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ASTRONAUT TO ASTRONAUT



A SHUTTLE ASTRONAUT ASKS TWO APOLLO VETERANS: WHAT WAS IT LIKE?

■ INTERVIEWS BY TOM JONES

You could say that astronaut Hall-of-Famer Tom Jones had a pretty good career at NASA—four space shuttle flights, three spacewalks, and the satisfaction of helping to build the International Space Station. One thing he didn't do: Go to the moon. So when we invited Jones to interview two Apollo astronauts, Charlie Duke and Al Worden, in March 2019, he jumped at the chance. The following are abridged versions of his conversations. (Read the complete interviews at airspacemag.com/jones.)

• CHARLIE DUKE •

Apollo 16 astronauts John Young and Charlie Duke landed on the moon on April 21, 1972, and spent three days exploring the Descartes Highlands. Three years earlier, Duke had been the CapCom for Apollo 11—the astronaut speaking with Armstrong and Aldrin from Mission Control as they made the first moon landing.

Jones: Let's start with how you guys were involved, if at all, in selecting the Apollo 16 landing site.

Duke: Well, the selection was [by] a science committee. They wanted to go to the highlands because they felt like the rock types up there were different from the *mare*. When they came to us, they said "We've got this site that we're thinking about." They had Stu Roosa on Apollo 14 fly over and take pictures [using a Hycon mapping camera] from the Command Module. Based on that, they selected the site. And when they came to us, all they said was, "Do you think you can land there?" Of course, John and I said, "Yeah, we can land there. It looks pretty good to us." That was our input.

The unfortunate part, Tom, was that the photo-



◀ On his fourth shuttle flight in 2001, Tom Jones helped to attach the International Space Station's *Destiny* laboratory module. A former B-52 pilot with a Ph.D. in planetary science, he left NASA in 2001, and is now a consultant and author.

graphs had a resolution of 45 feet. And there were a lot of craters down there less than 45 feet. John recognized [during the landing] that our guidance was taking us, if I remember, a little long and a little north of our landing site. He redesignated [the aim point] a couple of times and we came in...probably within 200 meters of our intended landing spot. John picked a tremendous landing spot; we were almost dead level. We were very fortunate, though.... [I]f we had landed probably 12 feet back, the back leg would have been in a crater which we didn't even see, because of the dust [that was kicked up by the descent engine]. We had a few boulders and a few small craters, but nothing of consequence.

Give me a sense of your role in landing. Are you inside the cockpit reading gauges for John? Or are you looking out every now and then?

Rarely looked out. I was basically giving him read-outs of altitude, rate of descent, landing point designation, which the computer was giving in a cycle through the programs. My job basically was

◀ On their first Apollo 16 moonwalk, John Young and Charlie Duke (pictured) made their way to a crater named Plum. Their lunar rover waits in the background. Duke remembers the rover ride as bumpy, but stable.

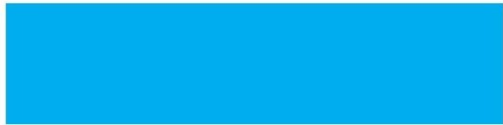
to keep looking down, and also to keep the thing running if we had an emergency.

The simulator [we had practiced on] had no motion, it was fixed-base. So as you looked out the window, you're basically flying a TV camera across the lunar surface. Whereas in flight, every time the [thrusters fire], you could feel that shudder or that vibration, which was significant to me.

Did you ever have a moment when you thought "I was at the CapCom console two years ago, and now I'm actually here doing this?"

Well, you don't really...to me, you're so focused on the landing I didn't think about that. But I'm so fortunate to have had the experience from both

"I STARTED TO JUMP....AND OF COURSE, MY [CENTER OF GRAVITY] WENT BACKWARDS, AND OVER I WENT. IT WAS SCARY BECAUSE THE BACKPACK IS NOT DESIGNED FOR AN IMPACT LIKE THAT."



ends of the line, if you will. Being CapCom [for Apollo 11] was, I think, more intense than [my own Apollo 16] landing. The landing is so dynamic, and you're looking outside, you've got these visual cues. The focus was more "Let's make this a good landing." Whereas at Mission Control, all you're doing is looking at data and listening in to what they're doing. So you get really, really concerned when Neil says "Oh, I can't land there." Those weren't his words, but that's what he meant. And we had the [computer] program alarms, and all of that stuff. So it became really, really tense.

What was your impression of the lunar landscape? What did you make of it when you first got outside and looked around?

We were in the Descartes Highlands, but the valley where we landed was called Cayley Plains. Out to the west of us it was sort of rolling terrain, and we journeyed out a mile and half or so to a place called Flag and Plum Crater. And [Plum] was impressive, like a 40-yard-wide crater. Looking to the north, one of our last objectives was called North Ray Crater, which was a very fresh crater about 500 meters in diameter, maybe 100 meters deep. We parked on the flank of that. It was so steep you

couldn't see the bottom. You didn't want to get so close that if it slumped in, you'd fall in and have no chance of getting out.

So now you're out there, doing fieldwork in a spacesuit. I know you guys practiced in the suits and wore backpacks with your blue jeans, things like that. But what was the real experience like, working in a suit on the moon?

It was, in one respect, very nice. With everything on, [you weighed] about 27 kilos [60 pounds]. You were able to move easily on the surface. I found that if the surface was flat, a little jog—one foot in front of the other and rocking back and forth—was most stable for me. Going up a hill, I found that hopping was better. Going down a hill, it was more of a skip. It was easy to lose your balance, I felt, on the moon because of the uneven terrain and the fact you can't see your feet. The only time it was scary, I guess, was when John said, "We're gonna do the Olympics," and he starts to bounce up and down. I started to jump, and when I did, I straightened up. And of course, my [center of gravity] went backwards, and over I went. It was scary because the backpack is not designed for an impact like that. Fortunately, I rolled right and broke my fall and bounced on to my back. I remember John came over and said, "That wasn't very smart, Charlie." I said, "Yeah, help me up." You could hear the pumps running in the backpack, and you could see the pressure was normal, and I began to calm down. That put an end to the moon Olympics. Mission Control was very upset.

How about rover impressions? What was it like to drive and be a passenger in that thing?

It bounced a lot, because up there it only weighed 80 pounds. It had a really good suspension system, but the moon was so rough in areas, it bounced. If you look at the film I took of John driving the rover, one wheel would bounce off the moon. So you felt all that when you were riding. But very stable. You never felt like it was gonna turn over. I did feel at times it was like driving on ice, because the back end was fishtailing back and forth. But overall, it was a fantastic machine, and we felt very confident.

When you look back on the three EVAs [moonwalks] and all you accomplished, what strikes you as the most important discoveries from your landing site?

One rock we picked up was on our first EVA, and it was on the side of Plum Crater. I identified this rock to the team, and they wanted us to pick it up. We argued with them and said, "Hey, this thing's the size of a watermelon." They said, "That's okay. Take your time." Well, I had to sort of back in

carefully into the crater; it was too big to pick up with one hand. The rake was not big enough, the shovel wasn't big enough. So I had to get down more like a football lineman and roll it up my leg. The chief of our science team was [geologist] Bill Muehlberger. So we called it "Big Muley." It's the biggest sample brought back from Apollo.

Can you describe the ascent from the moon in the Lunar Module, flying up to dock with the Command Module?

A lot of power on ascent. You know, the ascent engine was fixed, it didn't gimbal. So, we used RCS [reaction control system thrusters] to control our trajectory. Man, those things are firing; it rocked from one side of [the LM's attitude limit] to the other. If you listen [to the recording], as we lifted off and started to pitch over, I kept saying, "What a ride. What a ride." And it was closer to being in a T-38 doing acrobatics than anything I expected in space.

What about the return to Earth?

Coming home on the [deep space] EVA, I went outside while [Ken] Mattingly was working, and I was just observing and making sure his lifelines and tether were okay. I looked out to the right, and there was the Earth...like a thin sliver of blue

and white. It was 180,000 miles away, and it was spectacular. And over my left shoulder, as I spun around, you could see almost the full moon. It was, you know, enormous at 50,000 miles away. Very impressive. And the blackness of space, you know, is just velvety...you felt like you could just reach out and touch it.

• AL WORDEN •

While Apollo 15's Dave Scott and Jim Irwin explored the Hadley-Appenine region of the moon from July 30 to August 2, 1971, Al Worden orbited in the Command Module Endeavour, taking images and conducting experiments. During the return voyage, just as Duke would do on Apollo 16, he went outside halfway between the moon and Earth to retrieve a film canister—the first spacewalk in deep space. For both Worden and Duke, the lunar voyage was their only spaceflight.

Jones: Could you comment on the selection of the Apollo 15 landing site?

Worden: It was a challenging site because it was at 26 degrees north latitude, and Apollo had never gone farther north than 10 degrees before. We didn't know the lunar mass concentrations [dense



← Al Worden (center) calls Apollo 15 crewmate Dave Scott (left) possibly the best of the Apollo commanders. Jim Irwin he remembers for his quiet competence.

→ While Command Module Pilot Worden was enjoying a view like this from lunar orbit, Scott and Irwin were down on the surface exploring a lunar "rille," or channel, called Hadley, similar to the one shown here.



subsurface material that pulled more strongly gravitationally on orbiting spacecraft] well at those latitudes, and those mascons gave us some problems, altering our orbit and complicating our descent navigation.

It was an interesting site, with Hadley thrust up from the huge Imbrium impact basin. We hoped to get samples from the base of Hadley to understand that basin formation. Hadley was 15,000 feet high, in the third ring of impact-uplifted mountain belts out from the center of the basin. We would learn something about the energy of the impact required to form the basin—it must have been a huge asteroid.

Dave and Jim had to drop in over Mt. Hadley to land the LM. The mascons had changed our orbit in the final hours before the descent; we were lower than the 60-nautical-miles by 50,000-foot orbit we'd initially set up. We later determined that the LM cleared those mountains by just 9,000 feet!

We'd gone to bed the night before thinking we were comfortably clear of the terrain. But when I woke up the next morning and took the window cover off, I looked out and it sure looked like the mountains out there were above us! I was happy right after [Scott and Irwin went down to the surface] to get back up to a 60-nautical-mile circular orbit!

Did you encounter any surprises flying the Command/Service Module?

The CSM flew more like a Mack truck than a T-38. To dock, the trick was not to line up perfectly while far away, but to keep thrusting slowly forward and work your way toward the center of the docking corridor. It took about five minutes—no problems.

After Dave and Jim lifted off [from the moon] to return to me in orbit, the LM was the active module and I was the passive target in the CSM. The LM's thrusters were sized for a 37,000-pound vehicle, but with just the ascent stage left, those little rockets really rattled the LM around, and it was tough to get the ascent stage settled down to come in and dock precisely with the CSM. So when Dave got close and settled in about 50 feet behind me, we switched roles. I went active with the CSM, because we were still heavy and the attitude control thrusters weren't so touchy. The CSM was just easier to fly into the docking than the LM, using short thruster pulses.

One interesting thing about flying the CSM was that we had a mission rule that said we'd always have two people involved in any dynamic maneuvering. Well, when those two were down on the surface, I was alone in the CSM, and I did all kinds of solo maneuvering to obtain a variety

of photographs of the moon, and to track the LM in flight, using the 10-power monocular telescope. We also used an orbit-rate attitude program to keep our instrument bay pointed continually at the lunar surface.

I also tried low-light photography at night around the moon, trying to shoot star fields and faint phenomena like the *gegenschein* [a dust-produced sky glow opposite the sun]. To get the long exposures needed, I had to hold the CSM steady—that was a real challenge. I found it was almost impossible to kill all the rates for exposures longer than, say, 10 seconds.

Give us a flier's impressions of the lunar landscape.

From Earth we think we see color differences among the moon's regions, but up close everything's the same color—just shaded differently due to the different textures of the landscape. From Earth, relatively smooth regions look darker. Any color differences we saw were more due to sun angle—light brown looking up-sun, gray looking away.

What were the limitations or advantages of your suit when you went outside during the return to Earth?

For the EVA coming home, I was wearing my A7LB suit, and as you know it's a little stiff. But I was able to bend the elbow bellows enough to use my arms and hands to move around easily. The rest of my body, my legs...they just trailed along; I hardly used them at all. Getting my suit turned around using just one wrist on the handrail was easy enough. The suit did all I asked of it.

We took a gamble on that EVA. Both Dave and Jim had had irregular heartbeats on the moon due to the heavy workload, Jim Irwin most of all. There was some concern that if we put him in the suit and depressurized for this EVA on the way back that we'd increase his chances of a heart attack out there. But I think the folks in Mission Control sized up the risks versus the reward—we had to get that film back in—and gave us the "go." By then Jim had had a day or more to recover since leaving the surface, and had slept and drunk and eaten some good food. I think that reduced their concerns. And of course he was just fine on the EVA.

What were your EVA impressions?

One of the most stunning views on the flight for me was looking back at the hatch and seeing Jim in his suit, backdropped against the fully lit moon. But I had no camera, no way to capture that image. During planning I'd asked if I could take a camera out, but I was turned down. From

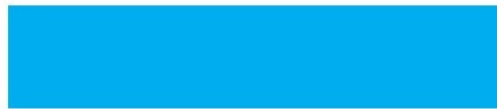
outside, I could see both the crescent Earth in one direction, 196,000 miles away, and the moon brilliantly lit in the other. Wow. I never got the feeling, though, that I was separated somehow from Earth.

The EVA lasted about 40 minutes. It would have been fun to stay out longer and enjoy the sights, but I guess I was too well-trained to linger out there after I got both film magazines back inside.

What were the best attributes of your crewmates?

Jim Irwin was my office mate for several years, and we became close friends. He was very quiet, very competent. Of course, he trained mostly with Dave, up in Bethpage [New York] in the LM, while I was in Downey [California] a lot of the time. So we trained separately for much of our preparation. Jim was supportive, a good follower, a sweetheart of a guy.

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Dave Scott was possibly the best of the Apollo commanders in terms of his competence and his ability to retain every detail of the mission. He took notes everywhere, on every aspect of our training and planning. I'd say he was the icon of what a commander should be like.

Anything else you would add about the moon and Apollo?

Our attitude during Apollo was that we as astronauts were expendable. It was all about reaching the goal. If we didn't get back, that's okay, as long as we advanced the goal of getting there. But I wanted to make sure I was not the one that could cause a failure.

I view Apollo as the very first step in a long-term process where humanity is going to get established somewhere else, before this world proves inhospitable to us. The value of our journey was more than just the findings from Apollo 15. It was instead about the quest for the knowledge that will ensure the survival of our species. ■