ORAL HISTORY TRANSCRIPT

OWEN K. GARRIOTT
INTERVIEWED BY KEVIN M. RUSNAK
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RUSNAK: Today is November 6, 2000. This interview with Owen Garriott is being conducted in the offices of the Signal Corporation in Houston, Texas, for the Johnson Space Center Oral History Project. The interviewer is Kevin Rusnak, assisted by Rebecca Wright and Sandra Johnson.

I'd like to thank you for taking time out to visit with us today.

GARRIOTT: Pleased to, Kevin.

RUSNAK: If we could start with you telling us a little bit about your background, the kind of interests you had going into college, maybe what kind of career you envisioned for yourself at an early age.

GARRIOTT: I grew up in Oklahoma, Enid, Oklahoma, in the northwest part of the state. As a matter [of fact], I'm fairly often asked about what got me interested in science and technology, or this sort of engineering career, how that might have led into an astronaut position, and it made me think back a little bit about it. I can really trace some of these interests way back as far as elementary school.

Now, my third grade teacher, for example, a very fine lady named Miss Bess Truitt, just happened to also be the poet laureate of the state of Oklahoma. But one of the things that she had in her class was an orrery, which is a word that I had no idea what it meant when I was in third grade, but it's a little device that has a whole planetary system in it. It has the sun at the center, of course, and then all the planets, and the moons of the Earth, and the moons of Jupiter and so forth. You turn a little crank, by hand in those days, and they all rotate. I think, gee whiz, so that's really what the solar system looks like. Fascinating. It got me started thinking about it all the way back as early as the third grade.

Then by a year later I was all the way up in the fourth grade, I had the chance to go back and talk to the third grade students about how the orrery worked. So I think that was certainly an early stimulation to my thinking about science and astronomy and some of the wonders of the world.

When I was in junior high school, I can remember quite clearly my father came home one evening and said, "Say, son, would you like to go to this adult class a friend of mine is going to be teaching about electronics, how radios and transmitters and things work?"

I thought, "Well, sure," you know, a chance to go with my dad and learn what the adults are doing, participate with this older group. I thought that would be fun. So we went to this radio theory class for about three nights a week for a semester or so. When we all got through that satisfactorily, my father then said, "Well, you know, this fellow is going to also be teaching a code class on Thursday nights. Would you like to come along and learn how to send Morse code and become a radio amateur operator?"

So I thought, "Well, we've got half of it done. Let's do that, too."

So my father and I went through then the code series, and finally got our license. I believe the year was 1945. I was fifteen years old at the time. So starting off in a technical area, thinking about science, and working with my father at his suggestion about learning to become a ham [radio operator], I'm sure helped direct me into the area of engineering, which was my both undergraduate degrees and eventual graduate degrees, as well.

So I went to undergraduate school at the University of Oklahoma in my home state on an NROTC [Naval Reserve Officer Training Corps] scholarship. In those days, it paid a very nice sum, about half the amount for me to go to college. That is to say, 50 dollars a month. [Laughter]

So with the NROTC scholarship I then had an obligation to go into the Navy at the end. Spent three years on active duty, but then went back to graduate school and again, when I applied at Stanford [University, Palo Alto, California], the group that seemed most interesting, back in electrical engineering again, was a group of radio amateurs, Ham radio operators in the Radio Propagation Laboratory.

So I can trace my interest all the way through graduate school and completing the Ph.D., eventually on the faculty at Stanford, studying the upper atmosphere of the Earth, radio propagation around the Earth, all the way back to my stimulation from my father and even a third grade teacher way back before.

I was actually on the faculty there at Stanford teaching, when along about 1963 or so, it finally dawned on me—I should go back and state one other thing further. I was a graduate student there in 1957, just completing a master's degree, looking for a research topic, because you have to have a research topic to complete a dissertation for your Ph.D.

All of a sudden, the Russians came along and, very fortuitously, on October the 4th of 1957, up came Sputnik I. So almost all of the graduate students and most of the professors in the Radio Propagation Laboratory converged on our field site, where we had a number of radio receivers and antennas and so forth for research purposes, listening to a Russian satellite go beep-beep, beep-beep, beep-beep, all the way around the Earth.

Well, I was looking for a research topic. What more could be provided than studying the signals from the Sputniks as they transversed, went through the ionosphere, and had various kinds of effects superimposed upon them due to transmission through the ionosphere? So that became my Ph.D. dissertation, was studying the signals from Earth satellites and the propagation through the ionosphere.

So I stayed on the faculty there, both teaching and doing research, when along about 1961, of course, the Russians first put a manned vehicle, Yuri Gagarin, it was launched in April of '61, and shortly thereafter, Alan [Alan B.] Shepard [Jr.] went up on an suborbital flight. So it was only another year or two before it finally became clear that NASA might actually take a person with a research background into the flight program. So that's almost the first time I really ever thought about the practicality, the possibility of actually participating personally in the flight program, after Alan Shepard's flight.

So I originally just applied for the program, the same way one would apply for any other government position. At that time, if I'd been a letter carrier or anything else, there's a standard form everyone submits, and put my application in. After a number of reviews and a certain number of other hoops one has to go through, I was fortunate enough to be selected.

So that's a long answer to how I ended up in the flight program at NASA.

RUSNAK: Prior to actually joining NASA, I saw that you had some technical reports on things like the propagation from satellites from space and stages of the ionosphere and such. Did this get you any contact with the people inside NASA that may have helped you become an astronaut?

GARRIOTT: No, I don't think so. In fact, I really doubt that any of the people who were responsible for the flight program had any idea what the research was about. [Laughter] It was not directly related to the flight program; it was just a subject that is of considerable interest to NASA from a research standpoint. Other parts of, say, the science directorates would be interested in that subject, and it would certainly have application to anybody studying the upper atmosphere of the Earth, but I think not necessarily to the people that are involved in the flight program directly. So it was only the fact that you had the right credentials, you had a Ph.D. with published papers and adequate qualifications as viewed by the academic community that would then qualify them from that standpoint.

But I think the flight program people would look to, say, the National Academy of Science. "Review this list of candidates. Tell me which ones are acceptable from a science perspective, and then we'll take a look at them and determine their suitability from a health and capability standpoint." I think that's sort of a shared responsibility, the way they ended up selecting people with my kind of background.

RUSNAK: Did you have any other qualifications that you thought might be particularly appealing, such as flight training, anything like that?

GARRIOTT: Good question. As a matter of fact, the answer is yes. Because when I first began to think maybe NASA would accept somebody with an academic and research background, I said, "Hmm, what will they look for?" Not necessarily how many papers you produced, but they would be interested if you could fly an airplane. So I'd been meaning to get my flight license for a good many years, and this provided the extra motivation. So I'd actually completed my private license and instrument rating by the time I was selected by NASA in 1965, partly because I'd wanted to do it anyway, then, secondly, because I realized it could be a qualification that would be important. Whether or not it factored in, I still don't know, but whatever the reasons were, it was a good thing, from my standpoint.

RUSNAK: After you got through the National Academy of Science level and were actually into the NASA side in terms of reviews, the interviews, that kind of thing, can you describe that process for me?

GARRIOTT: One thing related to that is the medical tests. What NASA, I think, wanted then, probably rather similar to what they want now, is not a world-class athlete, but somebody who has nothing wrong with them. They want average, everything right down the middle in terms of your biological characteristics. You wanted to be as normal as you can possibly be. One of the things they did want at that time—they're a little less strict on it now—is eyesight. So at that time, because we were going to get to go to flight school—that's another question I should come back to, by the way. But they wanted to have people starting the program with 20/20 uncorrected vision. Well, I had very close to that. When I went down to my eye doctor to have my tests made, which I had to send in to NASA, I really had no problem at either distance or close, except my right eye. My right eye was right on the edge. He says, "Well, maybe 20/25."

I said, "Well, let me blink a little bit. Let me see if I can't focus a little bit more carefully."

So I tried again and so finally he said, "Okay. Well, I guess that's about 20/20."

So I got in, right eye at near distance was just a little bit hazy, or a little bit questionable at 20/20. Distant was fine. Left eye was fine. So that got me through the first hoop. Now, if he'd have put down 20/25, they'd have never seen my application beyond the time that it arrived in Houston. But fortunately, as I then aged beyond the age of thirty-four, which I was at the time, your vision changes, of course. I still don't wear glasses at the age of seventy, except when driving. But my right eye stayed just the same. My other eye has changed a little bit, but for some reason my right eye is just where it was thirty-five years ago. It was just my very good fortune on this one little narrow thing, because the optometrist could in truth claim that my right eye was close enough to 20/20.

Then you were talking about the other medical tests. After going through the Academy and NASA decided here's a select group of people, there were about [fifteen] of us that were sent to the School of Aerospace Medicine in San Antonio [Texas]. We went through something more than a week, it was about nine days, I think, of medical testing, centrifuge, many kinds of other stress testing, putting your hand in cold water, and all the other kinds of things that physicians like to think of to annoy people.

Then from that group we came down to Houston for interviews with the flight crew, Deke [Donald K.] Slayton, Alan Shepard, others on the staff of the center. Then from that group they down-selected to six us, which were actually selected to join [as] the first group of science astronauts.

RUSNAK: What can you tell me about the other five people in your class?

GARRIOTT: The other five people. One person quit promptly for personal reasons. A second person stayed in the program for several years, would have made an excellent crew member, but decided that it was going to be so long, he was unwilling to commit to the additional number of years out of his professional career. So he returned to the university to continue his professional work as a physicist. So the four remaining all have flown. We all flew very close to the same time; Jack [Harrison H.] Schmitt to the Moon, and then within a few months, the other three of us were all on Skylab. So all four of us had our first flights, in my case—let's see, the others, well, at least in my case, the second flight ten years later. But we all flew within about [eleven] months of each other in '72 and '73.

RUSNAK: You mentioned one of the first things they had you do was go do some of this flying training.

GARRIOTT: Yes, I meant to return to that. In a way, it's like Brer Rabbit. I mentioned the fact that one of the things that the flight portion of the selection group would be interested in was, well, can these guys compete with professional test pilots. Of course, even though we didn't aspire to be a world-class test pilot, we did want to be able to fly aircraft and we considered ourselves capable of flying jets in the same way that they flew around Houston there.

So the first task was to send us to flight school for a year. Even though we were light-airplane pilots, three of us were not jet-qualified. Now, one person was, Joe [Joseph P.] Kerwin, who came directly to Houston. The other three of us went to flight school at Williams Air Force

Base in Arizona. Now, this was what it was like for Brer Rabbit. "Please don't throw us in that briar patch out there, because we're new pilots." So we had a very good year out there. We all enjoyed the flight school. It was a very hot summer out there, but we came back qualified, of course, in jet aircraft, and then we continued to fly the T-38s here for succeeding twenty, twenty-five years, however long we remained in the program.

As a matter of fact, I believe all four of us also went to helicopter school, so we were also flying helicopters. Matter of fact, I was just flying with my son, who has a helicopter rating, yesterday, over by Austin. I hadn't flown a helicopter for over ten years until yesterday. So I'm still enjoying it when there's a chance to get back.

RUSNAK: Great. I understand all of you did very well in your flight training and finished pretty high in your class.

GARRIOTT: We did pretty well. I can't remember exactly what our standing was, but I think it was certainly well above average. When we came back to Houston, I think we all did quite well in terms of our local flying, as well. There was another second group of astronauts, scientist astronauts, selected two years later in 1967, and at least one of them was tops in his whole class of undergraduates, Joe [Joseph P.] Allen, up at Vance Air Force Base.

So even though I don't remember exactly where we stood in the ranking, I do remember that Joe was number one in his class of probably sixty or eighty young pilots. Of course, we were really old folks at that time, thirty-four years old. I think I was about the oldest one that ever went to pilot training. Most of them were in their twenty-one and twenty-two-year-old range.

RUSNAK: When you first joined the astronaut corps, did you anticipate you'd be spending a year flying and then getting on to these other things, or what were your initial expectations?

GARRIOTT: That was our initial expectation. We understood that our first task for those not yet qualified, all but two of us, would be to go to flight school. So we were looking forward to it.

RUSNAK: What did you do once you returned to Houston after getting your rating?

GARRIOTT: Once we came back, the Gemini Program was nearing completion. We got back in the summer of '66, and that was toward the end of the Gemini Program, so we began to assist in various ways whatever needed to be done to provide assistance to the flight crews getting ready for Apollo.

Then also very soon the early stages of the Skylab, then called Apollo Applications Program [AAP], came into existence. So we began to spend time thinking about how Apollo Applications should be run, the configuration that should be used, and how it could best be flown. So particularly the three of us who eventually flew in Skylab began to think more about the experimental program of Apollo Applications and how Apollo Application should be designed to get the most benefit from it.

We also had a number of real fascinating trips, more like Brer Rabbit again. We had a lot of geology training that just had to be done, and survival training. We had to go take these courses. Of course, each of them lasted about a week or something like that. We went through survival training in the desert up in the state of Washington. They have desert up there. Then the jungles of Panama in the water down in Florida for water survival, and occasionally then during the course of the next ten years there would be refresher courses that needed to be taken. So we enjoyed all that.

But then in addition, there were a number of very serious useful geology courses all over the world related to the geology of the Moon. Of course, the Moon is a very cratered surface. Much of the basins have been formed by lava that flowed a millennia ago up from the interior of the Moon. We therefore studied a lot about volcanoes and we would go all the way to Mexico or the Western U.S. to Hawaii, to Iceland, to Alaska, and several other places around the world in addition.

These would be a week to ten-day courses taught by university-level and U.S. Geological Survey-level personnel about the geology associated with volcanism and how we could relate volcanism to the Moon. So that took up a fair amount of time, all of which we certainly enjoyed, and I felt was to our personal advantage to have the opportunity to participate in all that.

Then we began to also work into the kind of design of Skylab. It evolved over a period of about four to five years from what was originally called Apollo Application. Then its first configuration is what's called a wet workshop, which, as you may recall, involved at that time using the upper stage of a Saturn IV vehicle which had just been launched into space. Then you had to do what was called passivate the stage by entering it through a hatch, making sure all of the hydrogen and oxygen had been depleted and exhausted. Then you had to set up all of your equipment and hardware and living quarters and experimental apparatus on the inside of that second stage of the up-rated Saturn or Saturn IV [S-IV].

That would have been a terrible job, and fortunately over a course of year or two—and I think Pete [Charles] Conrad [Jr.] had a lot to do with making sure this decision was done correctly—they were convinced that it would be much better to use what the conventional design turned out to be, the so-called dry workshop. A dry workshop used a Saturn V vehicle in which the third stage of the Saturn V, which carried the crews all the way to the Moon, instead was fitted out with all of the stuff that we were going to have to put into the second stage of the up-rated Saturn. All of the living quarters, plenty of food, all of the water you needed, and all of the telescopes that would be used to study the Sun were mounted up where the lunar module would normally have gone on the Saturn V. So it was essentially launched ready for use. Then the crews went up on a Saturn-IB and docked with it and could conveniently go right to work.

So over the course of this four- or five-year period, a station design evolved from one of just very difficult tasks of building the Space Station on orbit into one in which the Space Station was built on the ground, launched into orbit, and then the crews arrived in almost a ready-to-use configuration. That was perhaps the most important decision was made in the evolution of the program.

As far as our work was concerned, as we got closer, say, in the last two or three years, we also worked with a university professor from University of Hawaii who was a solar physics professor, others in the science community, through the designed course work. We went through a full curriculum. I don't know how many hours of classroom work, probably sixty hours of class, a lot of reading associated with it, and a lot of testing of how the experiments were run, designed to acquaint the whole crew with the operation of all the solar telescopes.

So at the time the crews were launched, we all had very extensive training in solar physics, each individual experiment, each of the operation of each of the individual telescopes.

H. Alpha telescopes was one particular variety, and actually these visible rays penetrate the atmosphere so it could be seen on the ground and you can compare what the crew is doing and what the astronomers on the ground can see. But the other instruments do not penetrate the atmosphere in terms of being ultraviolet telescopes, X-ray telescopes and coronagraph observations, which look at the very faint corona of the Sun.

So all three crew members on each flight were fully familiar with the operation of all the set of telescopes and what the principal investigators who designed these telescopes wanted to use them for. So I think we were very well trained, because we had a fairly extensive training period time in which to do it.

The same thing is true for the medical sciences area. We trained all the way down at the hospital here in downtown Houston to our physicians here at JSC, to the principal investigators all around the country who had specific experiments that they needed to have done.

So we had a lot of training in this three- to four-year period prior to the launch of Skylab. I should emphasize again, all crew members were well trained in all of the areas, so we were essentially interchangeable in all of these activities.

RUSNAK: Earth resources was another area that was added rather late to the program. Did you have the same level of training and involvement with those that you did with these previous two?

GARRIOTT: We had an adequate level of training, not quite the same, because the operation of the earth resources telescopes was largely fixed and required relatively little judgment in terms of how you would operate the equipment. First of all, in order to look at the Earth, you had to reorient the whole spacecraft and hold it there for the pass across whatever terrain you were going to be photographing, a major job because you did not look at the sun, you could not do medical experiments, you had to focus just on earth resources.

Then you had your equipment mounted to special windows that were looking right straight to the nadir, that is toward the center of the Earth. Then once you got to the right spot, you simply activated them. When they turned them on, they ran for five minutes or ten minutes or whatever the appropriate length of time was, and they turned off and you stowed all the equipment. So there was relatively little judgment involved in how to operate it, which is not true for either the solar physics or the life sciences. Judgment is continually required all the way through these. So it did not take as much training time or involve as much judgment in how the experiment ran as it did in the two areas I first mentioned. We were adequately trained, because, as far as I know, they all ran just as planned, but it was because it was largely a cookbook operation, where you set it up at a certain time, activated it in a certain way, and then you put it all away again.

RUSNAK: Which of these appealed to you as an electrical engineer? Were there any in your sort of areas of specialty?

GARRIOTT: Some of the experiments were of a corollary nature, which we haven't talked much about. Some corollary experiments did actually look at the ionosphere or the upper atmosphere of the Earth. But I was really quite interested in both of the other two major areas, not because they are so closely related to my original research area, but because after joining NASA, your focus becomes that of a generalist.

I'm very interested in the medical experiments. I find it fascinating to try to understand how our body works, how it adapts to weightlessness, how it readapts when you come back home. There are so many things about it, your vestibular system, your cardiovascular system, your neurophysiological system, almost an endless subset of questions that could be raised. So I'm very fascinated by all of that.

The same thing is true for the astronomy. The stars, our star, creates the ionosphere. It has so many interesting things to see about it. It's so dynamic when you can look at the active regions and the mass ejections and the faint corona that you could only see when you get above the Earth's atmosphere, or wait for a total solar eclipse to occur. So I was really quite interested in both of the major areas, even though they did not directly relate to the research that I was doing before joining NASA.

RUSNAK: Did you find that once you were getting into these sorts of planning and training that there was much time for your own scientific and intellectual development outside of these Skylab-related ones?

GARRIOTT: There was a little time for that. I noticed on one of the discussion topics that had been mentioned there was some individuals, apparently, who had suggested that it's a little bit boring up there, that if you're going to stay there for several months, don't you sort of run out of things to do. My answer to that is not only no, but a very emphatic no, that anyone who runs out of something to do must have had a failure in their imagination block up here somewhere. Because if there's nothing else, you can look out the window, which would absolutely fascinate me for weeks on end.

But we were working approximately six and a half [days], six and a half days of the week. We had about a half a day for things on your own. When I say six and a half days, we ended up working from as soon as we awakened. One man would go to the solar panels, the ATM, the Apollo Telescope Mount. The other person would set about doing his weighing and other kinds of biomedical experiments. The third guy prepared breakfast. So we kept that up throughout the whole day. After dinner, one would go back to the Apollo Telescope Mount while the other fellows collected and took care of the wrapping-up things for the day. That's how we managed to get as much work done as we did, beyond that which was originally expected.

But even beyond that, before I ever left, I had planned in my own mind to try to bring back some recorded filmed material [and preplanned ideas in my notebook], which I could turn into, say, fifteen-minute little programs to be distributed to schools. So when I came back home, I had collected a number of experiments, some little simple things like the demonstration of gyros can be done so much better in Earth orbit, in weightlessness. For example, take magnets. Magnets have a phenomenal behavior. They'll oscillate back and forth, they'll actually line up and go the direction of a local magnetic field while you're in space, the same way they would out here if you can hang them on a string. So you can take a bolt with a big nut on it, spin it off and it will just stay spinning nicely. So put a magnet on it, and that will begin to precess. After it spins off the bolt, the spinning nut will then slowly tip over depending on what the magnetic field is doing, as long as you have a magnet on it. Well, that's a lot of fun to explain.

Fluid physics is so much more interesting in weightlessness, because you don't have gravity to keep from pouring the liquid on the floor. You can create bubbles out of one of your drink bottles or out of one of your syringes. You can take bubbles of different colors, see how they coalesce. You can fill them with air and watch them, see how the air bubbles on the inside will coalesce or if you stir it they'll be separated. Fascinating things of real importance if you're trying to understand how fluids behave in a weightlessness environment.

So I recorded on film, or video, a number of these kinds of experiments in my other half day. Then when we came back home, over the course of the next six months we put it together into about six or seven short fifteen-minute films that I think at this point have been seen by several million young people in the elementary and junior high school grades.

RUSNAK: So that was something you had worked out from before you even went up?

GARRIOTT: Right, because I realized we had a little bit of time. You can't be glued to the telescopes for sixteen hours a day, and so you could find little intervals of time when you could do these. Plus, we also had some student experiments that were approved by NASA. There were about thirty experiments approved, and then most of them actually were flown and conducted for students, high school students, all over the country.

One that got a lot of publicity is the two little spiders, “Cross” spiders [named Arabella and Anita], that flew in space. That young lady [Judith Miles] from Massachusetts, I believe, eventually ended up with an M.D. degree and was doing her work in the Pacific area. I've lost track of her over the last thirty years. But those two spiders were her concept, her idea, and they got a lot of interesting publicity for NASA, as well as for her. Those took up some of our time pleasantly, doing the kids' experiments.

RUSNAK: If we can change gears for a minute, since we've been talking a lot about Skylab, if we can take care of Apollo and some of your involvement with that program, your role as capcom on the mission and that kind of thing.

GARRIOTT: Most of us in Skylab, we had a fairly minimal involvement, although as you have suggested, I was a capcom on Apollo 11. I think that was useful to me from a standpoint of getting me closer involvement in the actual flight program and the conduct of the mission from an operational standpoint. Had we not had that experience, we'd have probably hit Skylab more cold without ever having as close as involvement.

So my role on Apollo 11, for example, was to be one of the capcoms. As soon as they landed, for example, and all went to bed, I was on the capcom's position while they were all sleeping for the first night on the Moon. So, not a lot of work on that one, but you have to be ready, of course. You have to be prepared to handle almost any emergency that might come along. So you learned a lot in that role. So I hope I was of value to the Apollo 11 team in the conduct of the flight. I'm sure it was of value to me in preparation for the Skylab Program.

RUSNAK: What about getting interaction with the flight controllers and the mission control team?

GARRIOTT: Well, that's true, although we interacted with the flight controllers in the process of training for Skylab, as well. We had integrated simulations, as they used to be called—I presume they still are—in which we would work with the flight controllers, then simulated the conduct of the mission and simulated various kinds of malfunctions occurring. So we got to know the flight controllers pretty well, had a good deal, a great deal of respect for them. I think we've managed to work quite closely with all the flight controllers during the Skylab period.

RUSNAK: Amidst your busy training schedule and planning for Skylab, did you have a chance to follow the Apollo missions? How closely did you monitor what was going on?

GARRIOTT: Oh, we followed every flight closely. I don't think there was any flight that I was either not at the Cape [Canaveral, Florida] or sitting in the control room at the time of launch. Even, of course, several times acting as capcom you have to be on the floor, but even if you're not on the floor, why, we followed all the flights very closely. For one thing, there's not all that many people in the office. The whole Astronaut Office at that time consisted of thirty or forty flight crew members. Right now—I just happened to check this morning—it's about 180.

So everyone had a significant role. It was, I think, a closer-knit group and everybody knew what the other guys were doing and what their jobs were and how they were coming, because we had our weekly meetings, appropriate brief reviews or comments about how things were going.

RUSNAK: Was there a lot of interest from the Apollo crowd in what was going on in Skylab?

GARRIOTT: Apollo came before Skylab, so I would say it's more the inverse. All of the Skylab people were quite interested in Apollo. The Apollo people were focused on that task, and unless they were going to be involved in Skylab, as were, in particular, Pete [Charles] Conrad [Jr.] and Alan [L.] Bean, then I think their interest in Skylab was somewhat less, because they had to do their job first. Once they had completed Apollo, then most of them went and did a variety of other things. Some of them, for example, like Deke Slayton was preparing for ASTP [Apollo-Soyuz Test Project]. But I think it was more the Skylab people being interested in Apollo than the inverse.

RUSNAK: With particularly the later Apollo flights, the J missions, the last three, you had a lot of scientific involvement going on there and the crews went through a lot of training. Did that provide any useful lessons for you in preparing for Skylab, in terms of NASA learning how to work with scientists and integrating experiments?

GARRIOTT: It had started much before that, because the very people who were working in the science community, in the science organizations, particularly from a geology side, are the same ones we'd been taking field trips with for three or four years. They were the ones who were the principal investigators. They were the ones who had done the training for the Apollo crews, and, therefore, the training that we were involved in. So we felt personal affiliation and affinity towards all of those folks as they then proceeded with their work on Apollo. So it was sort of a continuation all the way, of the training that we had in geology, right on through Apollo into Skylab.

RUSNAK: As a scientist yourself, do you think you had a greater interest in these types of things than the test pilot astronauts did?

GARRIOTT: I think it really depends on the individual. Some of the test pilots had a lesser interest than did others. That would have been true for the geology, as well as for the Skylab. By the time we got to Skylab, I would say all nine crew members were highly motivated to do the science that was involved. Skylab basically was a science program. There are certainly flight aspects of it, like the launch and rendezvous and return and so forth, and there's no doubt that the flight commanders had to be particularly expert in the conduct of those phases of the flight, the launch, rendezvous, docking, and so forth.

However, 90-plus percent of your time is spent doing useful science research on board the Skylab, and everybody was highly trained, highly motivated to get that done. I could tell no significant difference between, say, Alan Bean or Jack [R.] Lousma motivation from my own. We were all highly motivated.

RUSNAK: Since you've mentioned the other two members of your crew, could you tell me a little bit about them and your impressions of them as you were working on them before you actually flew with them?

GARRIOTT: Of course, before I flew I'd already known them five years, and so we were already good friends. I would say I not only had a great deal of respect for their talents and capabilities, and I could see that they were as interested and they were coming up in terms of a learning curve into areas that I might have had a higher level of background experience than they had had, but they were coming up very fast and they were learning it and approaching the same level. So we were all equally competent at the experimental work. So I had a great deal of respect for them at the time we flew, and I would say that succeeding years have only increased that.

For example, we're still very good friends. We even took vacations together the last two years. All of our families have taken trips to Wyoming and Michigan and various other places together, so three couples of us. We still have fairly frequent communication. So they're close friends of mine, still. I respected them at the time and appreciated them even more after thirty years.

RUSNAK: That's great that you guys get along that well. Can you give us maybe a little bit of personal character on each one, what were they like?

GARRIOTT: Okay. Yes, there are some interesting features about that. Alan Bean is a very highly motivated individual. Anything that Alan undertakes, you can be sure that he is going to give it his absolute 110 percent. He stays focused. He is very different than I am in a number of ways. He is a clean desk type of person. You go in at the end of the day, his desk is clean. Mine gets cleaned maybe once a year, if I'm lucky and working hard. Usually it stays stacked. That's a difference in our personality. I'm not sure what that difference means. [Laughter] I'm not sure what the difference between a clean desk and a messy desk person is, but I'm sure there must be something up here that's different. So that's one of the basic differences.

He is so highly motivated. He is motivated by a good speaker who can bring that out, the importance of staying focused. He tries to focus all of his other crew members in the same way. I would say it's almost impossible to keep the same focus that Alan has on a single subject for a clear lengthy period of time. Very confident, obviously. So I'd say that's the prime thing about Alan, is to think about how he is motivated principally internally, self-motivated, and how focused he can become on whatever it is his accepted task is going to be.

Jack is, again, different. He is almost a conventional Marine. Jack, when he has been given a job or he undertakes on his own to do the job, you'd better not get in his way, because he is going to get it accomplished. Nothing is going to deter Jack from completing his job. Very loyal, very friendly, and sort of a personality that no one can find a problem with.

I've often joked, since his first name is Jack, if there ever was an All-American boy—you remember Jack Armstrong, of course, from probably, at least, my childhood, if not yours. If there ever was an All-American boy, this Jack is it. So you have to admire Jack and enjoy his personality.

RUSNAK: Two Navy guys and a Marine on the same crew.

GARRIOTT: Hardly came up, but that's true. Of course, we convinced Jack that the Marines really is just a subset of the Navy. So actually that was noticed and we were pleased to have all come from the same service. But since my total time in the military was three years, it hardly compared to the career that both Alan and Jack have. But that was a minor unifying factor, and we had a chance to joke about it from time to time.

RUSNAK: As you mentioned, you guys had been working together for several years before you were actually named to a crew. How did you find out that the three of you were going to be the second manned crew?

GARRIOTT: I don't remember the answer for sure. I could be mistaken about this, but it was perhaps two years or a little more before launch, and there had been a number of us in the Skylab group who were focused on getting it done. From just a personal standpoint, I knew that there was Joe Kerwin, Ed [Edward G.] Gibson, and myself who were scientist astronauts. There were three flights, so there was a pretty good chance that we were each going to have a chance to fly. We didn't know which one exactly.

So Deke Slayton, Alan Shepard probably made either the decision, or had the largest factor in making the decision. They, I believe, spoke with the commanders about it and may have allowed them some leeway or approval long after the decision was made. But Alan, I'm almost certain, was the one who mentioned it to me, and said, "How would you like to come fly with Jack and myself?" So obviously I was very enthusiastic. I can't remember the details about it, but I believe that's how it came about.

RUSNAK: That sounds like a—

GARRIOTT: Typical.

RUSNAK: Typical, yes, I guess, is the word I'm looking for. Once you're on a crew, how does the training and the types of activities you're doing change?

GARRIOTT: It becomes more focused, because then there are other things that you can begin to look for. For example, the first flight had extra tasks associated with getting the station set up. They had other tasks eventually because of the problems that Skylab had that they didn't know about. So that was not a difference at the training stage. But theirs was a shorter mission, ours was a little longer mission, and so you had to tailor your training to the specifics of a flight. Although the basic solar physics training, the basic biomedical training, was the same. You then needed to be into more carefully delineating exactly what the flight program was going to be for the individual flights. So it allowed you to then focus on your individual flight and see more precisely how you would do things differently based upon the different tasks that you would then be called on.

RUSNAK: Since you were the middle mission, the fifty—

GARRIOTT: Fifty-nine and a half, we'll call it. We were out about sixty days.

RUSNAK: This was going to be a record duration, so obviously the medical effects on your body and such were going to be an important thing to be studying. How did you go about establishing the baseline and going through experiments to see how this affects you physiologically?

GARRIOTT: Good question. Actually, each of the Skylab flights was a significant extension beyond what had ever been done before. Prior to Skylab, I believe the longest U.S. exposure had been eighteen days and the Russians twenty-one, something like that. The first flight was twenty-eight days, so a substantial extension beyond that which either the Americans and Russians had flown in flight duration. Ours at approximately [60], again, doubled that, and then the third flight was [nearly] 50 percent more. So every flight had the same problem of convincing themselves and convincing them on the ground that the crews members were remaining in good condition.

A particular thing to be concerned about was what the physicians called orthostatic intolerance, namely, were you going to faint when you stand up. When a person who's been in bed for a long time pops out of bed, quite frequently there's a tendency for the blood to pool in your legs and a possible fainting spell. In fact, it is still found to be true in the Shuttle Program today that that can happen. So the question was, how can you be confident that after your extending or even doubling the time in space, you can come back to land and not faint when you get back, or not really become incapacitated.

So one of the most interesting experiments is called a lower body negative pressure, LBNP. The LBNP is a device which you can still see in the mockups that are available of the Skylab. It's kind like a half of an iron lung up to your waist, you're enclosed in this small cylinder, and sort of a tight seal made around the waist. Then a very small vacuum is drawn in the lower half of the cylinder, up to a maximum of about 60 millimeters of mercury. Now, that small difference in pressure is just enough to suck a little bit of the blood to the lower half of your body to the same degree that we can stand up in 1-G environment.

So if the physicians, or yourself, wants to get a good idea of how your body would behave if it were returned to Earth at that particular time, go hop in the LBNP, let it draw about 60 millimeters of mercury, and then your physiological response is about what you would expect if you'd return. So we did that on each crew member every third day, one person each day, cycling around for the whole flight. All this data is telemetered to the ground. We also metered it out and recorded it, of course, because it's one of the basic biomedical experiments that we do, LBNP.

That gave us confidence, as well as the ground, that, yes, indeed, you're doing well, no problem, you can keep flying longer and longer. So that is perhaps the single most interesting, most important experiment in terms of giving one confidence that the flight extension is not getting into dangerous territory.

RUSNAK: What about some of the other effects of long duration, such as losing the bone mass and muscle mass, that type of thing?

GARRIOTT: As long as we're all over twenty-five years old, we are all losing mineral bone mass right now, as we stand. It is a very slow decrease, but bone density, bone mass, is typically decreasing at a very slow rate.

Now, if you do a bed-rest study, lie in bed, don't ever get out, there's an accelerated rate during that period, which is just barely at the measurable level, because no one really wants to go spend two months in bed and never get out. It's a very difficult experiment to run. But that's the kind of experiment that you're running in weightlessness in space. Your body does not have any loading on your legs, your big muscles, and so your body thinks that, gee, there's no one stressing that bone, I guess I don't need as much strength or as much bone density as I had. So the similarity between weightlessness flight and bed rest is very close from a standpoint of mineral loss or bone densitometry.

So that is an important experiment, and it's still of value. They're still taking bone density measurements on current flight crews and flight crews that have returned in order to try to determine whether or not there's been any decrease. Now, what might be expected? Well, after you come back from in space, maybe it is accelerated, maybe it drops down a little bit and then plateaus again. But the problem is, the changes are so small, the measurement sensitivity is not giving an answer with sufficient accuracy to be confident of what the real result is. So, yes, there's undoubtedly continued mineral loss. How serious it is, is an unknown question. It's an important question for six-month, twelve-month stays. It's an important question for trips to Mars. So it's one that I'm sure that we will want to continue to study in the Space Station here, as well. But from my own view, we'll either find some ways to combat it or we're going to find that the exercise protocol that we have aboard Skylab and now Space Station is going to be adequate to combat it. So I personally do not think that it's going to be an insurmountable hurdle, but it is one of those questions that we still need to have better answers to.

RUSNAK: Certainly that is one of the things they're going to be looking at in the International Space Station.

GARRIOTT: Right.

RUSNAK: I think ostensibly that was one of the arguments for sending John [H.] Glenn [Jr.] up here in the past few years.

GARRIOTT: I've not heard anything back about any bone densitometer measurements from John.

RUSNAK: I haven't actually heard any results from that, either.

We've been talking to this point about the preparations for your mission and such, but you guys were, as we mentioned, the second crew. What were you doing when they launched the workshop itself and there were some problems?

GARRIOTT: That magic date is May 14th of 1973. I think probably all of the Skylab crews were down at the Cape for the launch. Of course, the Saturn V launch, big earth-shaker, and it went extremely well. We saw the takeoff, saw it disappear, we were very pleased from the VIP stands over there.

So we all came back to the motel, and I remember we changed our clothes into flight suits, because we were going to go out to Patrick to fly back in our T-38s to get ready for monitoring a flight. And as we were coming by, walking out to get into our car, I noticed a gentleman on the second story up there, whose name was Rocco [A.] Petrone. Rocco had just been recently appointed the Director of the Marshall Space Flight Center [Huntsville, Alabama], and so we come up and say, "Hey, that's great Rocco. Sure looks good."

"Owen, don't get too excited. There's something on the telemetry that doesn't look quite right. It looks as if they're not getting the electrical power and the attitude is wrong, so we don't know just what's happening yet, but we have a problem."

So that's the first time we knew, because we were not sitting in the control room, that there had been a problem at the time of the launch. So we were even more anxious to get back home and to try to start assisting the program. But that's what it was, and that's how I found out about the difficulty when the launch occurred and the micrometeoroid shield had been torn away from the third stage of the Saturn V.

RUSNAK: Did you do any immediate training or help in those two weeks before they sent up Pete Conrad's crew?

GARRIOTT: It was actually [delayed] ten days, they launched on the 25th of May. In my opinion, that was the finest ten days that NASA has ever had. That includes the roughly one-week period when they saved the Apollo 13 crew and brought them back safely. Apollo 13 was largely a JSC [then MSC] activity. The saving of Skylab was a full NASA/contractor activity all across the U.S. and particularly JSC, Marshall, and the Cape, and 100,000 contractors all over the country were focused on understanding what went wrong, how could you bring temperatures down, how could you control the attitude before you ran out of fuel, how could Skylab be saved.

Then after they understood the problem, they had to say, "How can I fix it?" They had to conceive of these fixes. They had to build the apparatus to do it, like the parasol or the sunshade, and so forth. They had to test it. Then they had to get it all prepared for flight, get it to the Cape and load it, and that all was done within ten days.

And this was not a single problem. I mean, there were temperature problems associated with the micrometeoroid shield. There were attitude-control problems, because the high temperatures had destroyed some of the equipment. To bring the temperatures down a little bit, you had to change the attitude of the spacecraft out of a solar inertial attitude. Then you began to use up propellant, because they only had cold gas nitrogen. So there were a whole sequence of problems. They had to decide whether the food was any good. Do we have to send up new food? Has the atmosphere been outgassed and have a poisonous atmosphere on the inside? Can you dock with this Space Station? So many problems that had to be solved.

I think that NASA had performed twenty-four hours a day, literally 100,000 people, in a far better manner than they've ever done before or since. You still talk to the people at JSC or Marshall about the cooperative attitude that they had and the way they worked together just as one team, still thirty years later you talk to any of those people, they'll say, "Yes, we sure worked well together." Everyone looks back at that as sort of the golden era. If we could only continued to work well, as well as we did, during that period between May 14 and May 25 of 1973. So it was really an amazing period.

We all contributed. Yes, I did a little bit. I had a couple of thoughts about what might be done to help stabilize the attitude. Turns out those weren't used. Other things were done instead. Other people were in a water tank devising various ways to try to erect a parasol or erect a solar sail. The parasol worked fine on the first flight. We put down the solar sail on the second flight. All of those things were just done so quickly. It's an amazing period in NASA's history.

RUSNAK: We've heard similar sentiments from several of the people that we've talked to, that had been involved here with particularly the parasol, in creating that device, like Jack [A.] Kinzler and such.

GARRIOTT: What's his last name? Not Kinzler. How's he spell his last name, Jack?

RUSNAK: Yes, Kinzler was the one—

GARRIOTT: Kinzler. I couldn't remember how he spelled his name, yes, who got his fishing poles out and built it here.

RUSNAK: Right.

GARRIOTT: Interesting thing, I was just talking about this at an astronomical meeting in Huntsville a couple of weeks ago. One of the fellows said, "Oh, yes, I helped design that." So I said, "Okay." [Laughter] I know he really didn't. I guess we probably ought to take this off the record. But as far as I'm concerned, everybody had a hand in it. The more people who think they did it, the better, even though I know the facts of it were just as you've mentioned to me here. But that wasn't a lazy period. People all over the country were helping.

RUSNAK: Once they figure out a solution, these ten days with all this work, they send Pete Conrad's guys up to fix it, were you then following their crew closely in the developments going on with them and the EVAs [extravehicular activities] and such, too?

GARRIOTT: Oh, yes. We were still only three months from our own launch, so we had to primarily keep focused on what we were going to do. But there wasn't any point in worrying about what we're going to do unless they did their job well. So we followed it very closely, particularly the first few days of it, because that's when they were trying to decide whether or not [they would be able] to deploy the workshop solar array, which we had to have if we were going to have adequate electrical energy. They did finally get that done.

We were very interested to find that, yes, the atmospheric, the internal temperature could be brought down to eighty-five or ninety degrees with the parasol and the food was largely acceptable. That meant that during the two months between their flight and ours, we could fine-tune anything we needed to do on our flight, like the solar sail deployment and other kinds of fixes that remained to be done on our flight. So we certainly followed theirs very closely, but were also in the final stages of making sure we had everything done for ours.

RUSNAK: Were there any particular lessons learned from their flight that you could then apply to your training and to your flight?

GARRIOTT: I would say basically we understood it pretty well and pretty accurately right from the beginning. We were reassured to find that the interior of the workshop was just about what we expected it to be, that temperatures were going to be tolerable and, yes, everything worked just about the way it was planned.

There was a little bit of a problem, for example, with one of the solar telescopes. One of the ultraviolet telescopes did not have the designed or adequate sensitivity, and so we managed to bring up a hood and some faint viewing image intensifier cameras to work with it. So we learned a few things that we needed to bring up for either repairs or improvement, but basically we were pleasantly surprised to find that we'd anticipated almost all the situations as it really existed and any problems that we might encounter.

RUSNAK: With their deployment of the parasol, there was some concern that the material was going to degrade, so they wanted to put up the twin pole sunshade, as I guess they called it.

GARRIOTT: That's right.

RUSNAK: Tell me about training for that and preparing for it and using the neutral buoyancy simulators, that type of thing.

GARRIOTT: We did the training for that down at the Marshall Space Flight Center in the big water tank, which has now been deactivated. That's a particularly interesting subject, because Jack and I, Jack Lousma and I, were the ones who had to deploy it. It was pretty much a two-person job, but my job was to actually build the twin pole. We had the aluminum segments strapped to an aluminum plate with a little elastic band wrapped around each of the tubes. We then needed to take it off of the aluminum [plate], lock it together, roll down a ring, like a screw and a nut, and then roll down a locking ring at each section joint. So there were about six or seven connections on each of the two poles.

Well, we tried it all out of the water, first of all. Then we were going to practice it under water, as well. I remember rather clearly they said, "Well, the one that you're using is the only flight unit we've got. We've all had to prepare [it] rather quickly here. If we tear that one up, we're a little afraid we won't get the next one, or another flight unit ready in time. Can you simulate it here well enough so we don't have to take this flight unit down under the water and get it all messed up down there, and we can leave it in its more improved condition up here?"

I said, "Okay, that should be all right." We had to sort of lift the elastic out and pull the pole out and so forth. It looked like it could be done all right. Well, that's about the only part that we did not properly simulate under water [in a pressure suit].

So now fade ahead about two months until we're trying to do this in space, maybe only one month until we're doing it in real life outside the spacecraft, with this great big bulky pressure suit with pressurized gloves. Your fingers are, of course, about twice the diameter that they are here, and you don't bend over nearly as easily as we do here in street clothes.

So I had to reach down and stick a finger under that little elastic band and try to lift it and at the same time get the rod pulled out. Couldn't do it. There was no way when those rods were side by side and a small elastic band around each of them, to get a finger in there. So what I ended up having to do was to grasp the whole rod, pull it up far enough that I can get my fist underneath the elastic band, try to break it. Have you ever tried to break an elastic band? They're tough. Those are tough. So I really couldn't pop it either. I had to pull it over far enough that I could, you know, move the rod far enough that I could then slide it out from under it.

That turned out to be the most physically demanding task that I did during all of my three EVAs, three EVAs of fifteen hours or so. That was the toughest, and it's because the one thing that I did not simulate under water was the thing that I had a problem with when I got to space. So it shows the importance.

For example, if I thought back about it, if that had been Alan Bean, he probably would have insisted on taking that flight unit to the water, because he doesn't like to compromise on those things. In this case he'd have been right, because that was about the only thing that gave me a real problem. But we managed to deploy it all right eventually.

It did bring down the temperatures. I think that the parasol material, because it had been manufactured very quickly, almost overnight, did lose some of its reflectivity characteristics.

The twin poles sunshade was important to bring the temperatures down to a more permanent seventy, seventy-five, eighty-degree level.

RUSNAK: What about training for the other two EVAs you did?

GARRIOTT: The other EVAs, let's see. Jack had to change out some gyros. They had various other kinds of experiment works to do on the outside, bring back the cameras and so forth. But the one I just described is the one that sticks in my mind because of the difficult that I had putting those poles together.

The other two EVAs went off more or less as advertised, although we did have some other activities, like, oh, for example, some of the windows, the aperture doors on the telescopes had to be pinned open. They were getting sticky. So we had to use a little wrench to take some of the nuts off and open the doors permanently, so it wouldn't remained closed. Some of those washers probably stayed in orbit for about another seven or eight years, because I couldn't keep six or eight washer in my hand, and they eventually floated away and probably burned up over Australia somewhere.

RUSNAK: What an appropriate fate, given the rest of Skylab.

You mentioned that this was all a month or so before you actually had to launch, and your flight was actually moved up several weeks because of some problems aboard the workshops, some mechanical issues. Do you remember what was going on there?

GARRIOTT: I don't even remember that. [Laughter] Ours was advanced, was it?

RUSNAK: Yes.

GARRIOTT: I don't remember any of that. I've forgotten that. Thanks for reminding me.

RUSNAK: I think they were concerned that some of the new mechanical systems weren't going to hold up for—

GARRIOTT: Yes, they thought that they needed some people up there to attend to the control moment gyros, now that you've reminded me. I hadn't thought about it for decades. But there were a few problems they were concerned about, and so that was not a particular problem, as I recall. We thought we could handle that part all right.

RUSNAK: If you can describe for me the days moving up to your launch and then the day of launch itself, the kind of preparations you went through.

GARRIOTT: Things went smoothly right up to and including the day of launch. There were no particular hangups or problems. We had a morning launch, and the launch went just perfectly, no real problems.

But we did have a few problems during the rendezvous phase, as you might have recalled. Let's see. I was sitting in the middle, Alan on my [left], Jack over here. As we were proceeding through the middle of the rendezvous, why, Jack said, "Look at that." I looked out his window over here, and here came what looked to be the nozzle of one of the reaction control thrusters just floating by the window. You can recognize a nozzle pretty quickly. It couldn't have come off the spacecraft. It did, in a sense, come off the spacecraft, because what had happened, the propellant line to that nozzle had sprung a leak. So when the fluid propellant comes out of the fluid line, it then freezes on the nozzle, and then after a certain amount of it escapes, it acquired the shape of the nozzle, it floated away. So what floated away was an ice sculpture of that reaction control thruster.

Well, that wasn't good, because since we had a fuel leak there, why, we had to then secure that whole quad, four thrusters, over on Jack's side of the spacecraft. Not only that, we then had to secure the ones on Alan's side, as well, so there would not be an asymmetric thrust. So that really meant that we only had two of the four quad thrusters available. Still enough, but only half of the authority that we expected to have. Of course, we hated to lose one. We didn't want it to happen again. But it also meant that you had to be careful, because you only had half as much authority.

Now, even though everybody knew that, we then had to complete the rendezvous. As we approached the Skylab, you then have to slow down, and part of my job and Jack's job was to assist Alan in determining whether he was approaching just right and how much range rate should be used. We did not have the range rate equipment on Skylab that is now available on the Orbiter, where you can read right out directly what the range is from the radar. Didn't have that. We had to estimate it by the size of the object and how much time it took for the size to increase.

So I was using a little handheld calculator in those days, not a computer, a handheld calculator estimating range and times and so forth. I said, "Alan, better slow down. Better slow down some more." He was underestimating how much he needed to slow down, because he only had half the authority that he would normally have, and you sort of get a feeling for how long you need to leave your translation thrusters on. You get accustomed to that and it's kind of hard to force yourself to leave it burning for twice as long as you normally would.

So Alan, in retrospect, said, "I'm sure glad you told me that, because I was coming in too fast. I would have missed that rendezvous if you had not been reminding me and telling me." Part of that going back to that problem that we had with losing a thruster. But we then completed the rendezvous after we flew around a little bit. It was a little bit more touchy because of the lack of authority that we had with the lost thruster.

Then we finally docked, and things were going along very fine, until day six. I'll jump ahead and complete the story because it relates to the thrusters. But on day six, we had just awakened and Jack had gone to the wardroom window, which is just around the corner from the sleeping quarters. He said, "Owen, what's this we got out the window?"

So I floated over there promptly and looked down, beautiful aurora. The most pretty aurora—well, first one I'd ever seen from space, or Jack or Al. So I was just about to call the ground and say, "Hey, we have a great aurora down here." We were down there at New Zealand at the time in the southern auroral area. All of a sudden what appeared to be a snowstorm came right by the window. Boy, a real blizzard came by.

Well, since it doesn't snow very much in space, we realized there had to be another explanation, and in this case it was obvious we had another fuel leak. So both Alan and Jack took off like a beeline for the command module to secure that. So that meant we had to shut down another of the four, and then that only left us one, which wouldn't be much good by itself.

So that brought the ground into consideration, well, are these guys going to get home okay or not, or do we need to send a rescue mission? So we got another lengthy discussion about that. But we knew what the problem was on day six, and we were just getting up to speed and getting into high gear in terms of our experiment operations at that point, and we were very disappointed to find that we had another doggone reaction control thruster pop up, which could threaten the extension of the flight.

RUSNAK: I guess this capability of having a rescue mission didn't allow NASA to give you a guys a little bit of extra time to consider whether or not you need to come home, give the flight controllers time to think about this, because if there was no rescue mission, I guess, they'd have to bring you guys down right away.

GARRIOTT: That was a concern, because you know if we had one failure during rendezvous and another failure on day six, when's the next failure going to occur? Obvious question. It took some time for the ground to try to figure out why did the failure occur. Is it systemic? Are we going to have a continuous sequence of failures, or is it just random occurrences?

Our position on board was, we didn't have all the facts that they had on the ground, but our bias was that we must stay. Let us continue our work up there. There really are some backup alternatives. We still had control over the command module reaction control system, and these thrusters are on the service module, they're somewhat larger ones. So if it really came down to having to get back home, we thought we could do it with the command module reaction control system. So we didn't want to leave.

So the ground debated, and my inclination is to think they were probably thinking maybe we ought to go pick those guys up. They did make some changes to the next vehicle to enable them to come up with two crew members and three seats, extra seats, to bring us all back.

Then they got to thinking about, well, how soon can we do this, and it was going to be, as I recall, day forty-three before they could get there, before they could all this stuff modified and prepared.

Well, why crank up and spend all this money to bring people back on day forty-three of a fifty-six to fifty-nine-day flight? So finally they made the right decision and said, "Okay, if they can stay there forty-three days, they can stay there fifty-nine. If we have to rescue them then, we will, but we'll let them stay." So we were very pleased when that decision was made. I don't remember whether it was on day ten or somewhere around there, they all decided that, yes, we could complete the full flight extension.

RUSNAK: Seems like logic prevailed there.

GARRIOTT: One of those cases. I know it's a minority, but it did in this case.

RUSNAK: Great. I guess I'd like to back up a little bit, then.

GARRIOTT: Sure.

RUSNAK: Since you were talking about the rendezvous and you docked. I guess you guys had some physiological problems once you first got up there.

GARRIOTT: Yes, Jack's job soon after we docked, I believe it was the next morning, was to go down to the Skylab to make sure things were okay and begin to get it activated. It's like going from a VW-sized [Volkswagen] compartment, command module, into something the size of a full room. You float across really a large area, floating freely, no particular orientation of walls and ceiling and so forth. In retrospect, it now looks rather like moving around in a large volume, unrestrained, is one of the things that provokes motion sensitivity. When you're confined to a Mercury or a Gemini module and don't do any moving around, the tendency to become sick is much less. Only when you got something the size of Apollo or larger, like Skylab, is the tendency provoked.

The Russians found the same thing. The bigger spacecraft that they had, they had people getting sick and couldn't figure out why only Russians got sick. It's sort of an accepted answer, the point is, when you're really confined in a small volume and then strapped in, you don't tend to feel that. So I think that's probably what got Jack to feeling a little of that to begin with.

Now, Alan and I never got so-called frankly sick, but we were feeling what I call lethargic, you know, really not up to speed, not ready to charge full speed like you wanted to do. So we did operate slowly for several days and did take more rest and didn't do as much work as we would have liked to get accomplished. We were just about to hit our stride on day six when this extra thruster problem came along. So that took a little bit of time out to try to figure out what was going to be done there.

But you're right, there was some motion sensitivity at the beginning. I am now convinced that we all experienced motion sensitivity or motion sickness to some degree, and a little more, frankly, in Jack's case. Alan and I were just lethargic enough, not quite ready to work at 100 percent.

RUSNAK: It was only for the first week or so, though, that you guys were less than 100 percent, and after that you were running ahead of schedule with mission control having to find more things for you to do. How did you guys accomplish such an ambitious schedule?

GARRIOTT: We hadn't exactly planned it this way, although we'd talked a little about it before flight. But once we got into orbit and saw that we could do it, it's rather like I mentioned a little bit earlier, when we got up in the morning, one person went straight to the Apollo Telescope Mount to begin looking at the sun. We knew what we could do to make it operate correctly depending on what active regions and things were visible. We didn't have to have too much ground instruction to do that, although they did send us up plans every day of what needed to be done. We asked them, "Okay, start sending up." We were starting at 6 a.m. Houston time. So they began to work with us to start as soon as we were arose.

The other person would begin to do his body-mass measurement and the other kind of housekeeping activities. The third person would go to the wardroom to start making meal preparations for all of us. Then we would have our regular schedules through the whole day. Anytime the sun was up, that's when we were on the sunny side of the Earth, there was somebody at the telescope mount there.

We had scheduled times to do all the biomedical experiments. So we'd run through this full protocol, probably five hours of work, roughly, on one crew member each day. Well, that took two people. One was the observer, one was the subject. Then the third person was on the Apollo Telescope Mount. So that pretty well took up all the time during the day.

After dinner, at night, one person goes back to the ATM again. So we could really that way look at the sun probably sixteen hours a day, except for the nighttime periods on the back side of the Earth. So that's how we accumulated the time, and we did so by simply making sure our schedule provided for one person to be at the panel all the time. That's where the 150 percent number came from, was simply because we were at the panel anytime we got up, someone was awake, there was somebody monitoring.

We did all the biomedical. There wasn't too many ways you could do more than that there. You had to pretty much fit the protocol, because they were monitoring things on the ground at the same time we were conducting the experiment in space. Then whatever time remained, we could do such things as do the experiments and the extra experiments like for interest.

RUSNAK: You talked earlier about how setting up the sunshade differed a little bit on the ground from in space. How did running these other types of experiments differ from how you had prepared for them?

GARRIOTT: They went pretty well as advertised. I can't think of any major difficulties. Some of the student experiments didn't have the same amount of preparation and thought behind it, or the experience that a Ph.D.-level university professor might bring. So there were a few of those that didn't work quite right. For example, one that I was doing had to do with cytoplasmic flow in a little leaf. Well, it turns out they got too dry, and so the plasma didn't flow. So that was an experiment that didn't work quite as advertised. In other cases, like the fluid physics, we began to find all sorts of other kinds of things to do, all the way from joining globs to putting air in globs and all sorts of fascinating kinds of things that are of interest to physicists.

One, for example, just a simple one, is to put just a glob of liquid out here and then begin to spin it up, and you can spin it up with either a straw or with a pair of strings or things like that, just to get it spinning. As you can imagine, centrifugal force will slowly begin to separate it and pretty soon it will sort of form a dumbbell and then break. If you look carefully. there's going to be a little drop left in the middle, sometimes three drops left in the middle if you're very careful.

Well, physicists can explain why that happens. It's not a simple thing. I'd never known this before. But it also relates to nebular formation, as it turns out. In a way that's how astronomical objects in the large nebulae form is by spinning and rotating and sometimes they separate. A tough problem that apparently has never been solved mathematically, but yet you can demonstrate how it works and demonstrate why there is an odd number of these little globules that are left in the middle when the two large sections separate. So a lot of fascinating things like that came out of it, that were not really preplanned ahead of time.

RUSNAK: What kind of activities did you do in your free time, what little that you had?

GARRIOTT: Some of it was fun, like running around the ring lockers. I think probably Joe Kerwin and Pete Conrad may have first realized that you can do that. Then there's a rather simple calculation you can work out. It's simple jogging, slow stepping. You can generate about a tenth of a G just by centrifugal force running around the ring lockers. So a tenth of a G is enough to hold you against the ring lockers, either barefooted or in sandals. Then you can do flips and twists and remarkable what you call gymnastic performances. I'm sure you could win all the Gold Medals on Earth if they were just allowed to compete from space.

In our case, we all three were doing that kind of thing. I noticed that Jack and I were tail-end over tea kettle, just random arms and legs going every which direction. Then I looked at Alan. Alan was so nicely controlled. I mean, he might have won some medals. I only then realized that Alan was a gymnast when he was in college. So that explained how well he could do all the twists and so forth. We had a lot of fun doing that.

A couple of other little tricks that we ended up using in some of our movies that we bring back to show related to such things as floating freely in weightlessness. But one of the tricks, for example, that Jack Lousma—some of the nitrogen bottles, after they'd been used, we used them for the mass maneuvering unit experiment, into a long pole. So they looked like enormous weights, 1,000 pounds on each end. So Jack struggled with that weight to lift it up, finally got it above his head, then he released his feet and they just floated slowly right on out of the field of view.

Or doing pushups with one and then two and then three people on your back, two people on your back. So little tricks like that, that were fun to do and they were useful when you got back home putting together general public kinds of film clips.

RUSNAK: How did you find doing some of the basics of daily life, like eating and using the shower, those kinds of things?

GARRIOTT: Interesting question. I think I'm the only person who went two months and never took a shower, but I was as clean as anybody. The reason is, the shower, to use it, of course, we had a cylindrical shower, collapsed to the floor. You had to, first of all, get hot water, put it in a bottle, get the plumbing connected. Then you had to erect the shower, had to get in the spray, soap up, wash off, then spray again to wash off the soap. Then vacuum it all up, then put all the stuff away. And to take a five-minute shower took about one hour. I begrudged that time, and so I said, "I don't need a shower. I just need a washcloth getting wet and give yourself a good body scrubbing. That's all that it takes."

We ended up with Alan, I think, took two showers in order to fill that square in terms of how well did this device work. Jack took one, and I took zero. It was basically because we didn't need it. You can get yourself clean far more quickly with a wet washrag and a towel.

Now, an interesting application to that is under lessons learned, what do they do on Space Station. If we go back, say, five years from now, inquire about what the design includes, the design includes a shower. And it's tough. First you've got to bring up that water, which is difficult to do. Then you have to clean up the water and recycle the water and all sorts of difficulties. The expense of all this, I said, "Why are you doing that? You don't need it."

"Oh, well, people like it. People enjoy taking a shower." Which is true. I enjoyed a shower this morning, etc. But you don't need it in space, and time and the money is a pretty high priority. Well, as it turns out, the way things have worked out, money became very short and development time became very short. As I understand it now, there is no shower. I just heard an interview with Ellen [S.] Baker on television just last couple of nights and Ellen was describing how they're going to do it on Space Station. She said, "Yeah, we're going to use a wet washcloth." [Laughter]

Finally, not because they learned anything from Skylab, but because they were forced into it by the press of time and money, to save money, where they didn't need to waste it, and that would have been a waste. It did not need to have a shower on the Space Station.

RUSNAK: I'll bet it felt good to take one once you got back to Earth, though.

GARRIOTT: Oh, you bet. As a matter of fact, we were picked up by the USS *New Orleans* in the Pacific. All of us had had time in the Navy, and there are such things as Navy showers. Navy showers are different from land-based showers. In there you take a quick shower, soap down, rinse off and get out, because in the old days you had to distill all of the water from the boiler. Not quite so difficult these days. But at any rate, when I got aboard the *New Orleans*, I forgot the Navy shower bit. I took a fifteen-minute shower regardless of how short they were on the water, and I did enjoy it very much.

RUSNAK: You guys had earned it by that point.

If we can stop here to change out our tape for a minute.

GARRIOTT: Sure. One of the objectives of the interaction with the ground, of course, is to try to pull funny jokes on one another, things that are unexpected or put them in a funny situation when you can. So one that I did appears in the following way. From the standpoint of the mission control in real time it would sound like the following. As Skylab comes around in orbit to get into radio communication, all of a sudden this female voice comes on the line, and says, "Hello, Houston, this is Skylab."

The capcom, who happened to be Robert [L.] Crippen, said, "Well, hello, Skylab. Who is this?"

This female voice says, "Hi, there, Bob, this is Helen," my wife at the time.

"What are you doing up there?" Crippen asks.

"Well, we just came up to bring the boys a fresh meal, or a hot cooked meal. They haven't had one for quite a while. We thought they might enjoy that."

He says, "How did you get there?"

She says, "Oh, we just flew up. We've been looking at those forest fires that they have all over California. It's a beautiful site from up here." The female voices says, "Well, I see the boys are floating in my direction. I've got to get off the line. I'm not supposed to be talking to you. See you later, Bob," and then it goes off.

Gene [Eugene F.] Kranz—no, it wasn't Gene Kranz. I think it might have been Neil [B.] Hutchinson, one of the flight directors at the time, said, "Bob, what's going on?" This is what really happened. Bob said, "You heard it the same time I did. I have no idea. I was just responding to the questions."

[Bob Crippen] said, "Well, obviously she wasn't there. I don't think she was there, but that's the way it sounded. It came right down over air-to-ground. I mean, it was just a two-way conversation for about thirty seconds there."

So they never did understand how that happened. They, as far as I know, never had the right explanation figured out until about a year ago at the twenty-fifth anniversary I explained how we had done that. About two or three months before flight, I said, "Well, now, what are we going to see from space that will validate a person's credentials?" It could be a hurricane, could be a forest fire. At least those two natural events are certain to occur if we wait a little while. And who are going to be the capcoms? Karl [G.] Henize and Bob Crippen, I knew would be on there.

So I worked out a little script which talked about seeing a forest fire or seeing a hurricane, and talked with Bob or talked with Karl, and then after I knew that fires were occurring in California, I knew Bob Crippen was going to be on. And by the way, I recorded this, my wife's voice, with appropriate gap, as long as the capcom know how long he had to reply. Then I talked with Bob and Carl about this, that I would have the recorder on and when I saw a forest fire and knew one of the two were available, I would play it.

So on one occasion, this is probably [about] day forty, way into the flight, I said, "Bob, I'll have something for you special."

He said, "Fine, Owen." He pulled out of his pocket the script because he'd been carrying it for six weeks and just sort of reviewed what he was supposed to say, and Karl Henize could have done the same thing. So then when I played my wife's voice, he knew exactly how long and what he was supposed to say. He filled in the gaps in real time exactly in the conversation like that, and they never figured that out until I explained it here last year.

So that provoked a little bit of discussion and they thought she must have been talking from my home down there on the ground or something. But they said, "No, it came down air to ground." They all knew where it came from. It really did come air to ground one. It provoked a little bit of discussion. They never figured it. So we had fun with that.

RUSNAK: An extra stowaway.

GARRIOTT: Right. Right. But they also earlier had pulled one on us, which, as far as I know, this has never been told before, because it's not exactly socially acceptable or socially—that's not the right word. Some people might be a little bit offended by it.

I mentioned a little earlier that we had one of the cameras which had low intensity. So we took up what was at that time a new development in the way of a Polaroid camera. Now, a

Polaroid camera has the ability, when you open the aperture, it will stay open until it has received enough light to make a good image and then the aperture closes. So it's a way to see faint objects that are too faint to just see in a brief exposure.

So we had to set up a little hood and the camera, and one of the solar physicists prepared all that and got the camera ready and loaded for us and sent it up with us on our flight. So Paul [Patterson], on about day three or four, said, "Owen, have you got the camera set up yet?"

I say, "No, we've been awful busy on day three or four. We just haven't got around to that."

"Okay." Day five, "Owen, have you got the camera set up yet?"

"No, but I will soon."

Day six, "Owen, is that camera set up yet?"

"No, but I'll do it now." So I set up the camera and got it all ready and thought, well, I'd better take a picture or two to make sure that it's working right. So as Jack Lousma floated from one end to the other end, click, and as you remember, the Polaroid film just rolls right out. So looked at the picture; centerfold, right out of *Playboy*. So I took another picture, another centerfold right out of *Playboy*. So he loaded the whole camera, the first film pack with centerfolds from *Playboy*.

So the next time he called, "Owen, have you set up that camera?"

"Yes, Paul, I did get it and we got some very interesting pictures." That's all he ever said. [Laughter] When we came back home, we then discussed it and joked about how it had worked just as planned.

RUSNAK: Sounds like a similar joke to what they did to Al Bean on his Apollo 12 flight and their checklist. They'd put pictures similar centerfolds on their checklists or whatever.

GARRIOTT: I'd forgotten that. I did not remember that part. Yes.

RUSNAK: But it sounds like there plenty of merriment to go around.

GARRIOTT: You try to do all of those, but you can't, but it does give a good feeling among the crew. I think it actually serves a very good purpose to pull those kinds of jokes, simple things that everyone can enjoy.

RUSNAK: Would you then say that was characteristic of the relationship between your crew and the flight controllers' relationship?

GARRIOTT: Absolutely. Absolutely. Very good relationship. As a matter of fact, I'm still well acquainted with Neil Hutchinson and Gene and the other flight controllers. We talk whenever we get a chance. Neil often calls me for dinner when he comes through Huntsville, Alabama, where I now live. So I still see Neil from time to time.

RUSNAK: He stops by here every once in a while, sits down and talks with us.

GARRIOTT: Good.

RUSNAK: Was there anything from your flight that you found particularly surprising or eventful or unanticipated from your ground preparations?

GARRIOTT: Not too much. Actually, I think we had properly anticipated almost everything. I did mention this one about the difficulty putting together the twin poles, and obviously we hadn't anticipated the RCS failures, reaction control. But basically the operations on board went pretty much as planned. We were pleasantly surprised to have a very active sun, even though it were nearing the time of low sunspot activity. So those were some kind of pleasant surprises, but not the kind of answer I think your question was intended.

So, no, I think we were not terribly surprised by events. We had properly planned and considered most of the things.

RUSNAK: When we were talking about training, you mentioned some of the corollary experiments, some of these, I guess, hodgepodge things that they'd lumped together under that, one being testing the manned maneuvering unit [MMU] prototype. Can you tell me a little bit about some those and that one particularly?

GARRIOTT: That was an interesting one from my perspective. The manned maneuvering unit, which was currently being designed here at JSC, and Bruce McCandless, who flew the first one outside the spacecraft, along with Ed [C. Edward] Whitsett, were the two principal designers of the MMU. We had it on Skylab, so that we could try it in an inside environment to where if there was something went wrong with it, this was not going to be a tragic situation. We weren't going to be blasted off into space somewhere or be thrown out of control.

So it was operated on bottled nitrogen, the same bottles that I mentioned earlier in the discussion. So those were connected in such a way with the same thrusters, translation, and rotation, or actually translation and rotation this way. Alan Bean and Jack Lousma were scheduled to run the experiment, and they ran it both in shirtsleeves and then in a pressure suit. They ran it, it worked just perfectly, no problems.

Then I think it was Alan mentioned to me one day, said, "Owen, would you like to try this thing?"

I said, "Yeah, that sounds like fun. It looks like fun. Why not." I'd had no training on it, but it operates just like a spacecraft with translation control in this hand, operates the same way, attitude control with this hand, and fairly simple modes of operation, automatic [attitude] hold and so-called command control where you can just find immediate thrust when you want to.

So they checked it with the ground and said, "We've completed all the experiments as planned to test your apparatus. Why don't we take a novice here and see how fast it is to learn."

So they agreed with that, and so when there was a time or a break in the schedule, why, I managed to get strapped into the machine and I remember Alan saying, "Okay, Owen, you're on your way." Just turned it loose. It is surprisingly intuitive. With just a modest amount of training in how to fly a spacecraft with a translation and attitude control thruster, you could fly around that spacecraft, making turns all the way around, say, the ring lockers, holding yourself maybe an inch away from the surface and maintaining attitude control and translation control where you wanted. So it was very pleasant to see how easy it was to fly, and perhaps useful to the designers, as well, to see that a person with essentially no training could learn to fly it so quickly.

RUSNAK: Sounds like it must have been fun to try, and also a positive learning experience there for everybody.

GARRIOTT: Yes, I think that's true.

RUSNAK: Any other corollary experiments stick out in your mind?

GARRIOTT: The astronomy experiments were interesting, because we had two scientific airlocks on board. One of them was used in the solar direction to extend the parasol. Any experiments that were intended to go out the sunny side were essentially no longer useful, because that port was permanently filled.

However, the ones that looked out the other side were astronomy experiments, and we had a number of fascinating air glow experiments, looking at the horizon air glow, and ultraviolet stellar experiments that we could run out this small aperture on the anti-solar direction. You had to be a little careful, because if you were on the sunny side of the Earth and had that aperture open, even with glass in front of it, the ultraviolet light could come right in. We had an ultraviolet sensor a couple of times went off, because we still had that aperture open with an ultraviolet glass in it on the sunny side of the Earth and you didn't want too much ultraviolet light inside.

We had some very interesting experiments with that. The air glow layer that we were looking at is also something that's very fascinating to see. We had even more experiments ten years later on Spacelab I, but avoiding that discussion for a moment. What you can see, for example, in looking at stars, when you're looking at a star from above the Earth's atmosphere, it's almost like the same thing from a high mountain here on Earth. When people ask whether were they're brighter, the answer is no, they're the same brightness above the atmosphere as they are below. However, they really don't twinkle, and so they twinkle when we see them even from the top of a high mountain because of irregularities in the atmosphere. Those irregularities cause the twinkling.

The planets don't twinkle because they're larger, they're not point sources the way stars are. So when you look from the top of a high mountain, planets don't twinkle, stars do. When you get above the atmosphere and look at stars, none of them twinkle. Then as you rotate around the Earth, they are quickly either setting or rising. Let's assume we're going in the setting side, they will be nice and steady until they get down to about an altitude above the Earth's limb of about a 100 kilometers. Now, there's going to be a layer of emission coming from the atmosphere where the constituents of the atmosphere give off light and the star will be extinguished, or you can't see it through the light of the air glow layer.

Then it drops down below the air glow layer, below about 80 kilometers above the limb, and now you can see it bright again. Now, as it begins to set down further, now it begins to twinkle, because you're right near the limb, and then it fades out as it goes below the limb of the Earth. So it's interesting to see stars rise or set, because they do so a little differently than they do here on the surface of the Earth.

RUSNAK: Looking back at the entire fifty-nine and a half days that you were up there, what do you think the greatest contribution of your Skylab flight was?

GARRIOTT: I would want to list two, really, instead of just one, because I wouldn't know which to place them in priority. It also probably depends upon the background of the individual receiving information as to which priority it should have. Those would be first the stellar measurements or [rather] the solar measurements, our star, because we could see the sun in ways that simply were not possible before, for long periods, [at] ultraviolet and X-ray wavelengths, and look at the corona, look at the mass ejections throwing material far out into the corona. Some of that is actually still being used for research purposes today for comparisons with some of the more modern satellites which can do things even better than we did twenty-five years ago. So that would be one.

The other one would be the focus on human adaptation and the ability to work for long durations in weightlessness. We've already talked about, of course, we extended the duration to one, two and three months, roughly. The Russians have now gone on to extend that to even over one year in the case of one individual.

Remember, they didn't have anything like the biomedical monitoring, the measurements that we were able to do on Skylab over twenty-five years ago. So from that standpoint. we're not going to exceed the research results that we obtained on Skylab until we've been up on Space Station with similar kinds of research apparatus. So I would say both of those two have to rate number one, and place the priority, depending on your own interest.

RUSNAK: Aside from the usefulness of a shower, which you mentioned before, were there other lessons from Skylab that you think Space Station could benefit from?

GARRIOTT: I think so. One of the things I would list first is the fact that long duration is not a handicap. Even—one step back: Why is it not a handicap? It stresses the importance of exercise. If you do not exercise, you're going to come back in the same physical condition that you would be in if you'd lain in the bed for the one-, two-, or three-month period. You shouldn't expect to come back without muscle atrophy. You shouldn't expect to come back without orthostatic intolerance, you'd probably faint, until your body learned how to readjust the fluid balance. Because you're simply low on fluids and your body doesn't know how to tolerate that until you've had a chance to rehydrate.

So we learned the importance of exercise, and if you have the appropriate amount of exercise, namely one to two hours a day, then you're going to come back in essentially as good a condition as when you left. And it is possible to indeed work for very long periods. Now, I used that example of a shower as a simple way in which they saved some money and eventually came around to the right idea. I'm not sure that they learned the idea on long-duration spaceflight. They're still having to reprove the idea that, yes, now, by golly, we just showed we could three months, four months, six months. I think that's largely a wasted effort. It's already been proven by Skylab experience and by the Russian experience, yes, you can stay as long as you want to as long as you keep an appropriate exercise protocol. This should not be a particular hangup in terms of even long flights to Mars.

Mars flights, there's a big debate as to whether or not you need artificial gravity or not. I think we've shown in both Skylab and in Mir that you don't have to have artificial gravity. If you want to for some reason, okay. There's nothing wrong with it, maybe, although we've never tried it. We don't know about the coreolis forces that are going to be much more serious in a rotating station as compared to the experience here on the ground, but [where] we don't have coreolis forces on our body. So there could be even some problems having artificial gravity. But that's a debateable point. There's not agreement on whether or not we should have a rotating station or not. My view is, Skylab and Mir show them you don't have to have that. So there's still some lessons, a few that have been learned and a few that haven't, that are applicable to Space Station and beyond.

RUSNAK: Any other comments you want to make on Skylab before we move on?

GARRIOTT: Let's see. One more, yes. People often ask, isn't it a shame that you didn't get a chance to reboost Skylab, because that was kind of a big deal along about the late 1970s when as we approached solar maximum the atmosphere was expanding, the drag was increasing, and it was clear that Skylab wasn't going to stay up there too long. As you probably remember, it came down in 1979, most of it over southwest Australia right at the time of the Miss Universe contest [held in Perth], by the way.

I sidetracked myself. [Laughter] I was putting all sorts of funny stories related to it. Where was I?

RUSNAK: Talking about Skylab coming down.

GARRIOTT: Yes, but there's something about that.

WRIGHT: People asking you how you [unclear].

GARRIOTT: Oh, yes, that's what I wanted to talk about. [Laughter] Thank you.

Isn't it a shame that we couldn't reboost it [Skylab]. Because there was a lot of thought and consideration given to sending up an early Orbiter, which wasn't quite ready before the Skylab came down. Well, the fact is, that's the right thought, but the wrong solution, because the Skylab that we were flying had one of the CMGs [control moment gyros] completely broken down, and the second was limping, only leaving a third one. You really need three full CMGs, control moment gyros, attitude control devices, to maintain proper attitude and control. It had problems with the heat shield. It had one of the scientific airlocks that was already plugged. It had others of the instruments that were beginning to degrade.

So it was limping along, and it would not have been nearly as useful as it would on [a] new Skylab, but we had the new Skylab! The flight unit, the backup flight unit, was ready to be launched. We had three Saturn Vs from the Apollo Program that had never been used, flight units ready to go. We had uprated Saturns ready to take crews, and they decided not to use it. The Saturn V vehicles were left on the ground as tourist attractions. The Skylab flight unit sits in the second best place for it, namely the Smithsonian Air and Space Museum.

What should have been done, of course, was to put it into orbit and then continue flying crews to gain six- and twelve-month experience. So the value of the Skylab Program could have been doubled or tripled by simply taking advantage of the flight hardware that we had already built and paid for. The decision was made not to do it, because it would have cost a few extra bucks and possibly competed with the development of the Orbiter, which didn't fly for another eight years.

So that's my biggest annoyance about some of the foolish decisions, largely political, partly financial, that were made at the end of the Skylab period instead of taking use of the flight hardware that had already been purchased and sitting there available.

RUSNAK: Do you think having launched a second Skylab that it would have been able to stay up for these periods of time? I know, for instance, the nitrogen reaction control system wasn't replenishable, so you've got a limited amount of supply there, given the problems that the other one had with the gyros and coolant and these kinds of things.

GARRIOTT: The short answer is yes, and here's why I say that. First of all, the nitrogen was depleted because of the first ten days when we had to go out of attitude. That used up probably the majority of all of the nitrogen that was used for the whole flight. In theory, you won't use any nitrogen as long as your CMGs are healthy, because if your CMGs are healthy, you use them to balance the torques and you never need to use any of the nitrogen. You would probably be put into a slightly higher orbit and you could have also used the Apollo command module to give it a slight boost before you came back home and even boost it a little bit higher.

So, yes, you could have kept it up there for a longer period. Once you [pass] the maximum of the solar cycle in along about 1979, then it would have been easy coasting for another decade after that. So I think it could have easily stayed in orbit for another ten years beyond what it did stay.

The question is, would you have had enough crew vehicles to continue to man it during that period. The answer to that might have been no. You might have had to wait for the Orbiter, unless you wanted to build more uprated Saturns. They might have decided that that was too expensive. I can understand that decision. The thing that I can't understand the decision is not using the Saturn Vs and the Saturn IVs [uprated Saturns] that were available and never used.

RUSNAK: Certainly from a technical standpoint it seems like it would have been a useful thing to have up there, but obviously these political and financial factors—

GARRIOTT: It would have been amazingly useful, because we got so much benefit from extending the flights from one, two, and three months. We've had to wait now for Mir to come along and buy the time from the Russians. Cooperative work is fine and good, but, still, we should have had that data available with good quantitative biomedical measurements made of six- and twelve-month durations up on the "Skylab B."

RUSNAK: By the time you came down from your mission, Skylab's fate wasn't yet sealed, but what were the tasks you were doing after your mission?

GARRIOTT: Rather shortly after I came back from Skylab, a matter of months, it was offered that I should go to the Science and Applications Directorate as Deputy Director. So I accepted that position and began to work in the physical sciences area outside the Astronaut Office, although while you're still at JSC, it's never really very clear whether you're keeping a foot back in the Astronaut Office or have it fully over here in another discipline. I preferred it that way, because I wanted to come back to the Astronaut Office at the appropriate time, when the time was right for another kind of a flight, as it eventually did with an Orbiter flight.

RUSNAK: Do you think it was likely that you would get another flight once the Space Shuttle came on line?

GARRIOTT: I thought it was fairly likely. We didn't have such a large number of people in the office by that point. I guess we'd selected some people in 1978, but that was the time that I came back. So we still had a pretty small office, and coming back in with experience, I thought, and the fact that my research background, my professional interests or scientific interests were related to the objectives of [Spacelab], I thought there was a pretty good chance.

RUSNAK: As someone in Science and Applications, what role did you see for the Space Shuttle in doing these types of experiments?

GARRIOTT: Spacelab I, if this is your question, the whole mission was oriented towards making clear that the Spacelab, the laboratory that fit in the payload bay of the Shuttle, was useful for the whole range of scientific disciplines. So we had about six different disciplines represented, so very interdisciplinary, which is, well, my interest is interdisciplinary work. So not only a lot of biomedical work, but also astronomy, fluid physics, materials processing, atmospheric sciences, all were represented with differing experiments.

So I found that quite interesting, and I think it does relate to the fact that you need an interdisciplinary background to try to conduct experiments for all of these PIs [principal investigators], because you obviously can't have a representative for each PI there, and you need somebody who has got some degree of competency in all of the variety of areas.

RUSNAK: Was Spacelab then your primary focus once you moved over to Science Applications?

GARRIOTT: Oh, yes. Yes, I didn't come back—well, I took one year out. I actually was the Deputy Director there for about two years, then I took a year off for, like a sabbatical, only they called it another thing, within NASA for a one-year trip back to the university. I went back to Stanford for a year. Then when I came back, they'd combined the Physical and Life Sciences Directorate and I was Deputy for Physical Sciences there for a year or so, until it became time to select crews for Spacelab, and that's when I went back to the Astronaut Office. So I went back from that position specifically for Spacelab.

RUSNAK: When and how did you find out that you were scheduled for the first Spacelab mission?

GARRIOTT: Probably George [W. S.] Abbey, but I can't remember. Either George Abbey or John [W.] Young was the Commander of the Spacelab flight. I can't remember which.

RUSNAK: What kind of experiments were you going to do on this first mission?

GARRIOTT: The ones that I was referring to, multi-disciplinary experiments in the area of life sciences. Vestibular experiments, a whole array of those, blood-drawing. We didn't have quite the full range of facilities that we had on Skylab, so to some degree they were different. For vestibular, there was a rotating dome. There were other kinds of visual experiments to be done.

In fluid physics, we had a whole rack of equipment that enabled you to inject liquids, shake them and rotate them, combine them, stretch them, do all sorts of things to look at the small forces associated with the surface tension and even smaller forces that are associated with fluids that you can not well demonstrate or measure here in a 1-G environment. So a whole rack of equipment oriented toward a variety of fluid physics experiments.

An adjacent double rack associated with materials processing, some of which you would have furnaces in which you would insert rods that heated up to very high temperatures and then solidified very slowly. Others in which you focused light on a crystal and melted it and then allowed it to solidify more carefully.

So again, a whole array of material science experiments. We then had a large overhead window in which we had to look outside for experiments related to stellar astronomy and air glow with sophisticated spectrometers to look at the air glow layer and see just what wavelength it was coming back. So you could see this line comes from hydrogen or oxygen and nitrogen, more likely, to see what the wavelength and intensity of those lines associated with the atoms and molecules might be. So really a very large array.

RUSNAK: It sure sounds like it. How did training and preparation for a Space Shuttle mission compared with that of Skylab?

GARRIOTT: Actually, they were somewhat similar. There were fewer disciplines represented on Skylab, and so we did not have to travel as far to talk with the principal investigators on Skylab.

In fact, for most of the time, they came to JSC for our solar physics training and for our biomedical training.

On Spacelab, the investigators were all over the world, because this was an international flight, as well. We had the first foreign national to fly with us, Ulf [D.] Merbold, on Spacelab I. A lot of the fluid physics rack and much of the material science was designed and built in Europe. The principal investigators were in Europe. The biomedical experiments here were largely, many of them, at MIT, as well as at JSC. The atmospheric sciences, many of them at the University of Michigan or University of Utah.

So we were continually traveling all over the world to see the investigators in their home laboratories where they had the instruments similar to what we were going to be doing in space, and to learn what it was they were looking for, to understand better the objectives of their experiments. So we had to do more traveling on Spacelab.

Also, the Japanese had a very interesting experiment. It had to do with electron beam emission. So we had to take a number of trips to Japan, as well as them coming to the U.S. to explore the conduct of their experiments. So really we were very international and traveled all over the world in order to talk with the investigators about the conduct of their experiments.

RUSNAK: It certainly sounds like your interdisciplinary focus and these interests you've had really came into play here during Spacelab.

GARRIOTT: That's very true. I feel so fortunate to have had the chance to work in all of these different disciplines with the real world's experts, and to learn from them.

RUSNAK: It's interesting, as one with your background in electrical engineering, here you are branching into all these different sciences.

GARRIOTT: I think EE is actually a pretty good background, because it is a general background, and people with that kind of a background are often in solid state physics, optical physics, optics and so forth, as well as just circuits and so forth. A lot of it really depends upon your mental attitude. Do you want to be interdisciplinary? Are you really interested in a broad range of other people's business? Only if you have that broad interest is it really going to be as much fun as I found it.

RUSNAK: I was reading, in my preparation for this interview, one of the scientists had commented on your inquisitiveness during Skylab and how that was very refreshing for them to have you asking more questions of them than they had to send up to you. So it certainly reflects this true interest you've had in these other types of experiments and things.

GARRIOTT: I don't know who that individual was, but I do recall on Skylab, for example, one of the solar physicists, whose name happens to be Bob [Robert M.] MacQueen, was the first principal investigator to actually speak directly with flight crews. They'd always done it through the capcom, which is fine, but on the other hand, if you're trying to talk about what the sun's doing, and his experiment had to do with the corona, you really quite often can be far more precise and direct if you can talk to the expert right there.

So we were very pleased that once we started talking back and forth a little bit, we had excellent capcom representative in Bob Parker, Robert [A.] Parker, still with NASA. They called him the czar. He was a Skylab science czar representing all of the disciplines. But he could work out the relative merit if there had to be a tradeoff between disciplines. Bob helped on that. Then he could help get the PI associated with that experiment talking directly with the crew. After Bob was allowed, then they saw that it didn't really hurt anything. He didn't mess up the Skylab or give the crew wrong instructions, it worked out well, and then it was continued far more easily since that time.

RUSNAK: Is that how Spacelab then operated?

GARRIOTT: Yes. Yes, by the time [Spacelab] was around, then the PI could be at some remote location, usually at Marshall Space Flight Center, because that's where all the payload operation was done.

I ought to correct one thing. I called Bob [Parker] the czar. No, he assisted one of the PIs on a rotating basis who was called the czar. So for one week or some period of time, why, the solar physicist might be the czar. Then the next week it'd be a flight physician. Then it would perhaps be a corollary experimenter. So they rotated that job around. So I misspoke a moment ago.

RUSNAK: Earlier I had you characterize your crew members on Skylab. Could you do the same for some of the people on your Shuttle flight?

GARRIOTT: Oh, sure. I've always gotten along extremely well with my fellow crew mates. On the second flight, John Young, who was the commander of Spacelab I, is not an Alan Bean.

He's motivated differently, different personality, standard sort of a prototypical test pilot. A little concerned about that. Bringing in the first foreign international. How well is that going to work? It turns out it worked extremely well, for which I give John Young a lot of credit. I really enjoyed having John as the commander of our flight. And I think after we came back he had no better friend on board our flight than Ulf Merbold. They still often talk. Whenever Ulf comes back, I think they get together for dinner, the same way that I had talked about earlier. So we got along extremely well.

On Spacelab I, one of our first experiments had to do with a rotating dome, which would be taking a picture of your eye as it sort of twisted a little bit. That camera, the apparatus to which it was mounted, broke very early in the flight. And to get these pictures properly required thousands and thousands of frames of photographs on a very nice format camera, special camera. After the frame [experiment apparatus] broke, all of this film and camera was sitting there without any particular use, so John Young helped find a use for that. He took the camera and all of these rolls of film up to the flight deck. I think he spent a major fraction of the Spacelab I flight time taking pictures out that left-hand window with this nice format camera. He was very willing to let anybody else come up there and have that seat and take the pictures of the things that you thought were interesting or valuable and so forth.

John really jumped in and assisted in the conduct of the science, and I think before flight there was some little concern about that, that whether or not a standard prototypical test pilot would enjoy and participate. But we all really enjoyed having him on board. He did his share, as did the rest of us.

I worked with Byron [K.] Lichtenberg on my flight. He is still a very close friend of mine. We were working on two shifts there, so three of us together, then three on the other shift, although we overlapped quite a bit. So we would often still get together. Good bunch of people to fly with.

RUSNAK: It was certainly a successful flight.

GARRIOTT: Well, I think so. It was a little hard to tell when you came back, but when we came down and landed, of course, like a glider, I remember going in the van, being picked up by George Abbey and he said, "Well, the science community is very happy," or very pleased with how things went. So that was the clue we had. But when George was willing to tell us that, I was very pleased.

RUSNAK: Yes, that's certainly a positive experience when you can get his okay that something went well.

GARRIOTT: Yes.

RUSNAK: After your flight, you moved into the Space Station Program as a program scientist.

GARRIOTT: Right.

RUSNAK: Could you explain what that job involved?

GARRIOTT: We had the responsibility for the principal program office here at the center at that time. In fact, Neil Hutchinson was the head of the Space Station Program here in JSC at that time. We were simply making preliminary plans for the conduct of science and looking at preliminary ideas. There were several different alternative configurations that the Space Station should look at and might be designed to follow. One of Neil's job, principally, I think, was to decide which of these options were going to be best. My job was to advise on the conduct of science on these various options, how would you do it and so forth.

Also at that time, one of my other—perhaps my second big complaint about NASA decisions has to do with the decision that was finally made to put the Space Station up with Shuttle, which, of course, now we're doing. It's only going to take about another forty-five Shuttle flights to get there. We could have put it up with the other two of those Saturn Vs, for example or another alternative heavy-lift vehicle which could be a Shuttle derivative, very much more quickly, very much less expensively had we done that.

I tried to convince them, even though it's a little bit out of my main line of responsibility, that the conduct of the program would be much better had they used heavy-lift vehicle and we could, of course, have done the science earlier, as well. So from that standpoint, it was a connection to my real responsibilities. That wasn't accepted either. But that's the kind of work that I was doing when the program office was here at JSC.

RUSNAK: The Space Station really kicked off when in 1984 Reagan said, "Let's build a station in ten years." How do you think his pledge compared with that of Kennedy, and really the results coming out of them?

GARRIOTT: It didn't have the public appeal, but I think it was the right thing to do. Had we done it in the way I just described a few minutes ago, namely putting it up on a heavy-lift vehicle, we could have done it on his time scale and we could have probably done it within the financial resources that NASA would have had. But the way it actually got implemented cost us a fortune, two fortunes, twice as much, at least, as it should have, and took twice as long. So I think that it was the right thing and the right time for Reagan to have made that. NASA screwed it up when they implemented it incorrectly.

It did not have the impact of a Kennedy talk, because it simply did not have the public "gee whiz" and science "gee whiz" as flying to the Moon. I mean, I think all of us would be enormously impressed with a challenge like Kennedy made in '61. That yardstick is so high, so large, that to compare it with that, almost anything else is going to fall short. The only thing that could compare [with] that would be a clear commitment with time scale and financing to go to Mars. I think that would have a comparable impact, but it can't be done on a similar time scale. Of course, we don't have the political commitment to do that now. The political will to do that is still lacking.

RUSNAK: Why did you choose to leave NASA a few years later?

GARRIOTT: A few years later, Challenger came along, and then it was clear that before my next chance to fly, it was going to be another five years. See, in '86 I was fifty-six years old, and five years would have put me at sixty-one, and I was getting to the point where I was a little doubtful that I would have enough time to really finish that crew. There would be no opportunity for another additional career beyond that. So it was essentially a career decision from my standpoint. It was going to be too long before I had a chance to fly again. If I'd have had a chance to fly in late '86 or '87, then I wanted to stay for another opportunity. But when that was clearly going to be delayed five years, I just decided that from a personal perspective it'd be better to leave that to somebody else.

RUSNAK: Looking back on the years you spent at NASA, how would you describe the changing role of science and scientists within the space agency?

GARRIOTT: Clearly their contribution is being recognized more and more. They are not called science astronauts the way they were when they were selected in '65, which I think is a mistake, but it's been done for a variety of reasons to allow some additional flexibility in the way they are selected by NASA, I think. But that probably depends on who's answering the question about why that was done.

But I think clearly there is an improved recognition of the role science will play, and especially so on Space Station, because that's its whole purpose in being. If you don't do good science, if you don't do good technology research and don't bring back benefits to society, the program's not going to be considered a success, and that requires more than just pilots. Pilots can do good research, but scientists can do decent piloting, as well, and it's the combination that I think is better recognized. In fact, I think it was well recognized soon after we arrived. I think very quickly in Skylab it became recognized by test pilots as well that, yes, this is a joint effort here, and several kinds of expertise are required to complete the job.

RUSNAK: What types of work have you been doing since you left NASA?

GARRIOTT: When I left NASA, I took a job in the space program, still, with a company in Huntsville, Alabama, doing payload processing, payload development for NASA on Spacelab. It happened to be Teledyne Brown Engineering. I was a Vice President for Space Programs there.

Since that time, I've done a few other things and done a fair amount of traveling, including three trips to Antarctica bringing back meteorites, some of which are being studied at the Planetary Studies Foundation in Michigan.

Last year, with a son, I got a flight on *Mir*, but not the Mir that you have in mind. There is a Russian oceanographic vessel called the *Academic Keldysh*. They have two submersibles called *Mir I* and *Mir II*. They can go down to as deep as 20,000 feet, about seven to eight kilometers deep. The deepest part of the Atlantic, well, not the deepest part, the part that most interested us last year, where the sea floor is spreading, there are vents along that region of sea floor spreading called black smokers.

So we went down, my son and I, along with others on this trip, you go down, one pilot, two passengers in *Mir* at a time to the black smokers. Brought back samples, some of which within the mud of the black smoker are very small microbes, less than one micron in diameter, but which, rather interestingly, live in very high temperatures, well above the boiling point of water in a pan here in one atmosphere.

So we're culturing these in the laboratory at the Marshall Space Flight Center and at the University of Alabama-Huntsville, and we're finding that these microbes lived probably at higher temperatures than have ever been published before. So we hope within the next six months we'll have publications out describing that. Some of the high-temperature microbes are quite fascinating from a commercial standpoint as well, because they have enzymes in them which obviously live at these extremely high temperatures. So we're very enthusiastic about that kind of research. So I've been doing some of that.

Then just a couple months ago, I took another full-time job. In Alabama we've organized a consortium between the six Ph.D.-granting institutions in Alabama and NASA. It's called a National Space Science and Technology Center. We've got now about a large group of university people moving in and space science people from NASA. We'll have about 400 people in there in the next month. I accepted the job as the interim executive director, so I presume I'll be finding a replacement within the next year, but in the meantime I'm helping getting this one organized.

RUSNAK: It sounds like your plate has remained full since leaving the space program directly.

If you look back on your career, who do you think, besides some of the people you've mentioned, who are some of the key figures that you worked with that you really felt made a valuable contribution to either your career development as a mentor, or some of the people you felt that were important that maybe deserve some recognition?

GARRIOTT: Well, obviously a number of teachers way back in high school were very important, as well as my parents. I give them the top credit. It would be nice if they were around to receive it in person.

But in college, I really enjoyed working with the professors in the Radio Propagation Laboratory where I did my Ph.D., because they helped me find research topics and they essentially gave me free rein. I was managing a research program to look at satellites while still a graduate student. I didn't realize how fortunate I was to have dropped into that position at the time. They all had their activities and businesses, not businesses, but I mean their activities and research under way. But here came a new area. Well, that means they'd have to take time away, so they were willing to let somebody step in and do it. Obviously, that was a nice opportunity for me. So I enjoyed that.

The people in the Astronaut Office, the pilots there, they were all pilots when we arrived, very pleasantly surprised by the reception we received. No friction developed with any of them, you know. Deke and Alan Shepard, I think, treated us evenhandedly with all of the rest of the test pilots that they had there. They didn't send us off to go do a test pilot's job because we hadn't the experience. That shouldn't be our job. But they integrated us fully into the operation of the space flight preparation and the conduct of the experiments, and even would ask our advice about the conduct of the science where appropriate. So I have nothing but praise for and appreciation for the reception that we got from the test pilots. As I've already mentioned, test pilots like Alan Bean or Jim [James A.] Lovell [Jr.] are close friends, and I still see them quite frequently.

RUSNAK: That's great. I wanted to give Rebecca and Sandra a chance to ask any questions, if they had some.

WRIGHT: I just have a couple.

GARRIOTT: Sure.

WRIGHT: You've shared with us the difficulty that you had during your EVA, but can you share some thoughts about the rest of the EVA?

GARRIOTT: I can think of one that I enjoy, really, because when you're out at the sun end, sending back these film packages, it takes a moment or two for the film package to translate in and then the other fellow on the other end to unload it and so forth, so it gives you maybe a minute or two to sort of stand back in your shoes and sort of survey the situation and look at the world go by. One thing you can do, of course, is look over the edge of the "elevator shaft," and you can look down that shaft 435 kilometers. A long drop. It's fun to say, "Boy, that is the deepest elevator I've ever looked at."

But even more fun, I can remember coming across the South Pacific towards South America, and it was near a sunset somewhere near there, because I can look to my right and see clear down to Tierra del Fuego, right down here. And here are the Andes right across the center of my view, all the way up to Peru, over here on my left. The snow-covered Andes, some of it is salt, actually high plains salt lakes up there on the top. Over Argentina to the Atlantic Ocean, all in one view. The big cumulo nimbus buildups up near the equator, so beautiful, were casting long shadows down south.

So I thought that was perhaps the most memorable image, which I would like to keep permanently imprinted up here, and however many bits it takes, I want to keep that one embedded of that view approaching South America and looking all the way from Tierra del Fuego to Peru and the Atlantic Ocean.

WRIGHT: The other question I had is that going to space twice you had two different ways of launching. Can you share with us what you felt and what the differences were going from the Saturn V as well as the other?

GARRIOTT: The launch phase is remarkably similar, because both vehicles have a thrust which is just a little bit more than the weight of the vehicle. So you start out at very low acceleration levels. You just lifted off no more than you would experience in a car acceleration. Then it keeps building up a little bit, but the important thing is it's steady. You know, when you accelerate in a car you accelerate for three or four seconds and then you reach the speed you want to be at. Here, you keep on accelerating, because the speed you want to be at is 15,000 miles an hour. So you keep up an acceleration which is increasing up to maybe 3 or 4 Gs. But it takes about eight and a half minutes, nine minutes, to get to space on either one of the two vehicles.

As you lift off, there's quite a bit of vibration with either vehicle, but it's largely because of atmospheric vibration. The sound waves that are all around the spacecraft causes it to shake. Once you get above about 100,000 feet, first of all, you stage, you switch to a smaller engine on a second stage, and you're above most of the atmosphere so the vibration diminishes. Then it just becomes a nice steady push, and you continue that push [at] about 3 to 4 Gs, all the rest of the way for the eight and a half minutes till you're into orbit. All of a sudden you're bouncing up against your straps.

So the launch is remarkably the same, in my view, between a Saturn V and a Shuttle. The reentry is what's different. On the reentry you come down on Skylab, of course, and after you slow down a little bit so that your orbit comes down into the atmosphere, then you see the air glow all around the spacecraft. That's the same whether it was in a command module or whether in the Shuttle. On the Shuttle I happened to be sitting right beside the side window on the mid-deck, so you see all of the—starting out, the blue and yellow flames coming by. Then you get a lower, why, it will turn to orange and reddish flames as the temperatures drop down a little bit. Same thing in both.

Then as you really get lower, on the command module you have to pop drogue chutes to orient your spacecraft. When you get down to about [10,000] feet, I believe it is, the main chutes come out, and then when you finally get down to a big splash in the water; then the command module had two stable attitudes, either this way or this way. Stable one and stable two. So we ended up in stable two. Had to inflate some balloons to flip ourselves back over. So that's quite different than coming down in a glider.

In the Orbiter, you come down in a glider and see all the same things [down] to about 100,000 feet. You've been used to either ten days or sixty days seeing the rate at which the Earth moves by. Once you get down to a lower altitude, the Earth starts moving by faster and faster, because you're lower, you're closer to it. You're really slower, but the Earth goes by at a faster clip. So it's interesting to see those two comparisons.

A lot of difference in the way you come back below 100,000 feet, but the launch is very much the same.

WRIGHT: Thank you.

RUSNAK: I wanted to give you a chance to make any final remarks, anything you may have forgotten or just want to close with.

GARRIOTT: I can't think of anything else, Kevin. I think we've covered a lot of ground here.

RUSNAK: You sure did.

GARRIOTT: In two and a half hours, almost.

RUSNAK: That's right. I'd like to thank you again for taking the time out.

GARRIOTT: Sure. My pleasure. I enjoyed talking about it.

[End of interview]