

While working with the suits, I met a lot of interesting people, some who would eventually become my mentors and boss. Joe [Joseph W.] Schmitt was one of those special individuals. He said, "You look like an energetic guy, Ron. How would you like to strap those

guys in the spacecraft?" So under Joe's guidance, he showed me many times over how to perform the crew insertion (Command Module and Lunar Module). It took a while to learn all that was required and the techniques that Joe wanted you to know. Joe was the best instructor, the first NASA suit technician. Like I said, Joe was a very thorough person, so any time things didn't go exactly right, the crew would always ask for Joe or Al [Alan M.] Rochford to take over and complete the insertion and give us additional training. I finally got it right thanks to Joe and Al. I paid close attention to all that Joe told us verbally and also in writing. Like I said, Joe was so confident at what he did and all the crewmen respected him.

Joe asked, "How would you like to work Apollo 8?" That was my first crew assignment and that meant you worked with a specific crew member through all his suited activities while at KSC. Each crew member had three suits for each mission: one for training, one prime flight suit, and one backup flight suit. We really kept busy supporting suited events in the flight simulators, training modules, altitude chambers at KSC and JSC, plus the water tank and the Zero G aircraft.

Prior to being assigned to the Apollo 8 mission and still at JSC, we traveled to KSC to support crew suited events. When the travel got to be a bit overwhelming, ILC decided to add more personnel to the KSC field office. My boss came in one day asking, "Would anyone like to move to KSC and work there? Anybody want to volunteer?" I said, "Yeah, I'll go." He says, "Well, when can you go down? We've got some tests next week, and we need some technicians, and we don't want to send people TDY (temporary on travel)."

I replied, "Well, I'd probably leave this afternoon." He said, "Are you sure?" I said, "Sure, I'll go home and throw my clothes in the car and head east." So I went home, got my clothes, told my mom goodbye, and headed for Florida. I stayed in Florida until we temporarily

closed the facility after Skylab in 1973. After Skylab, three of us (one engineer and two technicians) went to Houston, and returned to KSC only to reactivate the suit lab for Apollo-Soyuz on a TDY basis.

At JSC after Apollo-Soyuz, we were working on Shuttle suit prototype hardware, lots of interesting fabrication work. Then came the first working Shuttle spacesuit, called SP1. It was a very interesting time in the suit business, transition from one type of suit to another, adding more personnel and finding a new way to process a new type of spacesuit.

I was assigned to the SP1 suit, which meant support to lots of manned testing at JSC and on the road again. I remained with ILC until 1979 when they were looking for NASA Suit Technicians to support the ejection seats/suits that would be used on STS-1 through 5 in *Columbia*. So I left ILC for NASA.

WRIGHT: Could you talk about some of the innovations that you saw with the suits?

WOODS: One big difference was from custom sizing of the Apollo suit to almost custom sizing for the Shuttle suit. With the start of the Apollo Program—like Apollo 8, they had the intra-vehicular [IV] suit (two gas connector design) and the extravehicular [EV] suit (four gas connector design). With only minor configuration changes, the IV suits remained the same during Apollo, Skylab, and Apollo-Soyuz. With only minor changes the EV suit configuration stayed the same until Apollo 15. Then came the A7LB Suit for lunar surface work with the new Lunar Rover. Hardware mounting, zipper routing, and additional cabling at the waist area for mobility were the major changes. The new zippers design, pressure sealing, and restraint were separated, creating a floating pressure sealing, and not sewn in place like the A7L. The zipper

configuration went from the right side of the chest, around the back, to the left stomach area. By doing that, they were able to put cable systems and pulley systems at the waist area, which allowed the crew member to bend over and move from side to side more freely. This allowed the crewman flexibility to get in and out of the Lunar Rover. When we first saw the A7LB, it was like seeing the most radical change in spacesuit design ever. A little frightening from a maintenance point of view, but in all reality, it was less maintenance than the earlier EV model. At least the zipper change-out was easier.

I am still amazed at the level of work, the quality of work we were able to accomplish without computers. All the work papers (work authorization documents) were hand written, or typed. I was taking art classes at the time, and engineering would ask me to do drawing sketches of changes that we had accomplished in the field so that these changes could be air mail'd to ILC Dover for documentation updates. It was a very good art experience.

Of course, the suits at the time were all classified so everyone at ILC had a specific classification to work on the suits. Any time we had to support training events or take the suit components for corrective action at locations across the country, we had to hand carry the hardware. By this I mean, we placed the hardware in hard suitcases, placed government locks on the cases, and kept our hands on them as much as possible throughout the trip. We carried the cases from the shipping point, through baggage at the airports, underneath the aircraft while they were loaded, and stayed there until they closed and secured the cargo doors on the airplane, before we could get on the airplane ourselves. If we had a layover in route, we would get off the plane and go underneath to insure that the flight hardware was not handled for any reason. It was a lot of extra security and logistics to move Apollo flight hardware.

With all the extra handling we had to do, it was nothing for them to call you in the middle of the night and request that you come to work to support a hand-carry to Delaware or Houston due to a problem with the hardware that couldn't be resolved at KSC or a change in the crew schedule that we had to support. Most of the time you stayed at the test site or repair site for the return hand-carries back to KSC.

I recall one trip that took me from Florida to Philadelphia. I dropped off a pair of gloves at the airport to a guy from the plant, and he signed for them, then I went on to Ling-Temco-Vought [Inc.] outside of Dallas/Fort Worth. They had to correct a problem with a visor assembly. It was a week of observing the corrective action. Then on the return trip, I returned to Philadelphia, received the gloves and returned to Orlando. I drove straight to KSC and got the hardware received for a test or flight stowage they were doing as soon as I returned with the hardware. A very tight schedule. We were on-call, 24/7, for years.

WRIGHT: While we're talking about Apollo, would you like to share some of those memories of preparing for Apollo 8, and you mentioned Apollo 8, Apollo 11, 15. Also, receiving the suits back. Did they come back to you with the Moon dust?

WOODS: I was not assigned to process the returning suit hardware from the Moon. That was done by the JSC ILC technicians. Because we were so busy at KSC getting hardware ready to fly, we never got a chance to go to Houston to watch the disposition after flight. It would have been interesting to see the condition post-flight. Karen [Woods] and I were in Washington DC a couple of years ago, and we were fortunate enough to go to the Smithsonian [National Air and Space Museum], the [Paul E.] Garber [Preservation, Restoration, and Storage] Facility. I worked

on a couple suits with Amanda Young, the curator. We got to see the difference in the coloration of the lunar boots, [Harrison H. Schmitt's boots]. The Moon dust on everything was just incredible because I'd never seen that post-flight condition before.

To support the astronaut's suited exercises before flight, there was a lot of training required to complete before you were certified to be on the close-out crew at the pads. Some of that training included basic fire fighting skills. There was a fire fighting training area at KSC and we spent time there every year (yearly certification). The area had fire pits and tunnels with fire pits at various locations. They would open different areas on the side of these tunnels next to the fire pits, light the fire pits, close it up to smoke out whatever might have crawled inside the tunnel before we had to crawl through them. We would wear our breathing systems and take the fire extinguishers and actually crawl down through the tunnel, putting out the fires as we crawled, as if we were escaping from an accident at the pads.

Emergency egress training was very physically demanding. We practiced with suited subjects, pulling them out of the spacecraft like we were rescuing astronauts on the pad. After the Apollo 1 fire, a lot of changes were made to make it safer for not only the astronauts but the close-out crew that supported the astronauts on launch day.

In the O&C [Operations and Checkout] Building, we had the two chambers, one for the Command Module, one for the Lunar Module. We first would support the suited Command Module [CM] sea level test and then an altitude test. Then on Apollo 11 and subs, you had the additional Lunar Module [LM] sea level test and altitude test. This was to certify the CM and LM prior to move to the VAB [Vehicle Assembly Building] and stacking. Other suited events that we supported were training for the Command Module and Lunar Module in simulators. We used a one "G" Lunar Module (actual size), where the astronauts would practice suiting up (like

they would on the Moon). This was a very difficult event for the crewman, cramped quarters and lots of hardware to put on before opening the hatch. S0017 was a simulated launch countdown with everyone supporting the launch; we would go through a dress rehearsal for countdown. The crew would dress as they would on launch day, go to the pad, and get inserted into the spacecraft. During the suit training activities, there still remained the day-to-day maintenance of the training and flight suits. Once used, the suit liners had to be removed, unzipped at the lower legs and detached from the hook/pile fastener tape at the neck ring and wrist disconnects. We then hand washed the liners in Cleaner C, which was a solution of Ivory liquid soap and distilled water, rinsed them several times and placed on a rack to dry. Once dry we vacuumed them and reinstalled them in the suits. The suit bladders were also swabbed with IPA and D water. The flight suits were then purged with oxygen and a particle count was taken. The Millipore [Corporation] filters were removed from the exhaust ports and ILC quality [assurance staff] would [under a microscope] check how many particles were present. If you failed, then you'd clean it all over again. So the suit maintenance was no easy task.

When we got close to flight, the suits, the primary suit for each crew member, went through a process for flight that included removing TMG (Thermal Meteoroid Garment) from the pressure garment, so that it could be x-rayed. All the connectors (neck ring, wrist, electrical, water) were disassembled, cleaned, inspected, lubricated, reassembled, and installed on the pressure garment for testing and final crew sizing. Some of the pressure sealing zippers had to be changed due to damage during use by the crew member. This was a very time consuming task, usually two weeks. After final suit sizing with the astronaut, the gas connectors were once again removed, the Thermal Meteoroid Garment reinstalled, and then the gas connectors reinstalled. Prior to final testing all the reassembled hardware had to be cycled tested, which

meant the connector interface hardware was installed and the lock—locks cycled at least three times. The complete suit with helmet, gloves installed, was then tested and certified for flight with a leakage rate of less than 140 cc a minute. The fastest turnaround for a flight suit was for Apollo 13. When we found out that Mr. [Jack] Swigert would fly instead of Mr. [T.K.] Mattingly, we had only two full days to flight certify his suit.

Prior to close out of the Lunar Module in the VAB, we would take the lunar suits inside the LM, and interface the oxygen, water, and electrical connectors to the suit. This was to insure that no changes had been made to the spacecraft connectors since they were connected to the suit in the altitude chamber. We also did this same test in the Skylab Module prior to it being closed out and stacked in the VAB.

WRIGHT: You mentioned you were assigned to a crew, but were you assigned a specific crew person?

WOODS: When working a mission, you were assigned to a specific crew member. For every suited event, you were there to take care of his suit and help him get suited. Each crew member had options on where they stowed certain accessories in their suit pockets and what sequence they donned the hardware. We made sure that they were comfortable during suiting operation. We always followed a checklist to insure that the final configuration was as the crew member wanted. We always had a NASA suit technician as our lead, the primary insertion technician for the mission who would check the final configuration after the suit-up was complete.

I was very fortunate to have worked with Jim [James A.] Lovell on Apollo 8, Buzz Aldrin on 11, and Al [Alfred J.] Worden on 15, and then Skylab and Apollo-Soyuz. So it was a

lot of fun and very interesting. Some of the crews would give us a signed Beta patch for helping them with their suits. I got a really nice letter of appreciation and a signed beta patch from the Apollo-Soyuz crew.

A few years ago, Tom [Thomas P.] Stafford—General Stafford, rather—was at KSC and with family members. I was to give him a tour, so I brought the framed letter and patch to the lab with me. I said to him, "General Stafford, I don't know if you remember me or not, but I was one of the suit techs for Apollo-Soyuz." "Oh yes, I do," he said.

I showed the framed letter and patch to him and he showed it to his grandson, and said, "I gave them this after Apollo-Soyuz." He said, "By the way, that is archival glass, isn't it?" I said, "I believe so." He said, "I just don't want my name to fade."

WRIGHT: That's nice of him to pass that on.

WOODS: It was. It was just really awesome. I mean, you do a lot of work, and it's not that you expect anything like that, but for somebody to sit down and write a personal letter thanking the suit technicians for their work. It just made you feel like you had been in space with them.

WRIGHT: They meet so many people on that path to the rocket, don't they?

WOODS: Yes, right. That's the last thing you would think would ever happen. Another thing I'm really proud of, and that was the [Silver] Snoopy [Space Flight Awareness] Award that I got for working—it was on Apollo 15—for working on spacesuits.

WRIGHT: Did one of those crew members award the Snoopy to you?

WOODS: Well, the letter of appreciation was from Al [Alan L.] Bean. Then, we were presented the Silver Snoopy pin by Astronaut Robert Parker. There was like six or seven of us from ILC that got the Snoopy on the same day.

WRIGHT: That's exciting.

WOODS: Yes, it was. Very exciting.

WRIGHT: Share with us what it was like to be on the launch pad, the day of the launch, and being part of getting them ready to go.

WOODS: During Apollo, the only time that I ever went to the launch pad to support the launch countdown was on Apollo 11. I was Joe's backup insertion technician. So that I would miss all the traffic, I went to work the evening before the launch, stayed in the suit-up area most of the evening, going over the schedule of events of the next day. Of course, I couldn't lay anything out because the suits were all locked in a secure room.

I was able to go out in front of the O&C Building and look at the launch pad lights from a distance. That was so impressive. A chance to relax in the same recliner where Buzz would get suited the very next morning. Once everyone arrived, we started the suit lay out and preparing the ventilators and prepared the astronaut van for the trip to the pad. Joe, our lead NASA technician went through the checklist, to make sure we were ready to suit each astronaut.

There was a lot of excitement because we knew these crew members were on their way to the Moon. But it was a typical suit up, you knew exactly what you had to do, and you had all your test procedures, everything laid out the way that the crew wanted. When Buzz came in, he went to the bio-med prep area of the suit room to put on his bio-med instrumentation and constant wear garment [CWG] (long johns). This area was blocked off from the rest of the suit room by a drawn curtain. CWG were modified long johns that had button holes for routing the bio-cabling with a bio-belt and some comfort padding at the shoulder. We did a lot of customizing for crew comfort.

Then the crew would get checked out at the bio-med station by the bio-med engineers. When they completed check out, each crewman would start the suiting process at his designated area of the suit room. Mr. Aldrin's suiting location was the last one, located at the east end of the suit room. I went over the suit accessories that would be stowed in his suit pockets once the suiting and manned testing was completed. Once Buzz was in the suit and prior to zipper closure, you'd stop and connect the electrical from the suit console to the suit communication and bio-med connector. Buzz then donned his "Snoopy Cap" Comm Carrier and I donned my head set, then another bio-med check was accomplished. If that test was successful, the zippers could be closed and locked. Next the comfort gloves, IV gloves and the helmet were installed. At this point we performed the manned suit testing, then installed all the hardware that went into the suit pockets and strap on pockets.

At this point you can relax a little bit; each crew member would be relaxing in the recliners, talking with the chief of the astronaut office or suit engineers.

When we received the word from [D.K.] Deke Slayton or [Alan B.] Al Shepard that it was time to proceed to the pad, we installed the helmet protectors and transferred from the

console to portable oxygen ventilators. Connecting the ventilators for the CDR [commander] and LMP [lunar module pilot] to the correct set of gas connectors allowed that when they arrived at the pad for insertion you could connect them without breaking pre-breath.

I grabbed the extra ventilator and followed Joe and the crew down to the van. That was exciting, walking down the ramp out of the O & C Building, with all the press, flashing lights and applause. Knowing all the time it was for them, but exciting for me. We had a portable communication systems in the van so Deke could talk to the crew, until he got out at the LCC [Launch Control Center]. At A-11 roadblock, just past the LCC, we changed to the second ventilator. This would give the crew enough oxygen to last them until they were connected to vehicle oxygen.

At the pad, a small elevator took us up to the base of the LUT [Launch Umbilical Tower]. We proceeded through a hallway to the elevators that took us to the 320 foot level. On that particular day, I stayed back at the elevator with Buzz. He was flying in the CMP [command module pilot] position (center seat) for launch. I had to stay by the telephone and wait for the NTD [NASA Test Director] to give us the ok to proceed to the White Room. I can't begin to tell you how exciting that was, watching the Saturn IV, venting, ice falling, and Buzz checking it all out. Fully suited he couldn't hear what I was hearing, probably only the sound of O2 flowing from his ventilator.

Once we received the call, I tapped Buzz on the shoulder and pointed towards the exterior walk way around the outside to the LUT to the White Room. You had the rails to the outside and the LUT structure to the right. It is not a long walk, but it sure seemed so that day. One part of it sloped down so you wanted to make sure he was safe. In the White Room we removed the yellow protective booties. So that we could get them on and off with ease, we cut out the top

part above the toes and would sprinkle a little baby powder on the inside to keep it from sticking against the soles of the suit boots. Once you were strapped in and had no chance of anything scratching your helmet, off came the helmet protector.

When Joe was finished, I started taking the ground support equipment [GSE] out of the White Room and back to the elevator. Eventually we would place the GSE in the trucks stationed at base of the pad. We would all wait at the A11 road block until after launch. But before we left the White Room, we sat on the floor and Guenter [F. Wendt] passed around the candy. A job well done.

We all departed the pad and remained at A-11 roadblock until released after flight. It was exciting sitting up there thinking, "Well boy, in a couple hours these guys are actually going to the Moon." The next time I went back to the pad was on STS-1. Again as Joe's backup. Then on STS-2, I got to do the insertion of [Joe H.] Engle and [Richard H.] Truly, with Ellison [S.] Onizuka .

WRIGHT: Talk to us about the transition into Shuttle and how that affected your team.

WOODS: Well, it was sad that [Apollo] was coming to an end. We had a great team, good friends, people you worked with for a long the time. There was one point in the Apollo Program we had a total of 60 people processing suits for ILC at KSC. Our ILC, KSC site consisted of a field manager, engineers, logistics, technicians, documentation clerks, and a secretary. One of the logistics reps still works in Houston, Building 7. He is responsible for supply hardware that flies on the Shuttle, so we do have an opportunity to correspond on a weekly basis.

But the transition was difficult at times. We had to secure the facility at KSC, knowing that we would be back to support Apollo-Soyuz. Everything that was not required was either returned to JSC or had a disposition at KSC.

Knowing this would probably be the last time we would see each other, we had a big going-away party. Myself, another technician and an engineer moved to Houston. After supporting Apollo-Soyuz, we closed the suit room and sent the remainder of the hardware to JSC.

It was some very difficult times at JSC. At one point we were down to 10 people at ILC, Houston. We kept busy helping with the new Extra-Vehicular Activity [EVA] suit design and also the launch entry hardware for the Shuttle crews was being developed. We were working with the launch/entry helmet configuration, safety harnesses with flotation, and ejection seats that would be in *Columbia*. We were doing a lot of design and pattern making as well as sewing. Astronaut Ellison Onizuka was the crew rep and our interface for the astronauts. Everything that we designed and built in-house was fit checked and shown to the other astronauts by El for their approval before it got turned over to the contractor for manufacturing.

The Robertshaw [Controls] helmets are a good example. The same basic helmet was used by the Apollo chamber technicians at KSC. This type of helmet with some configuration changes was used by the early Shuttle crews for communication and breathing during launch and landing. It was interesting that as NASA suit technicians we got to help with the design and certification of this hardware.

Of course, the new shuttle suit was on the horizon. During the Apollo program, ILC had the suits and Hamilton Standard was responsible for the remote control unit and portable life

support system. Two separate contractors—the only connection was when you mated the hardware for a spacewalk training event or in space.

With the new Shuttle suit design the entire separate contractor world came to an end. ILC/Hamilton Standard technicians had to work hand-in-hand because the suit now had the computer and life support as an integrated part with the hard upper torso and soft goods of the suit. Our first real Shuttle suit, designated as SP-1 was a real joy to work on. And it did get a workout. Astronaut [F.] Story Musgrave was one of our suit subjects. We flew in the Zero G airplane for mobility studies, sized the suit for one crew member in the morning to support the Neutral Buoyancy Tank and resized the suit at lunch for another crew member in the afternoon. It was non-stop. Then we would take the suit out to LM [Lockheed Martin] in Colorado to support the Manned Maneuvering Unit [MMU].

I transitioned from ILC in 1979 to NASA. NASA needed additional suit technicians to support the Shuttle and some of the NASA technicians were getting close to retirement, so they hired Troy [M.] Stewart and myself. Troy and I had worked Apollo 11 together, so it was great that we became NASA Suit Technicians on the same day.

Once we were with NASA, Troy worked the ejection seats and suits that would be used for STS-1 through 5 and I got assigned to work with the MMU project for about a year. I worked the suit interface with the MMU. Working with Ed [Charles E.] Whitsett and the MMU team was a real education. I was the gopher for a lot of the projects, like the MMU decals and lap belt.

When we were close to flying again, I transferred back to the Launch Entry Suits. We supported crew training, which required a lot of travel. I worked the launch/entry suits until STS-5. Then an opportunity opened at KSC for a Flight Crew Rep for all the government

furnished equipment that is supplied from JSC for Shuttle flights. That's when I transitioned to KSC and have been doing the same job since 1982.

WRIGHT: The suits, of course, changed. After [Space Shuttle] *Challenger* [STS 51-L accident], did you have a lot of changes in what and how you did things?

WOODS: Yes, we went from the street clothes to a launch/entry suit. The *Challenger* Crew wore the Robertshaw Helmets, two piece coveralls, Danner boots, and other accessories for launch and landing. The program decided to go back to the additional crew protection with a launch/entry Suit, similar to the STS-1 configuration with some additional improvements. Basic changes were the orange outer suit material and a liquid cooling garment. Modification was then made to the suit room. The contactor responsible for the O & C Building verified cleanliness of the oxygen lines, and changed the supply from oxygen to breathing air. Breathing air consoles were installed to support the seven-suit donning station required for a Shuttle crew.

The support required for the launch/entry Suit dramatically changed our processing at KSC. Additional personnel were added at JSC and at KSC. Bill Allen, our suit engineer, developed new work authorization documents to support the new crew requirements in support of Shuttle Training Aircraft suited flights, of S0017/Terminal Countdown Demonstration Test and of course S0007, launch countdown and scrub turn-around. The suiting process is supported by at least 6 suit technicians and 2 suit engineers from JSC.

S0017 is a full dress rehearsal for launch day. The crew arrives at KSC for suited Shuttle Training Aircraft flights; suit fit checks and then suit up, a ride to the pad in the Astro Van. They are strapped into the Shuttle seats just like launch day, perform communication checks with the

firing room, and even inflate the suits. Once the clock stops, the crew exits the vehicle, and goes over the emergency egress procedures.

The suits are then cleaned, inspected and tested to insure they are ready for the launch countdown. Any discrepancies with the suits are corrected prior to securing them until flight. The crew and suit technicians return to Houston for additional suited training.

The suited exercise is repeated for launch. Hopefully there is launch the first attempt. If not the suit goes through the same routine for cleaning, inspection, and testing to make sure the integrity of the suit has not been compromised. There are lots of additional duties when suiting astronauts for launch with a pressure suit.

Other additions to the work load have included the crew escape pole and the annual controlled deployment, the parachute inspections and pyro checks, plus the additional shipping requirements. Taking all that into account, it's a lot more work than what we had pre-*Challenger*.

WRIGHT: Do you have more team members?

WOODS: We do have a few more team members. One is a backup for Bill as far as the suit area goes. We did add some people to cover the Closed Circuit TV system pre-flight work and the laser operation for the OBSS [Orbiter Boom Sensor Packages]. The Sensor Packages Sensor System was added as a requirement post-*Columbia* to inspect the wing leading edge and the tile. Once again, you not only have the cameras in the A, B, C, D, elbow and wrist positions, you also have the Sensor Packages 1 and 2. Each orbiter has a set of cameras and sensor packages.

WRIGHT: Are there still additions that you're making even though the Shuttle has now been scheduled to be discontinued in the next years? Are you still making additions and improvements as you go along the line for the crews?

WOODS: We continually make changes to our processes, ground support equipment and flight hardware. LEAN changes are exciting—changes where we can save time, money and keep flying safely. That is the key as we proceed down to the last mission.

WRIGHT: Looking back over all those years and all the processes and all the checklists, how many of the items in your processes were started with the Apollo days and have continued through?

WOODS: We process the flight hardware the same as we did in Apollo. The changes that we see in the Shuttle and ISS programs are additional certification and traceability documentation for the hardware. Our parts' tags and shipping documents remain the same; it's the use of computerized tracking of hardware and decisions that are made by committees as opposed to top down management that have increased our processing systems and time. Our success is due to very competent, disciplined space workers in our facility. The amount of hardware we process is greater than ever and we continue to create a better way to do business.

We stow hardware by the Crew Compartment Configuration Drawing which was started during the Apollo and is a product of JSC. As the representatives at KSC for this hardware, it is our job to make sure that all the hardware is verified at receiving at KSC and is a completed end-item prior to stowage in the orbiter. We review and make changes all the way to hatch closure.

Depending on mission requirements, some missions are a little easier than others. Overall, we have only missed one cable for flight since 1982 and we stow thousands of items each mission (7,000 to 8,000 lbs of hardware).

Color code of hardware is from the Apollo Program. The commander in Apollo had the color red, the CDR on the Moon had red stripes on his suit and now in the Shuttle Program the CDR has the color red on flight items.

WRIGHT: You are moving on to the next program and helping develop the processes. Can you tell us about what all is being done and how far you've gotten?

WOODS: So far we have provided information to the new program on what and how we did business during the Apollo program as compared to the Shuttle and ISS programs. JSC is looking at it from the hardware perspective and KSC is looking at it from a final processing and launch perspective. A lot of information passing hands and hopefully it will be interpreted correctly as not to reinvent the wheel.

I am writing a revision to the JSC/KSC Inter-Center Agreement on the Handling of Flight Crew Equipment. This is my second revision of this document; the first added the Shuttle Payload and ISS element to the original document. The document was originally written in 1979, several years before we flew the first Shuttle mission and it was right on the mark for processing. The document covers all the elements of pre-flight processing—Crew Equipment Interface Test, S0017 and S007 Launch Countdown, and post-flight processing of all the hardware that is flown in the crew module and payload bay.

WRIGHT: Kind of exciting for you to see that again? To see another lunar suit go up?

WOODS: It's exciting to me just to see all the new people, new engineers and technicians, and try to share the history with them. Kind of like what Joe [Joseph W.] Schmitt did for all of us technicians as our lead NASA Suit Technician. I was very fortunate to have Joe as a teacher all those years. He was always there, and any questions you had, Joe would find the answer. I am trying to do this for the next generation of space workers.

WRIGHT: I want to talk to you about your interest and your talents of bringing your craft to canvas, the fact that you paint and capture what you do and share that through your artistry. Tell us how you got interested in that.

WOODS: It all started in high school, where I always had the interest, drawing, technical drafting. I never really decided to be an artist until I was in college and working in the Apollo program. We had an opportunity to do some suit drawing changes for the engineers. By doing that I decide to get a degree in art. Certain classes ILC would pay for, but not my art classes, even though I did drawings for them. That was ok, it was fun. When I moved to Houston, I continued my education at the University of Houston-Clear Lake, which was a small school at the time, but they did have a budding art department, great teachers.

Then I started photographing subjects that I wanted to paint. After the Apollo Program, I had a lot of opportunities to photograph the reference material for paintings like, *Hanging Around After a Walk on the Moon*, and *I Don't Think We'll See Flight Again*, because it really

was a sad time to see all that hardware placed on display instead of continuing the journeys to the Moon.

Like I said, when you first get into a spacesuit, you're hooked on space—like wearing your favorite pair of jeans. It's a great program. You start looking at it from that artist standpoint. And you see Al Bean develop a great body of work, just outstanding. He's just so fortunate to have been able to fly, walk on the Moon, and now he can share that experience with the world through his art. He does such a wonderful job of it, an excellent artist.

But I have also been in the right place at the right time. I had an opportunity to pose for Bob [Robert T.] McCall. I used to go over to [JSC] Building 2 and watch him paint the mural [*The Next Giant Step*, 1979] in the lobby. I'd go over at lunch and just be amazed at what he was doing. "Wow, check this guy out. Here he is up there painting on a scaffold." It was just incredible. He is part of the NASA Art Program, where they select artists to paint major events of NASA.

WRIGHT: So are you in the mural?

WOODS: Not the one at JSC but the one in the Smithsonian [National Air and Space Museum]. It was interesting. Joe and I were asked to support a photo shoot for Mr. McCall, at [JSC] Building 8. I got in the A7LB to pose, and Joe was holding the flag. We did not know that Bob was still taking photographs when Joe and I were taking a break; Joe talking with me on the headset, and I leaning over to rest my back.

Bob painted over some of the black and white photos to make it look like a lunar surface around Joe. Joe was in street clothes and I was in the suit on the Moon. The inscription on the

note about the painting stated, "Joe, you never thought you'd walk on the Moon." He signed it, Bob McCall, and gave that to Joe. Then, we got to see Bob McCall down at KSC in the suit room for STS-1, and he signed some of the caches, the envelopes that he had produced. He was just a really interesting man to work with. I don't know him that well, but it's just those events that I did see him at, he was just incredible.

WRIGHT: Tell us about yours, and maybe one of your favorites.

WOODS: The *Hanging Around After A Walk On the Moon*, I think it's just to see that kind of—that's why I did those ones on the gloves, and I got an opportunity to show that one to Neil [A. Armstrong] with his name on the glove, and also to Gene [Eugene A.] Cernan. I always mark his as *30 Years, Still First at Last*. It was like I always said to him [Cernan], "You're the first guy to be the last guy on the Moon," first and last.

My favorite one was on the brochure that NASA had about Apollo 17. The photo of Capt. Cernan touching the flag. I did a watercolor of the image, my first real good size watercolor. I took it into work, a friend/suit engineer looked at it and commented, "God, Ron. That's pretty good." As a self-taught watercolor painter, I was in shock. I've done eight originals of that, and the last one was printed as a Giclées before I sold it. I am truly amazed at the printing qualities that are available now.

Captain Cernan has one of the originals in his home. During some of his interviews, you can see that in the background. He is just an incredible person. When I did the first one; I had prints made of it. I had given one of the prints to a friend in Houston, who framed it and hung it outside of his office. On a visit to JSC, Captain Cernan saw it and commented on it. He got my

name and number, called my boss looking for me. My boss called one day and said, "Captain Cernan's office called and wants you to get in touch with them." I'm said to her, "Yeah, right, I'm sure." A few days later, she called and asked, "Did you ever call Captain Cernan's office?" I said, "No, that really is a big joke." She said, "No, it's true, they want you to call."

So I did, and his office manager says, "We were trying to get in touch with you because we want some of these prints." I'm just like, "Oh my gosh!" So I got some of the prints to their office in Houston. I was going through there on a trip one time, and I dropped them off. Like I said, he's such a tremendous person. He said, "Did you ever see the painting in the Smithsonian?" I said no. He said, "Well, I've got one of the prints signed by Bob McCall." He says to his assistant, "Would you print up one of those letters that tells about that print?"

Here's this long printout of the painting on his desk and it had the Apollo 17 patch on it. But the one in the Smithsonian couldn't have any patches on it; it had to represent all the astronauts in the program. He said, "That's me in the suit," and pointed to the print on his desk. I said, "Wow, that's me in the suit too because I posed for it at JSC." That was interesting, how we had both been a part of the original painting before Bob did the mural. He was so kind to sign it, thanking me for continued support of the space program.

I have had several opportunities to do commission work for other space workers and astronauts. A friend's wife asked me to paint something related to his work for his birthday. So I painted an EVA glove and a decal with a tether that would be attached to the [International] Space Station. The decal read, "Made in the USA by Dave Moore". The image also contained a note with a listing of things that Dave had accomplished while working at KSC. That's what I like to paint, images with a personal touch.

WRIGHT: Well, our time is coming to a close. Before we do that, I wanted to ask you if you had some thoughts or any special component of what you've done through your life that you'd like to share that you haven't had a chance to share yet.

WOODS: The best part of the all the jobs that I have had was working with the best people in the business, the space workers as Al always called us. It just doesn't get any better than this. I couldn't have gone to college and had a better adventure than what I have had. How it all fell together, it's hard to explain. But I think a lot of it was hard work, and to work with guys like Joe and Al, what an education they gave me. I am really proud of the US Space Program, what we have accomplished.

WRIGHT: We thank you for your time today, and we'll close so that you can get back to your other responsibilities.

WOODS: Thanks for having me here.

WRIGHT: We really enjoyed it.

[End of interview]