# ORAL HISTORY TRANSCRIPT

JAMES W. MCBARRON II
INTERVIEWED BY KEVIN M. RUSNAK
FREDERICA, DELAWARE – 10 APRIL 2000

RUSNAK: Today is April 10, 2000. This interview with Jim McBarron is being conducted at ILC Dover in Frederica, Delaware, for the Johnson Space Center Oral History Project. The interviewer is Kevin Rusnak, assisted by Carol Butler.

I'd like to thank you for having us here in your office today, and if we could, just start with some of your background information, where you grew up, what kind of interests you had going into college.

MCBARRON: I'm pleased to be able to have the opportunity to do this interview.

I was born and raised in a small town in northwestern Ohio, Lima, Ohio, and I grew up with an interest in science. Of course, I didn't know the term "technology" back in those days, but that's sort of what I was interested in. I was a big fan of *Buck Rogers* and other space programs, *Flash Gordon*, that were shown on the local intermission activities at the Saturday matinees in our hometown movie theater.

Growing up in grade school and high school, I always sort of had an affinity for science and chemistry. My friends used to always remark that I was sort of the mad scientist at the time, because my mom and dad gave me a chemistry set for Christmas when I was a freshman in high school, and I was good at making flash bombs. We don't call them bombs, but flash reactions and other things. I always had trick pencils with flashing lights and all kinds of gadgets that I made when I was growing up.

So when I graduated from high school, I decided that I wanted to get into the science field. My advisor at the time recommended that I start out in physics. Not wanting to get too far away from home, I went to the University of Dayton in Dayton, Ohio, entered into the science program there as a freshman.

During my first year, I had a few problems with math, which led to an interview with my dean, Brother Mann [phonetic], at the University of Dayton, and he recommended that I not take physics due to the extensive amount of math that was required for physics, and suggested that if I wanted to stay in science, which I'd expressed to him, he said I had a choice of either biology or geology. Not liking biology too much in high school, I asked, "Well, what is geology?" because I really didn't know too much about it at the time.

It sounded pretty interesting, because I did get to take physics and a watered-down math program and chemistry that the pre-med students took at the time, rather than the true scientists. So I enrolled on a trial basis in geology, and found I liked it, and I liked the program, and graduated in 1960 with my bachelor of science degree in geology.

Next?

RUSNAK: Did you have any particular plans that you were going to do with your degree?

MCBARRON: Well, part of my expenses that I earned while going to college was working various odd jobs. I finally saw an ad on a bulletin board in a science building one day, they needed test subjects out at Wright-Pat [Wright-Patterson Air Force Base, Dayton, Ohio] to work in the Aeromedical Laboratory under a psychology project. I applied and was accepted, and led me to work for three and a half years part time during school time, full time in the summers and

holidays, working at Wright Field as a test subject and as a technician in testing high-altitude protective equipment, pressure suits, Air Force equipment, which included such things as, I was one of the guinea pigs that was used to set some of the medical criteria for selection of the Mercury astronauts. Later we did part of the medical tests on the candidates for the Project Mercury there, and I was one of the data recorders, in fact, for some of those. So I had exposure.

I also helped train some of the X-15 pilots with the use of the Air Force suit that they were flying for high-altitude pressure protection. So I got my start in this field of protective equipment at Wright Pat there at the Aeromedical Laboratory.

When I graduated from college in 1960, there was an oil glut, and there really wasn't many jobs open in the field of geology. So I was able to continue to work on this psychology project full time for about six months with the proviso that I had to remain a student, keep a student number. So I took several courses at night just so I could work in the daytime to keep my student number.

During the period I was working there, I met some of the NASA people who had came in, because we were doing an evaluation of the three candidate suits to be selected for Project Mercury. I was scheduled to be one of the test subjects for that and helped build the first closed-loop environmental control system for testing those suits that reduced pressure in a vacuum chamber.

So I got interested and submitted an application to NASA for employment. I submitted it to Edwards Air Force Base [California], is where I thought it should go, but somehow I got interviewed by a NASA human resource specialist out of the Cleveland [Lewis] Research

Center, and he forwarded my application on to Langley [Research Center, Hampton, Virginia], where they were starting up the Space Task Group.

So I got hired as one of the original members of the Space Task Group at Langley Field, Virginia, in the Life Systems Division, not knowing exactly what I would be doing, although I did know I would be working with high-altitude protective equipment.

What was interesting is it was on May 29th, which was my parents' wedding anniversary. I went home to Lima with the good news that I had got a job working for the Air Force that day, I mean, I was offered a job with the Air Force working on the Dyna-Soar project as a pressure suit specialist, and for Ed [Robert E.] Vale, who worked there. While we were sitting having dinner and they were celebrating the anniversary, and they were happy that I finally got a real job opportunity, I got a long-distance phone call from my roommate saying that he'd just received a phone call from the telegraph office that I had gotten a telegraph from NASA offering me a job for NASA at Langley Field, Virginia, and to forward on the TWX [teletype transmittal, pronounced “twix”] to me, which he did. So it was sort of neat.

My father and I went down to the telegraph office and got this neat TWX, saying I'm been selected as a member of the astronauts' team, and would you please consider working for NASA. They offered me a GS-9 starting, whereas the Air Force were stretching to do a GS-7. So my dad says, "Why don't you take the NASA job," which I did. We never left the telegraph office before I sent back my response, I'd be there in two weeks. So that's when I started, in June of 1961 at that point. My first boss was Dick [Richard S.] Johnston. You may have interviewed him.

RUSNAK: We have.

MCBARRON: He hired me to be the Project Mercury spacesuit engineer, which was my first assignment. This was right after Al [Alan B.] Shepard's [Jr.] flight, which was in May of '61. So from [Virgil I.] Gus Grissom's flight on, MR-4 flight, I think it was, I was the Mercury spacesuit engineer all through the Mercury Program. Technicians Joe [Joseph W.] Schmitt and Al [Alan M.] Rochford, I supervised them. They were the technicians that did the actual suit checkout and fit checks with the crew. But I was responsible technically for the suit and modifications and managing the contract that NASA had just set up with the B.F. Goodrich Company at Akron, Ohio.

So that's how I got my start with NASA, was the Mercury spacesuit project engineer and a tech monitor for the suits being manufactured, plus spare parts and repairs for suits that went back to the factory in Akron, Ohio, for repairs, which was sort of neat, because when I got to go to Akron on business trips for NASA, I could take a side trip home to Lima and see my folks, which was good, and also back to Dayton to see some of my professors in geology, because they were interested in was I going to get to work on the Apollo lunar program and work on the Moon and use my geology. [Laughter]

So I got transferred from Langley Field to Houston in late 1963. I was one of the last members of the Mercury Project Office team that was supporting Mercury from Langley, and went to work in Building 4 at the time at the Johnson Space—Manned Spacecraft Center at that time. I was made a section head at that point, because we'd had a growth period within the Manned Spacecraft Center where they hired a lot of new engineers, and fortunately, I was there early, so I got to become a supervisor of the newer hires. I was in charge of the spacesuit

section in the Gemini Support Office under Jim [James V.] Correale [Jr.], who was a branch chief, or support office branch chief, worked for Dick Johnston.

So I had the opportunity to participate in the selection of the David Clark Company [Worcester, Massachusetts] for the Gemini suit, which came about during a mockup evaluation of the Gemini capsule at the McDonnell-Douglas in St. Louis. A lot of people don't realize that there was an MA-10 Mercury flight scheduled at one point, and we were working on an improved suit for that flight that provided increased comfort and increased stay time on orbit for the crew member, but since it didn't fly, we did have this prototype, so we were evaluating that suit for use as the Gemini suit. Actually, it was an MA-10 suit made by B.F. Goodrich.

At that point in time, David Clark Company, who were making the Air Force X-15 suit, expressed an interest in being considered to provide suits for Gemini. So we had a suit evaluation at this mockup in St. Louis where Gus Grissom was the test subject. He wore both an MA-10 suit prototype and a David Clark suit, and made determination that from his viewpoint, the David Clark suit better suited the needs for the project. That's how the Gemini suit was selected for the Gemini Program.

At that point in time, it was strictly a contingency device. The suit only provided protection to the crew member in the event of loss of capsule pressure. We developed a G1C, which was the first version of the suit, which was a slightly modified version of the suit that David Clark brought down for that evaluation.

Then we had a G2C, which was a second version, which was the training suit version for crew members, which we made quite a few models of or copies of.

Then the G3C was the first flight configuration for extravehicular operation, and its configuration flew on the first Gemini mission, GT-3.

About this point in time, there was an interest on the part of NASA management at the Johnson Space Center, particularly Chuck [Charles W.] Mathews, who was the Gemini Program manager, and Reg [Reginald M.] Machell, who was the project engineer responsible in the Gemini Project Office for life support and crew equipment, to modify the suit to provide an extravehicular activity [EVA] capability to fly as soon as we could make it ready.

That's when a small team was formed, led by Larry [E.] Bell in our division, to develop a chest pack and modifications to the suit to enable a crew member to open the hatch on a Gemini in orbit and do the first American spacewalk. I was responsible for the suit modifications, which involved adding protection for the thermal environment, and also abrasion and puncture protection for the suit, which was the outer layer, and provide visors for the helmet to protect the crew member from the increased brightness of the sun that exists once you get about the Earth's atmosphere. So we had to reduce the transmittance of the helmet for optical reasons, as well as for protection of the gold coating on the visor for solar temperature control.

Then the interface with the chest pack was made by a different section under Larry Bell and Joe [Harold J.] McMann, did the chest pack. Of course, all this activity was sort of done hush-hush for political reasons, I guess, at the time. I really never did understand all that at the time. We were just doing our job, and made a system and tested it in the chambers there that we had in the Crew Systems Division, and got approval to fly it and it flew on GT-4. Ed [Edward H.] White [II] was the first American spacewalker wearing that system. That's how there was this Gemini IV Extravehicular Activity Team Award established for the members of that small team that had developed that.

At that point in time, there was a different group within the Crew and Thermal Systems Division developing the suit for the Apollo Program. I was located in the Gemini Support

Office under Mr. Correale and Charlie [Charles C.] Lutz as his deputy. Then there was another group of people in the division in the Apollo Support Office under Ed [Robert E.] Smylie and Matt [Matthew I.] Radnofski, who were doing the Apollo suit and PLSS [portable life support system], and actually had worked and selected the contractor for that through a competitive evaluation, sort of different competitive evaluation. There were teams formed for the program by the contractors and Hamilton Standard and the David Clark Company was one team that submitted a proposal, and Allied Signal and ILC [International Latex Corporation, now ILC Dover] got together and formed another team.

When NASA evaluated a proposal, which I didn't take part in, but from what I know, they liked the Hamilton Standard management and portable life support system part of the proposal, but not the David Clark. They liked the ILC suit part that was in the AiResearch [Manufacturing Division of the Garrett Corporation] proposal, but not the AiResearch life support system and management. So NASA forced a marriage between Ham Standard and ILC on a program to develop the Apollo suit. There were a series, I think, of four suits developed, four or five at a minimum, suits developed by the Ham Standard/ILC team, none of which met the requirements or expectations of NASA and the NASA astronauts who were working at that point in time.

So the suit program was behind in what was expected and required of it by NASA. At the same time, there was apparently some change in the command module, so they had to a Block I and a Block II program formed, and it was determined that they would fly an improved version of the Hamilton/ILC suit in the Block II program, and then on an interim basis they would use a modified Gemini suit for Block I, which I was put in charge of at that point in time, the Block I suit, due to my longstanding experience with David Clark and on the Gemini suit.

So we were put in charge of making the Gemini suit interface properly with the Apollo command module interfaces. Fred [A.] McAllister and I worked together to do that. At that point in time, I'm not sure of the time sequence exactly, but there still is a problem between Hamilton and ILC from a managerial viewpoint, as well as a technical viewpoint, with the suit. Hamilton canceled the contract with ILC and started a new contract with B.F. Goodrich, who was the Mercury suit supplier at that point in time.

So that was right around the time we had the Apollo 1 fire where we lost the three crew members and good friends of mine. So with the redesign of the Apollo command module to make it fireproof—I think that was a little later—there was no need for a Block I suit anyway. That program was terminated.

There was a competitive evaluation of three suits, the Hamilton/B.F. Goodrich suit, a modified version of the Block I suit made by David Clark that I was in charge of, the AX1C. ILC wanted in the competition, so they brought their own suit that was company-funded and provided under the auspices of George Durney [phonetic], who was their lead suit designer, our lead suit designer now.

There was competitive evaluation on a technical basis conducted by an independent group within NASA to select which suit NASA would use for Apollo. The ILC suit won hands down as being best in most different categories of the test evaluation and the highest total score. The Block I suit, modified Block I suit, made by David Clark was second, and the Ham Standard/B.F. Goodrich suit was third.

So at that point in time, NASA said, "We can't force Hamilton and ILC to work together again, because that didn't work." There was a lot of so-called bad blood between the management people, over which I not clear to this day as to why because I was still working

back on the Gemini side and the Block 1 side of the program. So NASA decided that they would award two independent contracts, one to Hamilton for the PLSS, one to ILC for the suit, and NASA would hire an integration contractor, G.E., locally to integrate the two companies' products to create a single spec that both companies would work to, and do an independent oversight of trying to make that whole relationship work.

When this program was being set up by Matt Radnofski, it was sort of interesting. On one Friday I was asked if I would consider being the NASA representative in ILC to participate in the monitoring of the suit program up here. Went home that weekend and talked to my wife about it, and with some reluctance we agreed that we would accept that job. I come to work Monday and find out that in the meantime Dick Johnston had his own scheme of things and asked me if I would run the program for Johnson and Radnofski was off the program. [Laughter] There was a whole new management scheme within the division.

So I was put in charge of the development of the A5L, which was the first prototype of the ILC contract effort, which fourteen units were built for supporting all the various needs within the program that existed at Grumman with the LM [lunar module], and North American with the command module, and Johnson for interfaces with the [MIT] Draper Labs on the navigation system and all other—there were a lot of needs for suits at that point in time.

Because people don't realize one of the few pieces of equipment that was used and had to work from launch to return back from the Moon was the suit. I mean, very few pieces of equipment actually flew the whole mission. Which meant that it had to interface with the command module, in addition to the—well, actually, to back up, it had to interface with the cooling system to get the crew member in the bus to the launch pad, up on the launch pad and into the command module. It had to interface with the command module couch and launch

support system, the command module navigation and optics. Then it had to interface with the LM environmental control system and instrumentation system for landing, its navigation system and all its displays. Then it had to be able to work with the portable life support system, and then all the way back. That's quite an integration job. It had a lot of requirements that people never realized to this day as to the complexity of what it was being asked to do.

But anyway, we did it. For interface and evaluations we used the A5L, knowing at the time that we had to work on the suit changes that were necessary from evaluation. There were some problems that were identified, and there was some interfaces that weren't satisfactory. Came up with the A6L, which at the time was to be the first flight configuration suit.

At that point in time is when the fire occurred, and it became necessary to change the suit design to make it less flammable and to interface. So that was that time sequence I was wrong on. So that's when the Apollo 1 fire occurred. As a result, we had to completely redesign the suit. We had a separate jacket and pants TMG [thermal micrometeoroid garment]. We had to provide an Integrated TMG [ITMG] to provide protection to the crew members inside the command module limb. It was impossible to make the suit fireproof from the viewpoint of selecting materials that wouldn't burn within the suit. We had a bladder that was flammable. We had a restraint that was—and it just wasn't possible to make certain parts of the suit out of nonflammable materials.

But we did provide a flammable protection cover with the beta cloth, which was developed by NASA. We were allowed through a waiver process to use a polycarbonate helmet which was flammable, because there was no acceptable substitute for that, and the crew members did need to see what they were doing when they were wearing it, wearing the suit. So with that integrated suit and the changes, we came up with the A7L EVA suit, which was the

first suit that flew on Apollo 7 with Wally [Walter M.] Schirra [Jr.], Donn [F.] Eisele, and Walt [Walter] Cunningham, I believe.

So that's how the Apollo suit came about. As you can see, each suit program there's been a competitive evaluation between a minimum of two U.S. companies and sometimes three: David Clark Company, who was the Air Force contractor for the X-15 and high-altitude aircraft that the Air Force provided; with B.F. Goodrich, who provided the Mark IV suit that was made for the Navy, and then to modified and used for Project Mercury; and ILC, which was truly an advanced suit that was a competitor for Project Mercury and a competitor for consideration for Gemini, but not too much so, but then selected for Apollo. So there was a competitive shootoff, so to speak, with actual hardware for all three programs. That was interesting, because when we get into talking Shuttle, there's an anecdote to that.

So we flew Apollo, and I managed the Apollo suit contract. I was the project officer on the contract, or tech monitor, whatever term NASA had in vogue at the time. I was responsible for setting up a field organization at the Kennedy Space Center, where we actually located ILC people, a team of ILC people who handled the flight suits there and did the checkout and maintenance and repairs, logistics and bond room and all that, and supported the crew chamber runs that we had there with the command module LM before we flew.

We had a small team out at Rockwell which has become—I mean, it was North American and became Rockwell. We had a small team at Grumman with the suits we had there. All these were under a field support operation that I also headed up, in addition to monitoring the plant development and production activity.

So I worked that contract, NS9 6100, for a period of ten years of my career, and this contract provided all the suits needed for Apollo and for the ASTP [Apollo Soyuz Test Project]

mission, which was a modified version of the Apollo suit, and then eventually for the Skylab Program, for the three manned Skylab flights to the workshop, all manufacturing being provided under this one contract for NASA.

Can we take a break for a second so I can get my thoughts?

RUSNAK: Sure.

MCBARRON: During this time of the development of the Apollo suit directly under contract with ILC, there was an activity to look at use of hard suits, so to speak, provided by Litton and AiResearch Company, the R-Series suits. While they may have provided more mobility in a pressurized condition than the Apollo suit, they were considered, but not selected for use due to the weight, because the weight was at premium for return of the LM back from the lunar surface, and the storage volume that would be required to stow them in the LM, which storage was at a premium. Also as the result of evaluations by crew members, who were expected to make the lunar commission trip and return, and their evaluation was, "This Apollo suit's adequate. We understand it. It's got a track record." The hard suits, while offering opportunities, really weren't ready and had the disadvantages of weight in both storage volume, so they were not selected. That occurred during the period from '65 to '68, I guess, because it was in 1965 that I started working on the Apollo suit program as the project manager on the ILC's contract. So there was consideration of hard suits, but not selected.

I can't discuss too much about the development of the Apollo backpack since it was not under my responsibility. I know about it. The big challenge there was to take in as small a package as possible, provide a portable life support capability, closed loop life support

capability that would last, initially it was for a four-hour system, and then for the J missions extended to six hours.

Its big development problem was that during Gemini it was learned that it was necessary to have—there was inadequacies with the air-cooling system in a Gemini suit during Gemini EVAs where a crew member overheated and the visors fogged, and it became necessary to have a liquid cooling system to remove the heat from the crew member and then expel it and to remove it from the system. They had to change the Apollo backpack from what they called the dash-five configuration, which was the air-cooled portable life support system to the dash-six, which was liquid-cooled system. So it even added more complexity, because it added the need for a sublimater and a pump and instrumentation and the plumbing associated to do that, and in addition, the addition of a liquid-cooling garment in the suit to interface with that.

You have a question here regarding the process used for drink bags and how they were integrated into the suits. The first development task I was ever given for NASA during Project Mercury was after Al Shepard's flight when we did not have a urine-collection device inside the suit to take care of the period of time from him leaving the Hangar S crew quarters until he got to orbit and could open a suit up. So one of the first jobs Dick Johnston gave me was to take over a contract with B.F. Goodrich Company for developing a urine bag for the suit.

Well, the contract didn't produce a product that was truly acceptable, so we started an in-house effort, and that was my first experience with the development of an entity, sort of the opposite of the drink bag at the other end, so to speak. [Laughter] That was to get a good handle. The first thing, of course, you've got to get a good handle on what the requirement is, develop concepts, and on this urine bag, using my experience as a test subject from the days

when I worked for the University of Dayton, I tried all these devices out myself first in my apartment.

I found that the problem was a seal to the crew member so it wouldn't leak. I mean, it was easy to store a liquid volume or the urine in the suit, but the problem was so it wouldn't leak and have backflow. Using prophylactics and modified version of same, I developed a way to attach it to the crew member that worked fairly well. We actually went to a prophylactic manufacturer and got him to make this modified version, and solved that problem, which is still used today by some male crew members in the Shuttle suit, although not by everybody. But it was used successfully for the rest of the Mercury missions, all throughout Gemini, and all the way through Apollo, and for the first part of Shuttle.

It's sort of neat to go to the Smithsonian [National Air and Space Museum] and look on the wall and you can see all of John [H.] Glenn's [Jr.] stuff hanging there. You can see this urine collection bag that I had personally, Joe Schmitt and I made in the lab, hanging there. [Laughter] People don't know the history behind it, but that was pretty neat.

So you go through a process of requirements, concepts, definition, verifying the design by test, trying it with crew members to get crew acceptability, because they had their likes and dislikes which needed to be satisfied. Then, of course, in those days cost came last, because we were more interested in providing a product than with the less cost emphasis than we have today. I mean, it was sort of a mandatory that we have a product. I won't say cost was at no object, I mean, we did have constraints and budgets we had to live within, but the primary focus was on technical performance compared to today.

My responsibilities during a mission. I sat in the back room over in the Mission Evaluation Room [MER] in Building 45. I recall during the Apollo 11, we had two teams of

technical people that provided EMU [extravehicular mobility unit] support, that's suit and PLSS support, and my responsibility was for Neil Armstrong's suit and system. We were there just to be able to answer any question of the mission operations people, the flight directors, that they might have and ask how this worked, and would it perform first characteristics of this piece of component or what have you. Then during a mission, during the actual spacewalk on the Moon, we sat there and watched and were ready to answer any technical questions or any problems that were to arise.

That was an exciting time. At the time we didn't—looking back now, I realize the significance of what we did, but there at the time, it was an important job, but didn't realize how significant it was. We knew it was important. I mean, not to take that away, but to be able to do that that number of times on the lunar surface and not have a suit problem was marvelous.

What role did the division have in the experiments and tools? We did develop, due to our experience with the suit and the constraints of the suit and how to operate things, controls and devices with gloves, and how to carry things on the Moon, the only place to carry it was on the crew member suit, we got involved with both the experiments, the ALSEP [Apollo Lunar Surface Experiment Package] deployment, and tools that the operator, the crew member, had to control, such as the drill and how to assemble the drill stems and drill bits and the walking and interfacing with all the equipment. We played a big part in the interface of the suit to all these devices. In some cases we actually provided the tools to provide for the opportunity for the crew member to do his exploration task and sample collection and return.

As far as mission training, my job was to provide the suits, the training suits, keep them up to date through our mission support, people both at the Kennedy Space Center and Johnson. We had two types of training. One type of training was actual physically having a crew member

wear the suit in a command module in the LM in an altitude chamber test at the Cape, which was a full-up systems integration test before every mission, where the crew members went through a complete dress rehearsal of entry into the command module or the LM, and doing a vacuum exposure test of all the systems, as well as there was a test called $C^3S^3$ test, which was a crew compartment physical and functional interface that was done at the Cape.

Then, of course, back at Johnson we had a rockpile back at that point in time where the crew member practiced laying out experiments like ALSEP and going through the physical geometry. Then in Building 9 we had a 1/6G simulator where the crew member could practice actually trying to develop his technique for walking on the Moon in a reduced gravity field at 1/6 gravity that we had at that point in time.

So in all of these, my job was to develop the suits and do the certification of the design, and then to manufacture the training and flight units, and support the crew's use of those training and flight suits through all the different mission activities in both pre-flight and post-flight. When we got the suits back, we did a big post-flight inspection, looking for any micrometeorite damage, which we never found, and vacuuming the suits to remove all of the lunar dust and pebbles that became embedded in the suit, and turn them over to the Lunar Receiving Lab, and then finally disposition of suits to go to the Smithsonian [Institution], which is where all the flight suits ended up.

In some cases we were able to reuse the training suits for crew members on a later flight. People don't realize that. But we did reuse some of the training suits through reassignment to later crew members. But we never reused a flight suit; they always ended up at the Smithsonian.

At this point in time towards the end of Apollo, Skylab was making an appearance on the scene, which was our first true space station. Since the transport vehicle to the Skylab space station, or orbital workshop, was the command module, it was determined that we would continue to use the Apollo suit, which had all the command module interfaces built into it, and did provide for an extravehicular environmental capability. However, it was determined it wasn't necessary to have the expensive portable life support system for that role, so we used an umbilical with a chest-pack mounted system, similar what we used in Gemini, although a little more complex, little more advanced, more capability, which was called the ALSA, or astronaut life support assembly. This was used in conjunction with the umbilical back to the orbital workshop to provide the astronaut the life support function, liquid cooling, and communications back to the ground.

Of course, it was through the use of the EVA that we were able to actuate, activate the workshop after the failure of the micrometeorite shield during launch and to deploy one of the solar panels manually from the command module by the crew member doing a standup EVA, and applying a solar panel, and beating on a battery box with a hammer to get the battery to work, and all kinds of good EVA tasks that made the workshop a viable part of the NASA manned space flight program. Because up to this time, other than for the lunar spacewalks, EVA was considered extremely risky, extremely dangerous, something you wouldn't want to do unless you had to do it, and it was looked at as a contingency capability.

The question during the early part of Shuttle, which was going on at this point in time, the NASA perspective of a Shuttle was an airplane that could take off and land on a runway, and the people inside and flying it and these passengers wouldn't need suits. The original Shuttle Program never had an extravehicular capability, in fact.

[Begin Tape 1, Side 2]

MCBARRON: It was through prompting and questioning and proposals made by the Crew and Thermal Systems Division, and Engineering Director of Personnel, certain Engineering Director of Personnel, that Aaron Cohen, who was the project manager then of Shuttle, finally accepted a contingency capability for closing of the payload bay doors, which was an issue that they were faced with, that actually put an EVA capability on the Shuttle Program, the Shuttle Orbiter.

RUSNAK: Is that the primary argument for having EVA capability?

MCBARRON: At that point in time it was for payload bay closure, yes. If you couldn't get the payload bay doors closed, what will we do?

RUSNAK: Do you remember who the people were that were arguing for this?

MCBARRON: I think Max [Maxime A.] Faget was the one who thought that it was not necessary to have an EVA capability, but was willing to accept it, because our division, who worked for him, was a strong advocate of it. Owen [E.] Morris was involved in that at that point in time. Aaron Cohen. I can't recall all the other players. Of course, at that point in time, my direct boss was Harley [L.] Stutesman [Jr.], who is now deceased, who was a strong advocate of having an EVA capability. There was a whole group of us in the EVA community felt that it was sort of foolish to go up into space and not have that capability. Finally we won out, so to speak,

fortunately, because it was found to be a good commodity and capability for rescuing several satellites, repairing several devices that didn't work, and are now making possible the assembly of Space Station, International Space Station.

So let's take another break. [Tape recorder turned off.]

A need for the Shuttle EMU was derived. There was an effort within the Crew and Thermal Systems Division of just what was the best concept and approach technically to provide that capability. Based on the experience with the Apollo suit, where we had problems of requiring fine adjustment between the suit and the PLSS for straps for attaching the suit and the life support system, and the fact that in the Shuttle that the EVA system was only for EVA use, we could optimize it for its primary job and not have the requirements for interfacing with couches and all the interior interfaces.

The NASA people in the division came up with the concept for a hard integration of hard upper torso and a backpack so it was always attached and combined from the ground up during launch. Due to the problems we had with Apollo suit, with cables and swedges, adhesive bonded seams, and the use of rubber materials in the bladder which limited the lifetime of the suit, and the fact that the suits were custom-made to the crew members' dimensions, it was determined that for a new RFP [request for proposal] that would be released for competitive procurement, that certain design characteristics that were undesirable from the Apollo suit would not be allowed for the Shuttle suit.

So the Shuttle RFP had in it the requirement that there could not be any use of pressure sealing slide fasteners, which were found to be necessary to be replaced up to three times before a flight on every Apollo suit for every mission. No cables or swedges in the axial restraints because of the problems we had continually with cables breaking and swedges failing, and the

problem of the low leakage requirement and the permeation and migration of gas through the adhesive bonded seams. We said we wanted the heat seal seam with overtaping, and we wanted a system that had a six-year life. Well, that automatically said you couldn't use neoprene or natural rubber products, because they have a four-year life. So we wanted something other than that. So that sort of levied a set of requirements on industry at the time.

By this time, ILC and Ham Standard managements had changed, and they had worked out a scheme that they would work together, because they thought they were the best, based on the Apollo experience, and they wanted to get back together, which they did. So one of the competitors was Hamilton and ILC was a team. Another team was AiResearch and David Clark. These same company names keep popping up.

I was on the Source Evaluation Board for Shuttle. ILC and Hamilton were smart. They recognized that all previous programs, the thing that sold their suit was having an actual physical piece of hardware that a crew member could get in and evaluate. So as part of their proposal, they also built a suit and submitted it to NASA for evaluation. They deviated somewhat from the NASA baseline concept by putting a waist bearing in a suit, which the astronauts found on evaluation was extremely useful and beneficial, and sort of sold their suit technically from an astronaut's viewpoint.

After the RFP evaluation of costs and management schedule and all that stuff, Hamilton and ILC were selected to be the Shuttle suit EMU supplier as a team. NASA specified that to reuse the existing Apollo helmet and EVA, modified, and has used many of the wrist disconnects and neck rings as possible to save cost in this new system, which was done. That's why the helmet sort of looks very similar to the Apollo, and the disconnects are basically the same design, although they've been modified somewhat to improve them. That was done to

reduce the cost, because still at that point in time there was this climate of people that said, "We don't need EVA. It's too expensive, it's dangerous, and too expensive," and so on and so forth.

So I was put in charge of the Shuttle EMU for a very short period of time, and then a little bit of an argument I had with my boss, Jim Correale about making sure the suit had all the improvements in it that were possible, which he had disagreed with. He took me off the program and assigned me on division staff responsible for the ESA [European Space Agency]-NASA interface on the Orbiter and the life support work. So I was out of suits and suit career path for about a year and a half because of our disagreement.

Well, the person he put in charge when I was replaced didn't work out too well. Finally Jim came to me and he said, "You know, I was wrong. Would you go back and run that program?" Because they were having problems with the suit again at that point in time. Which I did and worked it all out and worked the Shuttle suit, became branch chief not only for the Shuttle suit, but the manned maneuvering unit and all the tools and equipment eventually.

My relationship on the manned maneuvering unit is, I was made the chief of EVA Equipment Branch. [Charles E.] Ed Whitsett was a section head that worked for me, reported to me at that point in time, and he's the one that's responsible for development of the design of the man maneuvering unit. Then we had a group that did the tools and EVA-related equipment that was part of that system. I worked that job for several years.

Then the division reorganized and I was made chief of the Shuttle Support Branch, which included the EMU suit, but in addition I picked up the responsibility for the Orbiter ECLSS, environmental control life support system, and the other products the division had that were supporting the Shuttle Program. Then there was another branch that was responsible for the Space Station Program, and they had a Space Station suit and Space Station life support.

Sort of similar to what we had at the beginning of Apollo, where we had a Gemini Support Branch and an Apollo Support Branch. That was set up again, but this time I was a branch chief, rather than a section head.

That's when we had the Challenger problem. I was in that capacity and did all the return flight actions for that system, which ended up getting me the Exceptional Service Medal for the work on the suit and the Orbital life support system, return to flight activity.

Then at that point in time there was a separate suit being developed for the Space Station, a brand-new suit, different from the Shuttle EMU, by a different group again. It wasn't going too well, and the question was asked, why couldn't we use an upgraded Shuttle EMU to build a Space Station. [Harold J.] Joe McMann, who worked for me at the time, and I went to Headquarters, and the rest of the division went to Headquarters with what they did on the advanced Space Station suit. NASA Headquarters management decided to pick the enhanced Shuttle EMU to build Space Station, because it was considerably less expensive. At that point in time the station program was suffering from cost problems, like it always has.

A decision was made to use an upgraded Shuttle EMU. It sort of made the other groups' activity was canceled and terminated. So I worked the program with Joe. Joe did the life support system, and I did the suit primarily to build and enhance the shuttle EMU suit, which has finally come into fruition and flying now.

So all this period of time we've been talking about took thirty-eight years of my life working for NASA. I decided I was getting stale and doing it over and over was something where I needed some new horizons, so I retired from NASA in February of 1999, and was offered a job by ILC, who I had worked with since 1965, and actually had known people since

1959 when I was at Wright-Pat as a college student testing their suit, offered me a job to come work for them, to bring my corporate memory and my expertise and my contacts.

They wanted me to be their program manager for the suit work they were doing, but there was a determination made by NASA legal that that violated a conflict-of-interest statute. So in order to work here, they put me in charge of being a deputy program manager, and then it was acceptable to work on a program, as long as I don't have any direct contact with NASA people, as far as representing the company and making recommendations from a company viewpoint to NASA.

So all that good work of thirty-eight years sort of put a constraint on me working for a contractor, which is okay, because I still work for the contractor, but I probably could do a better job for NASA if I was working direct with them. But I follow the statute and don't break the law and don't get put in jail. [Laughter]

So here I am today, the deputy program manager. ILC moved up a young engineer to be the program manager and I'm sort of mentoring him. This assignment here is just a couple-year job, and I intend to go back to Houston, live in the NASA-Clear Lake area where it's really home.

RUSNAK: I understand your son also works here.

MCBARRON: Yes. During the years my son got excited about the work I was doing and was always interested in it and got an opportunity to work for—ILC had an off-site office where he was hired originally as a technician and while he was in college, and got a job working for them

as a suit engineer. He worked up here for a couple years before I came up here, in fact. Then he was transferred down to Houston to work, and I came to work up here.

Then he had an opportunity, because he had a girlfriend up here, that he wanted to come back up here. He's getting married up here next month to a local girl from Dover, whose mother works for the company. Talking about family relationships. And then she has come to work for the company. So over the years ILC has had quite an affiliation association with ourselves both professionally and on a personal basis.

My son is an engineer, sort of following in my footsteps, although I don't want to say that too loud because he thought that he would walk in a different direction, I think. [Laughter] But I'm pleased to see that he's—he comes to me for advice on things now and then, which I can give him my viewpoint.

RUSNAK: It's quite an interesting family business to be in, I guess.

MCBARRON: Yes. My family, when I was growing up, was in the restaurant business and had a well-known restaurant and cafe in Lima, Andy's Cafe. My dad was extremely proud that I'd worked for NASA. In fact, he had a display in the restaurant of all the astronaut pictures and autographs that I sent him. It was quite a focal point at the time. Really pleased him.

RUSNAK: It is something to be proud of.

MCBARRON: Yes. Of course, some memorable events was on the morning of John Glenn's flight I was asked if I would be willing to be interviewed on TV, national TV. So I got to be

interviewed by Walter Cronkite on the morning of John Glenn's launch, which ended up in our local newspaper, sort of like I'm not quite a headline, but local boy makes good, you know, and interviewed.

So from then on, apparently, I did a good job for NASA, because I was interviewed with a lot of different people from then on, Jules Bergman, Cronkite, because I'm a big believe in the PR [public relations] world as well. So I had quite a few interviews. Did demonstrations of astronauts' survival equipment in the swimming pool at the Holiday Inn in Cocoa Beach [Florida] for the press. I even at one point in time was sent to Huntsville when Wernher von Braun was working, on how do we repair the J-2 engine in orbit. I mean, he was a broad thinker.

So another NASA engineer, John [E.] Leshko, and I took Mercury suits, this was back just before the Gemini Program, in fact, about 1964, '63, went over to Huntsville and Von Braun and his engineers had set up an air-bearing floor with a J-2 engine on it. John and I got in the suits and tried to demonstrate how we would change out these big three-inch nuts and fasteners and electrical connectors, which we showed the suit wasn't designed for it, obviously, but neither was the J2 engine. Von Braun came down and talked to us. I got a nice letter from him that I still have, for helping him, so it was an exciting point in time.

Another exciting point in time in the PR world was a few years ago when Queen Elizabeth was visiting the Johnson Space Center. Aaron Cohen asked me to do a little suit demonstration and explanation to Queen Elizabeth and her entourage and her husband. So I got to meet Queen Elizabeth, one of the few people that she put her hand out and I got to shake her hand. I gave her a nice thing and Mike Foale was the astronaut. Of course, he was British. He was leading the show, but I got to explain the suit to her and her entourage.

It was sort of interesting, just a funny experience, was we had a glove box there where we can evacuate it with a glove inside and you get to feel space without having to put on the whole spacesuit. We had a glove box there and evacuated it, and we offered to the Queen if she would like to feel what space was like, and she said, no, but her husband would like to try it, which he did. She had a bunch of ladies in waiting, I don't know what official function they serve, but there were a lot of younger people in her entourage. They all wanted to try it, so I was standing there showing them how to put their hand in the glove. We had a rule that you couldn't wear jewelry when they put the gloves on. So here they were taking off these big rings with nice stones and say, "Here, hold this for me." I was collecting all this jewelry in my hand, I put it in my pocket. [Laughter] Then, of course, I gave it back. But it was sort of a strange situation. Of course, there was fifty people there watching, and it was interesting to have all these giggly ladies trying on the glove and getting the feel of space. It went real well. That was good. That was sort of unusual. That's when Aaron Cohen was center director. He came back later and told me I did a good job, that he got a lot out of that.

Of course, I gave other briefings over time. I was involved with a lot of schools and science fair judge. That's an important part of a person's job, I think, when they work for NASA, is to get the information out to the public.

RUSNAK: That's one thing we hope this project will help do, too, to get the history of all this out and really help with the public relations aspect of what NASA did and is still doing.

MCBARRON: Any more questions, or any areas we missed? I think there probably are.

RUSNAK: Sure. I guess, I'd like to go back to the beginning of your first experiences with the spacesuit. You'd mentioned that you had worked at Wright-Pat as a subject during the Mercury suit evaluation. So I was wondering how much you remember of that process and the results of that, that type of thing.

MCBARRON: Well, some of the other jobs I did when I was a college student at Wright-Pat was evaluation of different Air Force pilot protective equipment. I can recall being a subject to evaluate the cool-water immersion capability of various prototype Air Force suits, both dry pressure suit—that is, the suit was sealed so water couldn't get inside the suit—versus the wet suit where actually water could get in the suit. I can recall being put in a minus-65-degree F. chamber with a twenty-mile-an-hour wind, and in the chamber was this big tank of frozen water, and just before I was to get in, of course I was instrumented with biomedical instrumentation and wearing a suit, they chopped a hole on this tank so I could get in. Then they dunked me in the tank, and I stayed in this water immersion facility with this cold air blowing on me for about thirty minutes before the medics pulled me out due to various characteristics in the biomed they didn't like, before it was too dangerous. It was dangerous. So I did the cold water immersion test with the pressure suit.

I can remember one time they were having a problem with their partial-pressure suit that certain projects were using, where several crew members had to eject into the airstream from a fighter plane and lost their lives, because the helmet tie-down device failed or didn't work properly. It held the helmet onto the suit. So the Air Force decided that they would test that on a ground situation, so they took and had a big pipe with a seat that they'd sit you in front of, and then they had some big compression gas-blowing system, they'd blow 600-mile-an-hour wind

on you to see if they could understand the characteristics of what was causing this helmet and neck not to work properly. That was another test I was involved in.

NASA and the Air Force were doing some long-term studies on habitability within a spacecraft or an airplane, long-term airplane, and so I wore suits in a simulated cockpit for up to fifty-six hours, fifty-eight hours, strapped in a seat, eating special foods and liquids provided by their nutritionist, and periodically doing a time-motion study with the displays for their anthropomorphic people and vision checks with their optometrist people, just as a guinea pig. Multiple times I did this long-term test sitting in a cockpit.

I even had the experience on one vacation period, I think this was Easter break period, where I was put in an isolation chamber, which was completely black, completely soundproof. There was a refrigerator inside, a cold box, where they had a door on the outside that they could put food into so I could eat. Of course, there was a bathroom inside. But essentially it was soundproof, black, complete isolation, no clock, no time reference. The purpose was, how long could you stay there and what was the sensations and what were your psychological characteristics. That was interesting.

I got nervous. I think I went in on a Monday, and I had a date with this girl that I was interested in on Friday, and I lost complete track of time. They asked me when I came out, "What made you decide to come out?" I said, "Well, I thought it was time to come out, because I had a date." Well, I came out on Thursday. That's a day early, but that was interesting.

I also got to experience zero-G for the first time in 1959 in the Air Force C-131 predecessor to KC-135 aircraft at Wright-Pat, to evaluate suit mobility.

I got to go on the flight line at Area A over at Wright-Pat, where we were doing some cockpit dimension studies and I wore a suit and I got to sit in every airplane the Air Force was

flying at that point in time that was available at Wright-Pat, from bombers to all the different fighters, the fighter bombers, just to do a lot of measurements and criteria of cockpit. That was sort of interesting to sit in the cockpit of a B-52 that they had there, and a B-47, B-111. Not 111, it was TFX. But anyway, F-105, all those airplanes. That was interesting.

I got to ride on the centrifuge for an evaluation of man's characteristics. This was part of the Mercury candidate physiological battery of tests, ride on a centrifuge on a couch and experience 10 Gs. Rode on a centrifuge. Did a lot of the medical tests that the Mercury astronauts were selected to, as far as the Harvard step test, cold water foot immersion test, to set the baseline for—and I wasn't the only one. There was a whole group of people that they built their baseline on this. That was quite interesting.

I also tested X-15 suits. I was one of the test subjects that tested the equipment that Colonel Kittenger used for his jump out of a gondola at 103,000 feet. Before he made that jump, he ran some chamber runs at Wright-Pat, where they test all the equipment at the cold condition that they would be experiencing in that jump, and before he ran in the equipment, I ran in the equipment for Joe Kittenger. That was interesting.

I also did several tests of Air Force arctic equipment in minus-65-degree, twenty-mile-an-hour. That was sort of their standard test, arctic chamber where I simulated a campout in survival equipment and their arctic parkas and all that for a twenty-four-hour period, minus-65. Really cold.

So I did a lot of tests for the Air Force. It gave me a good appreciation for what a crew member could experience and how to deal with it and what the equipment requirements were. It gave me a good appreciation for all that, I think which really helped me in my job working for NASA.

I even got to test some of the suits that were worn by the U-2 pilots. Of course, at the time I didn't know that. I just knew that they were—Air Force has lots of special projects and you just don't ask questions. People come through and they just have numbers for names. We trained a lot of the U-2 pilots there at Wright-Pat for use of their partial-pressure suits. I assume we trained [Francis] Gary Powers. I don't recall him personally, but I assume all of them went through that training there. So that was a good experience, all while I was a student learning geology at the University of Dayton.

Of course, I ended up I liked geology. It was very, very good. I got to use it a little bit in design of the Apollo suit and boots when we were trying to figure out, we didn't know what the lunar surface characteristics were too well and what to expect, so we had a lot of conversation with professional geologists. I could almost communicate with them at times, knowing a little bit of the language. Of course, you're not a geologist until you finish grad school. I mean, an undergraduate degree in geology doesn't hold much water in the geology world.

So it's been a varied career. I mean, everything has sort of fit into a plan, I mean, an unpredictable plan, that's worked out real well. Fortunately, I made always the right decisions in each cross point. I've had a lot of good mentors—Charlie [Charles C.] Lutz, Dick Johnston, Matt Radnofski, Ed Smylie. They were really good to train me in product management.

Eventually I got to go get my MBA through NASA at the University of Houston at Clear Lake. NASA paid part of my way, some courses that you could show had relevance to my job. They were pretty liberal with that. Because this job requires more than just understanding how the equipment works and what's required, but you've got to be able to

manage it through the system of schedules and budgets and reports and resource control. You've got to be quite versatile.

Interesting things and accomplishments that I had that I think are really neat. NASA has a classification of hardware Class I, II, and III, as far as controlled hardware. I created that classification during the Mercury Program when we had control and uncontrolled hardware. I sort of first defined that classification system that NASA now uses this for control and uncontrolled hardware. That was because in Mercury, the NASA astronauts did not want inspectors and quality-control people in the crew quarters area. All they wanted was Joe Schmitt and Al Rochford, and I sort of intruded a little bit as an engineer, which they accepted.

The ground rule, when you went in to work in the crew quarters was, if you've got a job to do, you do it and you leave, and go back to the motel. It's okay to get paid for doing nothing at the motel with a swimming pool, as long as you're doing your real job, and to stay out of the crew quarters when you weren't needed there, which we did.

But they didn't want any quality inspectors, so eventually the question came up, well, who's verifying and saying that this equipment's okay to fly, other than McBarron and Joe Schmitt and Al Rochford? So I developed this classification of control and uncontrolled, and got a quasi-control that we did it ourselves, and eventually we ended up with inspection. Of course, crew headquarters went away for Gemini. We had a trailer and inspection found our way in, because that was their job. They were charged with that responsibility. So we did that.

RUSNAK: Well, before we go on, if we could stop to change the tape.

MCBARRON: Sure.

[Begin Tape 2, Side 1]

RUSNAK: Okay.

MCBARRON: Going back in time when I first started working for NASA, this was when NASA was in a period of hiring a lot of people, and the division was small at the time and they were trying to hire people. I was called in to my division chief's office, Dick Johnston's office, and he wanted to know who he could hire that worked at Wright Field that could contribute to the division in the suit world, because he told me he had just hired Jim Correale from the Navy, who had worked the Navy Mark IV suit for the Navy in Philadelphia.

I said, "Well, you ought to hire Charlie Lutz, if you could." Charlie was my boss at Wright Field.

So he said, "Really? Tell me about Charlie." So I told him about Charlie.

We called Charlie, and Charlie talked about it, and he actually accepted and came to work for NASA. That's how Charlie Lutz got his job at NASA. Charlie was probably my biggest mentor, both having worked together at Wright-Pat, and our experiences together. He's an individual that you should interview also, because in his career he was a chamber operator technician that actually worked on the Bell first—let's see, what was the Bell, Bell X-1 drop. He was a tech that helped the first man drop with the X-1. He was a tech that worked with protective equipment, pilot there. That's Charles Lutz, who's retired from NASA now, but still alive.

His son I hired. His son sort of followed in his dad's footsteps and worked for the Boeing Company in the flight crew equipment processing contract. He was an engineer checking out primarily the life support system. We had a vacancy, and I knew of Glen as he was growing up, so I hired Glen Lutz, Charlie's son. Now Glen is an EVA branch chief at the Johnson Space Center, another interesting relationship that you might want to explore, a father and son. I'm sure there's more than just my son and I and Glen and his dad's relationship. But in the suit world, the two of us that did that.

At the time, Dick Johnston was very smart, he hired the best that the Navy had in Jim Correale and he hired the best that the Air Force had in Charlie Lutz. So NASA at a point in time had the best this country had to offer in terms of experts on pressure suits and life support equipment, breathing equipment. They were the mentors for all the current people and the people like myself who are retired, the Joe McManns, the Larry [E.] Bells, Bill [William J.] Huffstetler. These were all people that they mentored and brought along who have done well. Frank [Francis J.] DeVos. I think Ed [Edward L.] Hayes came from the Navy with Jim, also. But they were the nucleus within the Manned Spacecraft Center, the Johnson Space Center now, of life support and spacesuits for all these people.

I think Jim brought in Matt Radnofski, or Dick brought in Matt Radnofski, who was excellent with materials, which we really needed after the Apollo 1 fire, to change out all the materials in the command module LM and provide the protection on the suit, all the materials that were developed like beta cloth and florel [phonetic], really was a leader within this country for providing nonflammable materials that eventually got incorporated in commercial passenger aircraft and other places, submarines. It's just sort of an unknown benefit that came out of Apollo 1 fire, if you can call that a benefit.

I also had the privilege of working for George [M.] Low indirectly, in that he was the program manager in Apollo, and he was a phenomenal leader. I gave briefings to him on several occasions when he was chairing the Configuration Change Board, where I had to go forward with any changes we were making to the suit. Boy, talk about a individual that could inspire you on one hand and give you hell on the other, and still get you to do your job, George Low was phenomenal.

It was sort of interesting, at that point time his secretary, who handled all the details, really was more like an administrator, was George [W. S.] Abbey. I think that's where George learned a lot of his skill, was from George Low, just from my observation. Because I think George Abbey's done a really great job with the Johnson Space Center. He's probably stepped on a lot of toes, but he's done well. He did the right thing to pull out the Space Station Program when it was on the verge of being terminated, and moving it from Reston [Virginia] to Johnson and changing the management structure so it was focused and under one head from a center perspective.

Other people that I recall working with that were great was Dr. [Robert R.] Gilruth. I can recall going down to the Cape for a flight readiness review for Apollo 16, where we'd had some suit problems with some cable swedge problems that I'd mentioned earlier. I had to give the briefing on the suit to this illustrious group, and here at this table were all the center directors from all the NASA centers and all the Headquarters managers, Rocco Petrone and all his people, General Sam [Samuel C.] Phillips, program director.

I knew they didn't understand how a suit worked, but I also knew I had to convince them, I mean, that we were ready to fly, that we felt safe, and why we were really safe, I mean, really what we'd done to show we were safe. This was to fly and to put a man on the Moon

again, to commit this big process. Here I am last on the agenda, and the guy gets up and talks about the Saturn V, and a guy talks about the command module, and another guy talks the LM, and there's Jim McBarron, this young kid, talked the suit and this is why we were doing all this. It's going to protect a crew member and allow the work to be done.

I can remember after getting done, I think it was Rocco Petrone looked at the group and said, "Anybody have any questions?"

Dr. Gilruth says, "No, I think Jim's done a good job. We're ready to fly." That was the end of the questions. That was neat how he supported me. That was really good. That was good, because I did that several times in FRRs [flight readiness reviews]. The first one was Apollo 7, when I was there just to say, not because we had problems, but just to say what we'd done and how we certified it and why we were ready to fly. But that was quite an experience. Not many people have an opportunity at my level, at that point in time and experience, because I'm probably GS-13 at this point and most all these guys were program managers doing the talking, you know, the big wheels. So the suit has given me the opportunity to approach various levels of management at different times.

The spacesuit, to the public, is the most visible part of the space program. At first you've got the astronaut and then you've got the spacesuit. People can relate to the person and they can relate to clothing. They can't relate to some kind of a digital thruster or some controller or some something that they can't relate to from their own life. But the crewmen and the suit, second, I think fascinate people. They find a hard time, why does it cost so much? Why is it so big? Why is it so bulky? If they only knew all the details of what it's expected to do. And that's the message we try to get across to people.

I can remember in Apollo, a spacesuit cost $100,000. I don't know where that number came from, because I don't know what a suit cost on Apollo, because we never bought them. They're not a commodity we bought off the shelf, you know. And there's different ways to amortize costs, whether or not you include development, whether you include all tests, whether you include all the mission support people. I mean, you could have a suit costing about six different ways if you wanted. We intentionally never gave out a number, because it wouldn't mean anything. But an $100,000 suit, compared today, I guess, with what they call the 10-million-dollar EMU. It all depends. You can't buy them. There's no demand and the production is a very small quantity. So that's why they're expensive. NASA requires all this quality.

Back in Apollo we had to—I mean, we knew in Apollo, we knew like for the neck ring or wrist disconnect, we knew where the mine was that the ore was mined from to make the metal, and then the treatments of heat treating and then machining. I mean, we could trace it all the way back to the mine, if you wanted to, as far as the traceability. Of course, that cost money. There were a lot of people involved processing paper.

We had to control the grain, how you machine it with respect to the grain of the metal, I mean to get the strength that was required, and to minimize the weight. We tried to minimize the weight of the suit, because every pound that we had in a suit meant 900 pounds of fuel or something. I mean, just the relationship. Weight was so significant.

In fact, we threw out, on the Moon, after the last EVA on the Moon, we left the life support system and the extravehicular visor assembly and the lunar boots, extravehicular gloves, and all the garbage the crew members collected while they were in the LM. Anything that wasn't required, they just opened the door and pitched it all out. Every landing site, we got a

little garbage dump of all this expensive space equipment that some day will be a gold mine for memorabilia collectors if they ever get back to them. [Laughter] It'll be interesting to see just how those materials held up under that environment for that long a period of time. There's some scientific value, technical value to that effect.

Apollo was probably the best program that I ever worked on, I mean where I felt I contributed the most.

RUSNAK: When you were mentioning following the materials back to the source and such, reminded me of, I think there was a problem in Apollo with some of the rubber that had like a high copper content or whatever, that was causing premature degradation.

MCBARRON: That was Apollo 14. I didn't mention that. About three weeks prior to Apollo 14's flying, a crew member down at the Cape was in his training suit and the boot bladder ruptured, lost suit pressure during a test. We come in the examination of the boot bladder, we found that the material of the boot bladder was reverting back to its natural state, and the boot bladder, as well as all the convolutes and the bladders and gloves of the suit, were made to a proprietary ILC compound that included natural rubber.

Once we found that boot bladder reversion was related to age, we found it was related to age, and we started looking. We found other boot bladders with the same problem and we found convolutes with the problem, the various stages. We couldn't figure out what was causing that. Of course, we were getting ready to fly. So once we determined that it was related to age, we said, "We've got to replace all the rubber, this suspect rubber manufactured components in the suits."

So we had to send the suits back to ILC to replace all the convolutes and all the boot bladders and all the glove bladders for nine suits, six for the prime crew, because every crew member had two suits, and three for the backup crew. Each crew member had one suit.

In parallel to the investigation to try and determine a cause, that was a very hectic period, because every day I had to give a report to the program manager, Jim [James A.] McDivitt—I think it was McDivitt at that point in time—of where we stood. They put a [Lockheed] Jetstar [aircraft] at my disposal, gave me a phone number, and a guy named Horace Bell set it up, who was the transportation officer at Johnson.

There were some rules. I couldn't send a crew member's flight suit with his backup suit at the same time, and they didn't want me to send the backup crew's suits with the prime crew's suits. So I had a real logistics game that I worked out to get the suits shipped from Kennedy back to ILC, get all the rubber replaced, ship them back to Houston, minimize the number of flights of this Jetstar that was out of Miami. But I had that airplane at my disposal for about two weeks. And we did it. Of course, the mission was successful.

Later on we determined—I mean, we called in experts from around the world, from the British, who were the rubber experts from their work in India, in Burma, and was told this characteristic of natural rubber reverting back to the natural gum state the way it comes out of a tree, that's just something to be expected over time with age, but something that expedites that process was a reaction to chlorine gas.

We said, where does chlorine gas come from? Well, we did a lot of materials examinations. We hired a Rice University [Houston, Texas] professor and some other people, did a lot of testing to find out that copper in the natural gum material, this is natural rubber, plus copper that was introduced from the plumbing in the dip tanks that were used to make the

convolutes in the plumbing, copper plumbing, copper reacted with the neoprene that was another ingredient in the rubber, the chloroprene, and then the chloroprene was chlorine, but it was locked up in the base. But somehow this copper reacted with the chlorine and created chlorine gas, and that gas is what was back in contact with [unclear], was causing the reversion of the rubber.

So what we did, we had to take all those dip tanks and take all the plumbing and change them off to stainless, so there was no copper in the process. Then for what was residual copper we put in what's called an antioxidant that prevented the start of the process in the first place. [unclear] was the chemical.

So all the Apollo 16 and subsequent have this different material when all suits were rebuilt. That was an interesting thing, to be able to change out the suits that quick. I mean, it took like two weeks. I mean, today people take six months to get a pair of gloves from here to the field. But we had 600 people working for ILC at the time. It's a bigger base than the little few people we have back in production now.

That was interesting on Apollo 14. That was another one I went down to FR, to explain all that stuff on.

RUSNAK: One of the things I find interesting, given something you said before about there being essentially no demand for spacesuits, and the supply obviously is limited, as well, is that for Mercury, Gemini, and Apollo, you had three different contractors. So I'm wondering why is it you think we ended up with this situation and how the technology was shared—or wasn't—between the three contractors.

MCBARRON: Okay. Well, my understanding before I started working in this field back in the fifties, there were other contractors involved. Well, you go back to B.F. Goodrich. B.F. Goodrich actually built the spacesuit, or pressure suit, that Wiley Post flew in the *Winnie Mae*. The engineer who worked with Wiley Post was a friend of Wiley Post, was a guy named Russ Colley, and he worked for B.F. Goodrich. Russ actually made the first pressure suits. His wife made them at home on her sewing machine. Russ Colley worked for B.F. Goodrich, was our chief suit person back—I got to meet Russ, I knew Russ just briefly in the Mercury Program, because at that point in time he had retired and was just a consultant. But he was a marvelous individual in terms of he was the first one to create—did a lot of inventions for B.F. Goodrich, like a pneumatic inflatable de-icer on the leading edge of airplanes. He helped build the—they built the suits. People don't realize that originally that Jimmy Doolittle's raid over Japan was going to be high-altitude and they were going to wear suits, and he built special suits for that. I know all this because I did research to write up an award from NASA to Russ for all his contributions to America's programs. I had the privilege of doing that, working with the Smithsonian, because they had a lot of the details of Russ Colley

But anyway, there was B.F. Goodrich, and Russ and their association with Wiley Post. They got involved with the Navy in a series of suits, the Mark I, Mark II, Mark III, and then the Mark IV, which became the standard Air Force-issue high-altitude-flying protection suit for jet aircraft, for high-altitude jet aircraft. And they worked with the Navy for years. That ended up being the Mercury suit.

David Clark Company had a hand. Mr. Clark, David Clark, Sr., was interested in the biomedical aspects of flight, and worked with the people at Wright-Pat. He knew Dr. Henry, who was one of the original Air Force principal investigators of high-altitude protection. He's a

physiologist. So David Clark, whose primary business at that point in time was making brassieres, got involved with Henry and Colonel John Stapp from Wright-Pat, and they—this is my recollection, okay? It may not be completely accurate, because it was before my time. But they got together and he built the first suits for the Air Force. So Clark established an Air Force relationship with the people. It's all people relationships to make things work.

So eventually they made the partial-pressure suits originally, the David Clark Company, whereas the Navy had all these full-pressure suits. The first Air Force full-pressure suit use was with the X-15, the MC2 suit. The Air Force established this relationship and they developed the AP22 S-2 and all the things that were equivalent of the Mark IV for the Air Force fighter planes.

At that point in time, I think the strategy of our Defense Department was to have competition and multiple vendors for similar things just as a smart way of doing business for the country. So we had two competitors, Clark and B.F. Goodrich. Then ILC got involved just through the work of George Durney and his interest. I'm not sure how he got started. Unfortunately, he's passed away a couple of years ago. I knew him quite well. They made a suit for competition in the late fifties for the Mercury Program that was not accepted. They never really got involved with Gemini. Of course, they got involved with Apollo and were successful finally, and then the Shuttle.

But Clark and ILC have been longstanding competitors for this period of time. B.F. Goodrich dropped out when NASA selected the Apollo suit to be an ILC suit. It was sort of a corporate decision, I believe, and several of the B.F. Goodrich people came to work for ILC at that point in time. Tom Waldenmuth [phonetic] was one that created a little bit of a legal problem for ILC, I think at the time, as far as transfer of Goodrich trade secrets. There was a

legal judicial activity that took place that I don't know all the details on. Then Goodrich dropped out. That's when ILC was selected to build the Apollo suit.

Then the competition for the Shuttle suit, they weren't even involved. So they no longer have—all their suit people are gone. I mean, I knew Wayne Galloway [phonetic] and Chuck Landers [phonetic]. All those people are either retired or dead. The younger people, I even tried to come work for NASA, and they went off on other fields, so they don't have a capability any longer, whereas Clark still makes pressure suits for the military and for special projects. Most of the aircraft today do not use pressure suits, but there are some special project suits for some reconnaissance aircraft that Clark still makes suits for. They also make the Shuttle Launch [and] Entry Suit [LES].

One thing people got interested in about suits, there's two types of suits. An individual suit, which is only for contingency use, and the biggest driver from a crew member's perspective is comfort. They normally don't pressurize in it, but they've got to wear it for a long period of time. Usually it's in a cockpit, and you're either on a landing strip for a long period of time or you're in a spacecraft for the launch to get to where you have the opportunity to take it off. So you want comfort, as opposed to an extravehicular suit where you normally wear it for a short period of time and you need mobility and tactility to do a task. Comfort becomes secondary. Still important, because pressure points, what have you, drive you crazy, but it's secondary.

So there's two paths now. The Clark suit technology, the way they build suits with link net and their fabrication techniques, lend themselves to the IV-type [intravehicular] of suit, where it's more comfortable than the ILC EVA suit, which relies on bearings and disconnects and convolutes with axial restraints that provides the mobility. So the Clark suit's not very

mobile. The ILC suit is very mobile. Clark suit is most comfortable. The ILC suit is less comfortable.

So you have these two competitors, and right now they're in the right niche. I mean, Clark makes the IV suit, the launch and entry suit, and that's the best technology for that application. ILC does the spacesuit, and they have the technology that Clark doesn't have for the EVA suit.

My company now today would like to do the suits some day as a business venture, but in terms of technology, I still think, and I tell my people that Clark has the correct concept. It's driven by what their technology is and not by the company. I mean, technology's there because of the company. I was in charge of the launch and entry suit for NASA during my tenure, and it's a good suit for its application, but pressurized, you can't do any work. It can get you down to a safe altitude where you can then bail out of the Orbiter unpressurized. So sitting in a seat, you don't have to do anything but operate some controls and look out, it's fine. It has other requirements added to it. It's got to have an integrated parachute harness, because if they jump out, you've got to have a parachute. You've got to have life vests. You've got to have a survival kit with a life raft and all your survival equipment, beacons and radios and food and water.

I didn't mention to you, but during Mercury I was in charge of the Mercury survival kit as well as the pressure suit. That was provided by our division also.

One of the neat opportunities I had was after [M.] Scott Carpenter's landing, and use of the survival equipment that I was responsible for, I got to fly in a C-130 from Patrick Air Force Base to Grand Turk Island in the Bahamas right after his flight, for his post-flight debriefing by all the chiefs. Dr. Gilruth and Paul [E.] Purser and Owen Morris and Kenny [Kenneth S.]

Kleinknecht. That was an interesting trip. I got sent there just to participate in the debriefing part for the survival kit at Grand Turk Island.

We landed at Grand Turk Island, which is out in the middle of nowhere. This was a military C-130. We sat in sling net seats, inside with earplugs. Nobody could talk. I mean, they tried to talk, all these chiefs. Took us about two hours to fly there, I think, in that airplane. We landed and we open up the doors of the plane, and there are all these big British military people with their white pith helmets and a red carpet for us to come out on. [Laughter] Of course, I came out last.

Then they took us off and they put us in beach huts. We were right on the beach and screened in. It wasn't a hut. It was just a screened-in enclosure on a wooden platform about two feet above the sand with a screen door and that was it. Of course we had lights and cots. That's where we stayed for three days, I think, just getting the debriefing. When we got there, Scott wasn't there. He was out snorkeling with some of his other astronaut friends. [Laughter]

We had a debriefing that afternoon where he went through, and I finally got to ask some questions about his use of all the equipment. In fact, he didn't have any problems, and it worked the way it's supposed to work, which was good. So I could write a report that I had to write.

Then I had to wait for the plane to leave and go back Patrick with all the chiefs when they finished their stuff with him. So that was interesting. They had luaus each night. It was an interesting occasion to participate in. That was another highlight-type activity.

RUSNAK: It's an interesting mission to have ended up on the debrief for, given how his flight ended and the fact that he was quite a bit off target and such.

MCBARRON: Right. I listened through all that.

Another interesting opportunity I had was, after John Glenn's flight, I had a special badge that got me into Mercury Control Center. So at the end of his flight, of course, his flight was very short, I went from—I didn't go up the gantry on John Glenn's flight. I was in the suit room. I was there when we suited him up and went in the backup bus over to the launch pad, because I was sort of like a contingency person. I didn't go up the gantry with John, but I stayed there and we went to the fall-back area.

After that we went to mission control to watch the mission. I got to watch that whole heat-shield thing standing there in the back row, watching Chris [Christopher C.] Kraft and his team work that. That was marvelous, you now, but everybody thought that heat shield had deployed prematurely. That was an interesting, fascinating thing.

I got to work on a Skylab emergency activity, where our division was responsible for trying to find a way to build a thermal protective shield to put on the outside of the orbital workshop to cool it down on the inside, because the temperature provided an atmosphere that wasn't habitable inside.

My job was more of a logistics job for that activity, by nature of having the ILC as my contractor and ILC's capability. I got asked to set up a sewing shop at Marshall, so they could build their concept of a solar shield, and to provide the materials that were necessary to build these competing solar shields. At JSC they were working on a parasol, under my boss, Jim Correale, and Marshall was working on a different shield approach with big booms. So I had the job of having a NASA Gulfstream fly to ILC and picked up sewing machines and sewers. We took them to Huntsville to set up a sewing shop to build their sail. That was on a Friday, I think, and Friday night we found out we needed some more material, this aluminized mylar.

Wasn't any to be had, so I participated in a phone call that my boss Harley [L.] Stutesman [Jr.] and I made to Sheldow [phonetic] in Minnesota. This was Friday night about seven o'clock, and we called and talked to the plant manager, and said we needed 500 yards of aluminized mylar as fast as we can, it was for this national emergency.

He opened his plant up that night and brought in all his people, and we had the NASA Gulfstream there at seven in the morning and picked up that material, no purchase request, nothing, and took it to Huntsville and to Johnson so they could build the flight hardware. Eventually it was the parasol. That was National Metallized. I mean, that was the kind of support, patriotic support this country provided to Apollo and Skylab that I don't think exists today. I mean, I don't see it today. Fortunately, we haven't needed it.

But we used to have to ship suits from one place to another, because we had a test here and tomorrow we had a test somewhere else. They wouldn't take them in at the counter. At one time the suits were considered classified, as far as security. You had to watch them being loaded on a plane. A lot of times we just packed them, take them on board when the pilots and the people pick them up at the other end. I mean, it was pretty neat. I mean, we had the support we got from the airlines and aviation in general. It was neat. We got a lot of good support.

RUSNAK: Did you participate in anything concerning the suit classification, the security classifications, any kind of meetings or anything?

MCBARRON: Well, at the start of Apollo, the Apollo suit was classified, and so was the Gemini suit. It was classified confidential. It was a hassle. We understood why, but it was a hassle in doing business, because certain drawings and certain documents were classified, which meant to

take them anywhere you had to have them specially wrapped, and you had to have authority, authorization signed and stamped. It made doing business harder. I mean, we understood why. Eventually it was dropped. Then we had to go through and declassify every piece that we had classified, with a note of who authorized it and what the authorization was, and the date, and you signed it. I mean, every page. But that was in the national interest. You did it. You didn't question it. It just was a hassle.

RUSNAK: On a related note, how much did you know about the Soviet technology?

MCBARRON: That was one of my hobbies, actually. That started when I was at Wright Field, in fact, was a collection of Soviet pressure suits and spacesuit data. I probably collected the most comprehensive set of Soviet pressure suit and life support data up to the point where they became partners on International Space Station to about '93, four file drawers that went on back to 1943. Eventually I got it all catalogued, and it was available to the people that have an interest in it. Big collection.

I did follow and I used to routinely—not routinely, but infrequently I would give a briefing to the center management on what the Russians were doing, and what their system—mostly it was descriptive-type briefing, "Here's what it is, what it looks like, and here's what we think it can do." I even gave a couple briefings at a couple conferences on what I'd learned, and tried to compare and contrast with what we had versus what they had.

Finally in 1993, I got to go to Russia, in fact. But before I went to Russia, I did get to meet my counterparts who worked for Zvezda right outside of Moscow. The first meeting was sort of interesting. It was at Houston, but we weren't allowed to meet them on the Johnson

Space Center, for some reason. Then the meeting came about through crewmen contacts. The first meeting that I had with Guy Severon [phonetic], who was the chief of Zvezda, general director, was responsible for all the Soviet suits, both military and space. They didn't treat them any different; I mean, they were the same. Was at a crew member's house on NASA Bay, where I was invited over and he was invited over and we talked through an interpreter. It was pretty interesting that the first contacts, so to speak, where we shared how we developed the suits and how similar the designs ended being in terms of the concept. Both used full-pressure suits, both found zippers weren't good to use, both found polycarbonate was a good material for the helmet, and a lot of similarities. I mean, the actual shapes looked different.

Our technology is much more advanced than theirs, in my opinion, now. I mean, our Shuttle suit is much more advanced than their Orlon-M that they fly, and they're going to fly International Space Station. They still use a lot of glued seams. We use heat-sealed seams. They use a lot of cables and swedges that we don't. Their materials availability constrains them what they can do, compared to what we have available. In fact, they use as much of ours as they can get a hold of. Like polycarbonate, it was originally a U.S.-developed product.

But that was an interesting meeting. It was first time I met them. Then later on I met them at a conference in Cologne, Germany, that I went to. We hit it off well there. In fact, we were asked by NASA Headquarters and the Russian equivalent of NASA Headquarters to write a joint chapter for a book that NASA and the Russians wrote.

So Guy Severon, and he has his deputy Dr. Abrahamov [phonetic], and Ed Whitsett on the MMU [manned maneuvering unit], and their counterpart on their MMU unit, wrote a chapter for the book *Foundations of Biology and Space* or something like that. So over a three-year period I really got to know them pretty well, due to our joint authoring of this chapter for

this book, which we did, and it's been published. It gives the whole history of U.S. EVA and Russia EVA. It's all Russia now, it was Soviet. A chronological of all the EVAs and everything's in it. So that was good.

Finally in '93, I got to go over to Moscow and meet with them. I didn't get out to their facility, because that's right when they were having the problem politically at their White House, where it was being bombed by the tanks, a mini-revolution, so to speak. We were isolated and stayed at the hotel. I never got out to Zvezda. Never have in fact, yet. It's on my to-do list yet some day.

But it's interesting to see how they've come over the years, I mean the parallels and the dissimilarities, mostly due to what's available to them. They're pretty smart people. They do a lot more analytical things than we do, I mean approve things analytically. They have a better connection with their university system than we have, where actually the universities do a lot of their work for them, whereas we hire another subcontractor, and the universities do more technology work rather than mainline program work, where there, there's no distinction.

Severon is a full professor at Moscow Aviation University. I mean, they're working like I would a professor at a college and I would teach. Part of their job is teaching students. They take the problems from the workplace, can translate them to a graduate student to earn his credentials working a real-life problem. I mean, their system is better than ours, from that viewpoint, from my opinion. It's pretty neat.

They can be good adversary, a hard adversary, and they could probably be a good friend once you get to know them and respect them. There, rapport is big. I mean, you just can't go start working with somebody overnight. I mean, you develop it and there's a trust period. You start with little things and you build up. That's inbred in them. Even internally, within their own

company, when somebody does something, he keeps his little notebook, and there's no copying of how he arrived at what he's done. I mean, there's a product, but he keeps his little notebook. I mean, that's their security, personal security for employment. And it's also a way they keep their security from being copied by other nations. I mean, it's internal, even. I mean, people don't realize that it's not an international thing, but it's inbred internally. So it's an interesting observation.

RUSNAK: As someone who's worked with every U.S. spacesuit that we've had, what do you think the key problems have been over the past forty years of development?

MCBARRON: Key problem. Technical problem, I assume is what you mean, not the fact that we've never had the right amount of money to do the correct job. [Laughter] Technical problem. Sizing the suit to fit the crew member, a wide range of people, like we do for Shuttle, has been a problem. It intermeshes somewhat with money, in that originally we started out with five sizes, for example, the hard upper torso on Shuttle EMU.

[Begin Tape 2, Side 2]

MCBARRON: Then due to cost considerations, we tried to reduce the cost by reducing the fleet up to two sizes. Then the crew said, "No, that's not acceptable." We had to expand it to increase it to more, which we did to four. Now we're looking at another extra small going to the fifth again. So there's been a vacillation of what the requirement is and how do you

accommodate it and still meet the budget. I mean, they're all tied together. So, sizing and its implications is one.

The big technical challenge is gloves, of course, to be able to put something over your hands and still let your hand do what it normally does without something over it. We've made some big improvements over the years from Mercury to what we're flying on the Phase 6 Shuttle suit now. Big improvements. Not only is it improvements of tactility and flexure and doing a task, but the useful life has increased. Like on Mercury, we started with a ninety-minute flight and now we're certifying the gloves for almost four hundred hours of operation. So it's a combination of performance and useful life have been the big drivers. Of course, the more useful life, the less you have to buy, which gets back to money again. So, gloves is a big technical challenge.

One thing we learned in Apollo is that we did not factor in properly the man loads that a crew person can induce into the suit just by movement or doing a job, the forces that he puts into the suit system that have to be counteracted by the suit. Originally we just designed to the pressure load, plug load, but the use of man loads significantly increase the requirement of strength of certain parts of the suit, especially were the waist and the brief and the hips. That wasn't properly factored into the Apollo suit until the later last two missions, where we had to put in redundant restraints, because we were concerned about the cables breaking, because they weren't designed for the loads that we were seeing, which we did. Then we incorporated them into the Shuttle suit, have already done axial restraints for strength and they work very well. So how do you factor loads imposed by the crew member, as well as the pressure load on the suit.

Optics for the helmet. The helmet we fly today, which is basically the same as we flew on Apollo, the helmet does not meet the goggle distortion particle-free spec of glasses or military goggles. It's due to the technology capability of making them.

The current suit has a problem that—the big disagreement I had with Mr. Correale when he reassigned me out of the suit program was a problem that still exists today in the Shuttle suit, is that we don't have a way to adjust the neck height for the crew member. Some crew member, you'll see that there's about four to five inches from the top of their head to the top of the helmet, and they're way down low, and they can't hardly see over the top edge of the neck ring because of its inherent concept limitation, which we saw it in the Apollo suit. We had an adjustable neck height. But Shuttle suit doesn't have it. So some people it fits fine, but people with short necks there's no—so that's a problem, neck height adjustment. Some of the people even here today in ILC don't understand that, or if they do, they don't want to recognize it. They don't do anything about it.

I think those are the big ones. Those are the big ones.

RUSNAK: When you're talking about the crew-induced loads on these, that got me to thinking about the roles of the various astronauts in contributing to suit design. I know like Wally Schirra worked on early suits. You mentioned Gus Grissom. John Young later became interested. I was wondering what contribution you feel that the crew members made directly.

MCBARRON: Okay. One of the ways the NASA Astronaut Office does business is that they have assigned a specific crew member to follow a certain part on the vehicle for two reasons. One, is to get the crew member smart enough that he can talk to other crew members and tell

them what's going on in that area. Two, is to contribute to the actual product that he's working on.

Like I say, Wally Schirra followed the Mercury suit. Gus Grissom, I traveled many times with Gus to David Clark working on the Gemini suit. Of course, we have a Gemini suit from Clark because of Gus. Had some good trips with Gus to David Clark.

Then we had George Nelson, "Pinky" Nelson, followed the early part of Shuttle. In Apollo we had Story Musgrave. Was it Story? John Young for a while, Story. Story followed it. When you say contributor, you mean they were more evaluators than contributors, and they were good. I mean, they fulfilled a real need. I advocate that system.

We found to use it, it was good to use it that way. If we could convince the crew member that was responsible for an area that this was the way it was, then he'll sell it to the rest of the crew members, because they all had their own ideas. I mean, you probably heard that story that it's hard to satisfy a group. You can satisfy individuals, but not the whole group. So they could help you sell it to the group.

Pinky Nelson, Story Musgrave, John Young, of course. John and I go way back to Gemini when he flew. But they were always evaluators, and at times we used to get John Young letters, which we hated, because he stated things in such an accurate and—I mean, he was accurate in what he said, and sometimes we didn't like to hear the truth. So that was good. But they contributed by virtue of their comments on how well things were and when things weren't so well. John Young was good at that and still is today, I think. That's why he is where is there on the director's staff, because he doesn't mind stepping on people's feet and necks and heads. [Laughter] Sometimes you've got to ask somebody to do that.

RUSNAK: Now you've got me curious about your comments that you ended up with a David Clark suit for Gemini because of Grissom. I wonder if there's anything else you wanted to say about that.

MCBARRON: Well, that was because of the evaluation and the mockup at McDonnell-Douglas where he evaluated the MA-10 suit concept versus the David Clark suit, and he found the David Clark better, you know, technically. Then he was put in charge of following the Gemini suit for a period of time. and he and I traveled to Clark for design reviews and fit checks quite a few times.

RUSNAK: Speaking of suit selection, Dick Johnston was recalling, in an interview with us, about the Mercury suit and that when it was evaluated at Wright-Pat that there were some issues there that they actually preferred the Air Force version of the suit rather than the Navy, so NASA had them go back and reevaluate them, because they actually felt that the Mark IV suit was better. So I was wondering if you remembered any of these events.

MCBARRON: Well, I'm biased there, because I was working for the Air Force. [Laughter] That is correct, that the Air Force did find in their evaluations that the David Clark suit was better than the B.F. Goodrich Mark IV suit. Then I lost track from that evaluation at Wright Field until the time I started working for NASA.

There was a period of time that I don't know what happened. I think a NASA guy was working for Dick with Lee [N.] McMillion at the time. I don't now what happened to Lee. But NASA had some additional test runs at ACEL by the Navy on heat stress, I think heat stress test.

At that time in the program, the Mercury capsule was thought that during reentry the inside of the capsule was going to get pretty warm, and they needed a suit that provided adequate cooling to the crew member, to keep them from getting overheated.

I think those tests run by the Navy this time—and I think they did them at Johnsville [Pennsylvania], maybe I could be wrong—showed that the Goodrich suit was better, the Mark IV suit was better for heat stress than the Air Force suit. And that was sort of what swung it. Also I think there was maybe some political things where the Navy offered to NASA to buy the first batch of suits under Navy contract, which was done before NASA had the process set up to buy them themselves. So I think there was some other than technical factors that played, and only Dick probably knows that today, who's still alive, because I wasn't party to that. But that's something to explore with Dick, if you ever get a chance to talk to him again. I would like to know that myself.

But you're right, the Air Force did fight for it. The tests they ran—and I was one of the guys recording the data—the Air Force data did show the Clark suit was better, but I don't think that was a complete battery of tests, that there were added tests run that were more significant run by the Navy. So I don't think it was—you know, the Air Force is going to recommend the Air Force, the Navy's going to recommend the Navy. I think that may have been a subservient part of that, but not the primary, not the basic reason for the difference.

I helped prepare the report that the Air Force did for the Navy. I was just a clerk at this point, okay, not doing any of the writing, but just consolidate it and putting all the pages together and putting them in binders, so to speak. I never observed any bias in the way they did the tests or recorded the data or anything. So I don't know. Dick's the one to answer that question.

RUSNAK: Looking back on your career as a whole, what do you think your most significant accomplishment was?

MCBARRON: My most significant accomplishment. That's a good question. I thought about that over the weekend. I think bringing together the NASA participants and the contractor participants in an open and free exchange, and respecting others' opinions, and forcing the establishment of the best for our crew member, keeping the crew member in mind, having warm suits and used them, keeping the purpose for why we do things just for the crew member. That's sort of a generalistic thing, but that's probably across the board for all programs would be being able to understand a crew member's perspective and bringing together the team to satisfy that need. I mean, that was sort of—there's no individual thing. I didn't invent any specific thing, okay? I think it was more of a collection of roles, technical, administrative person, people-handling, cut out the BS and get down to brass tacks. You've got to meet schedule, you've got to make a decision, can't be right, but you've got to make one.

Well, a lot people that worked for me just had a hard time making decisions because it wasn't perfect. If the time comes, you're better off making a decision. If it's not right, fix it later with another decision and wait. So you're marrying all these factors together, meet the schedule, meet the budget, meet the need.

That's part of the problem with the original Hamilton/ILC thing, is Hamilton was too much engineering. Space is still, there's a lot of art in spacesuits. There's no textbooks on how to design a spacesuit. A lot of art still. I mean, there's less art today then there was when I started back in Mercury. But back then there was a lot of art, and I think when Hamilton came

in and tried to impose on the ILC all these rigid engineering drawings and analytical disciplines on something that you can only do it by trial and error in terms of design, that just didn't work, and they never could communicate. That was a problem. They couldn't communicate. When you can't communicate, you can't have a product. I mean, it just doesn't work.

So it's still part of the suit, trial and error, make one, try it, test it, evaluate it with different people. It's not to a fixed set of standards that you would find in a textbook. It's become a lot less so over the years, but there's still a good deal of art in a spacesuit compared to a life support system, which is pretty much an engineering piece of machinery.

RUSNAK: We're almost out of time, but I want to give you a chance to make any final remarks, if there was anything else you felt you wanted to say.

MCBARRON: The obvious question is, where do we go from here to the future on spacesuits? I've heard comments from some crew members that, well, all we need is a pill to take that provides us protection, to other contractors who have never made a successful suit, have tried with trying to duplicate the properties of the skin for an outer layer of the suit, to people who have thought of making the suit more of a part of a vehicle, make it power-on air lock, where you carry this big bulky heavy thing that theoretically on the surface of the Moon or Mars wouldn't weigh that much, although you have mass, and then the relationship of kinetic energy with movement.

I think that the technology suits depend upon the materials, technology advancements. The suit contractor can't afford to develop suit materials; they only apply what comes out of the other fields of technology. So I think as materials get developed over time, suits will follow and

become better. I think that's the main gate or limitation of suits today, is the materials that are available to provide strength and the elasticity and the leakproof tightness and puncturability for the future. So I don't really talk about hard suit or soft suit or configuration. I think it's more materials-driven than anything.

Of course, you always want the suit to be as low a pressure as you can. People have talked about an APSI suit, so you don't have to pre-breathe to go on EVA. I say, well, reduce the cabin pressure like we've done in the past, and you don't have to pre-breathe, so you can operate the suit at a pressure where the technology lets the guy do more comfortably. So you want the lowest pressure in the suit, which is about 3.75 psi. Of course, in Shuttle it's evolved up to 4.3 psi, due to the design of the life support system and the settings of the valves and the regulators, and really don't need to be that high, but it ended up there.

So lowest pressure, probably going to be stuck with using 100 percent oxygen due to that low pressure in the suit. So you've got to pay attention to ignition sources in the suit, make sure you don't have any energy source that can create an ignition point in the suit, because that would be catastrophic. That's my one big fear with the next generation of engineers coming on board, is they don't understand how dangerous this thing can be if it's not properly used, both from an ignition point of view, primarily, where they're talking about putting batteries or power inside a suit. Boy, that scares me. So from a safety viewpoint, you've got to be careful.

I think the construction details that exist for current materials, as far as the seams and the fasteners and the attachments, that's what used in the shuttle EMU, for today's technology is probably the optimum.

Sizing-wise is still a problem, not being able to adjust the head height properly. There's nothing in the mill to fix that over the term that I can see. It's too expensive to change it at this point.

The other concern I have is, they're trying to do too much and make it last too long before they replace it with another one. We're about to reach the end of the technology limit, I think, right now. So that's where I think we're headed.

Hopefully we'll keep a David Clark around, and keep an ILC around, and maybe we can get some other—I mean, I'm speaking from a NASA viewpoint now, not an ILC viewpoint. But hopefully there's competition, because I think that fosters better work from all parties. I came to work for ILC because I think they have the best technology and the best people right now.

RUSNAK: I'd like to thank you again for taking the time out to speak with us today.

MCBARRON: Very good. Looking forward to seeing the product of this. We sort of jumbled up the time span. Maybe we can fix that, I don't know.

RUSNAK: We'll see what we can do.

[End of interview]