NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY TRANSCRIPT

ARNOLD D. ALDRICH
INTERVIEWED BY KEVIN M. RUSNAK
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RUSNAK: Today is June 24, 2000. This interview with Arnold Aldrich is being conducted in the offices of the Signal Corporation in Houston, Texas, for the Johnson Space Center Oral History Project. The interviewer is Kevin Rusnak, assisted by Rebecca Wright and Sandra Johnson.

I'd like to thank you for taking time out to meet with us today. If we could, tell us something about your background, the interests you may have had in engineering or aviation, these things that led you up into college and then into the space program.

ALDRICH: Thank you for inviting me here. I'm pleased to talk about the space program, particularly the manned space program, which I spent my NASA career working on and involved with.

In terms of background, I had quite a long and serious interest in aircraft during World War II. I was pretty young, but not so young I didn't know what was going on. Airplanes particularly interested me and interested me to the point of building models. It was a principal focus of mine in the early years.

Then as the years progressed toward college, also lots of mechanical things seemed of interest, working on things, taking them apart, fixing them. So I was pretty keyed on the kind of things that lead to engineering just as a natural intuition from the start, and it never seemed like there'd be much doubt that engineering would be the kind of profession I would want to go to college and go into.

But you had to focus that a little bit. Going through the latter years of high school, I was thinking about engineering and what you'd specialize in. At that time, electricity and electronics were becoming bigger, kind of the way information systems are today, and I got quite interested in electronics and electrical engineering. So I decided to go to school and study electrical engineering, which is a little bit, you might think, different from airplanes, but that led to a focus when I was about to graduate from school, what would you like to go do? I decided I wanted to combine those.

So I really interviewed for a career in aircraft flight test when I was graduating from Northeastern University in Boston, and interviewed with a number of aerospace companies. IBM and GE [General Electric] were not, but Grumman [Aircraft Engineering Corp.] and Curtiss-Wright were.

Also, just by accident one day at school, a group from NASA Langley [Research Center, Hampton, Virginia] came to Northeastern to interview. I didn't even know the interview was going to be held, but I went up and talked to them. After I got done, really the fall at Northeastern, where there were quite a few of these companies coming to school to interview students and potential employees for them, looking at all of it together, I decided that NASA was what I wanted to go do, and so I did. I graduated from Northeastern in 1959, in electrical engineering, and I went to Langley Field in Virginia to work for NASA Langley Research Center.

RUSNAK: Did you join NASA with the intention of going into Project Mercury, since this was right around the time where the space program was really starting to gear up?

ALDRICH: I didn't know too much about the space program. I knew some about it because there'd been some dramatic events. But NASA was only like nine months old. It was formed in, I think, October of 1958, NASA started. So this is just the next spring.

So when I got to Langley, I was confronted on the first day with the exact question that you're talking about, and that is, they had two options. There were about seven people of us all who were reporting that day. They said you could go to work on the aircraft side at the Langley Research Center or you could go to work on Project Mercury, this new program for manned space flight that's over on the other side of the field. It's really on the Air Force side of Langley Field, in the Space Task Group. It was pretty clear, thinking about that, that I wanted to go work in the Space Task Group.

But I also had family in the area, and we'd moved then from Boston down to Newport News. I had an aunt and uncle that worked there. He was vice president at Newport News Shipyard for a number of years. Their son-in-law was Bob [Robert] Champine, who was a test pilot at Langley. During that week when we were deciding which way to go, I went over and we had dinner with the Champines. I talked to Bob about it, and he pretty much talked about this new opening, great opportunity, too. So I think I would have chosen it no matter what, but Bob's advice was, you might have to go see what that's going to be. So that's what I chose to do.

RUSNAK: Had Sputnik and then America's attempts to launch a satellite had any impact on you during college?

ALDRICH: Well, Sputnik was a big impact on everybody. The day the Russians launched Sputnik, or I guess by then it was the next day in Russia, I was at a fraternity party at Tufts

University in Boston with a real good friend of mine, Pete Lund, who went to Tufts. For some reason, we went out somewhere in the car and turned on the radio, and here's this announcement about the Russians, the Soviets, launching this artificial satellite. At that time I didn't know much about the International Geophysical Year and how long that had been planned and what Soviet commitments had been and what ours had been, so it was kind of a complete surprise to all of us, to lots and lots of people.

Being in a technical field and, I don't know, for whatever reason, we were all very, very impacted by it in terms of what it meant and what it would lead to and thinking about it and what the future was. So from that point on, we started thinking about space. I did watch many of the launch attempts we made with Vanguard and the others leading up to our first flight on the Juno that finally, I guess, the organization at Huntsville did. Was it ABMA at that time?

RUSNAK: The Army Ballistic Missile Agency.

ALDRICH: Yes, pulled that off with [Wernher] von Braun. Anyway, so I had followed all that starting with Sputnik, but I hadn't thought about space before Sputnik. It was a dramatic start, although I just told you about my career with engineering and aircraft. Aircraft electronics is what I was thinking about.

So then NASA was formed, and I remember the announcement. At the time I went to Northeastern, it was a five-year program, and it was the largest cooperative education school in the country, maybe in the world, probably in the world. I don't know about the rest of the world, but in the United States. So I had a co-op job at a company called General Radio Company, which was in Cambridge and Concord, Massachusetts. I remember, for some reason, part of the

debate about forming NASA and [President Dwight D.] Eisenhower deciding to do it and it starting, but even then I didn't know that I was going to, a few months later, pick that as my career choice. So that led up.

Then when I reported in July of 1959 and got on board with the Space Task Group, I found it was just six months after the award of the Mercury contract to McDonnell, and it was three months after the first seven astronauts had been named, and they were now getting ready to report to the same place. Maybe they were at the same place. So it all kicked off at that time, and it was pretty close to the start, not quite at the start. The Space Task Group had already been formed, and the group of people that were the initial staff were in place.

Then I was part of this first group of graduates that reported there. That year there was something like 180 graduated students that reported to Langley Research Center for employment. Most of them weren't in the Space Task Group, but a good size was. I remember that group kind of coming together for—there was a training program at Langley Field at that time, where the first year you were sort of involved with tracking a project that you were working on and reporting it. There were like quarterly, four quarterly reports and then a final report on your first year of work, how it had come together and what you'd worked on. So there was a focus on these new employees that had just graduated from college, and a fairly large group. It was quite an exciting, dynamic environment. I remember it quite well.

RUSNAK: What was that first job that you had?

ALDRICH: Well, when we started working on Project Mercury, they had awarded the contract for the Mercury spacecraft, which prior work at Langley, probably before the Space Task Group was

formed, had kind of conceptualized what that was going to be. I think it was kind of in the wings as a program that NACA [National Advisory Committee for Aeronautics] probably had wanted to do and had built towards. But the kind of support you'd have for the Mercury Program, the control center and the ground network and the operations teams, really hadn't—I would say they created the spacecraft first and they brought on board the astronauts next, and then they started to think about, you know, what kind of staff. Probably some of the people that I went to work for there would correct me in saying, no, we'd done this kind of planning or that, but for the most part, the worldwide network and the control center and how we would go about executing a flight operation needed to be put together and planned. So those were the things I worked on the first couple of years, particularly the remote site network and the procedures and the process for supporting manned space flight.

But the project that I worked on that first year and that I reported on in this companion program of being a new fresh-out-of-college employee was on a thing called a flight monitoring trailer. The control center in Florida that we were going to have, the Mission Control Center at Cape Canaveral that we were going to have, was being planned by a group of people there in the same office. I think it was led by—is it Frank [J. Chalmers]? He was from the AVRO [Aircraft, Inc., Malton, Ontario, Canada] Canadian group. Anyway, they were planning a control center, but as we kind of clicked along a little bit, it wasn't clear that we'd have it ready in time. So there was a plan to have a backup to the Mission Control Center that was called a flight monitoring trailer.

In conjunction with the Mercury spacecraft, the McDonnell Aircraft Company in St. Louis were building several trailers for checking the spacecraft out and for supporting some of its communications and instrumentations. I think there was probably three trailers being built in

support of the spacecraft, to be delivered to the Cape. It was decided that we'd build this flight monitoring trailer which would have consoles in it. We could actually support a Mercury flight operation out of this trailer, an early operation that probably wouldn't be as complex as they would get when the crew started to fly, but it could be used before the control center was ready. So I was assigned the task of structuring what the consoles would be and the displays would be and what would be in this trailer to support the Mercury spacecraft, particularly in the astronauts, but to support the operation.

So I worked on that, and I worked with the people in St. Louis, and we developed this trailer. It was actually built and it was delivered to the Cape in about a year with the other trailers. As it turned out, other things slipped, and so the control center did get ready in time because time had a little slide to it. So it was a great project, but we never actually used the flight monitoring trailer in real time. But it was a great project to do. A lot of the display features and the operational features of the consoles are the same ones that we put into the consoles for the remote site network, which maybe we'll be able to talk about here in a minute. Anyway, that was my project and I enjoyed it a lot. It took about a year, and I still have those reports that built up to this final one that says, "Here's the trailer and here's it looks like."

RUSNAK: You mentioned [Chalmers] from the AVRO group.

ALDRICH: Yes. Is it Frank? I think it was Frank [Chalmers].

RUSNAK: Yes, I believe it is.

ALDRICH: I never worked directly for him, but he was right in the same area. I worked for [C. Frederick] Fred Matthews, who I think you've interviewed for this same oral history project.

RUSNAK: We have. That's why I was curious about who of them you did have a chance to work with maybe at this early point, because I seem to recall one of them mentioning that this flight monitoring trailer was something that they had used for the AVRO Arrow when they were up there.

ALDRICH: Oh, I don't think this particular, this same trailer may not have been, but the concept—

RUSNAK: The concept, right.

ALDRICH: I did work for Fred. He was my first boss at Langley Research Center. Fred didn't go to Houston when we transitioned, and so somewhere in that period I transitioned working from Fred to working for Gene [Eugene F.] Kranz, who was my second boss.

RUSNAK: So what do you think these group of guys from AVRO, who did have some experience, obviously, in flight testing and these design, what do you think they brought to the space program?

ALDRICH: Well, there were three—four groups of people in the program at this time, and each group brought, I think, a very important element to the start of this manned spaceflight series.

The people from AVRO were very capable, experienced engineers. It was an incredible team of people in terms of things they'd done and how they could see doing new things. I mean, they could tackle these jobs and they understood them and they knew how to go about them. So it was a very, very strong resource to add at that time, and there were about twenty or twenty-two people. That's a strong group of senior engineers to bring in and have available.

A second group is the one I just mentioned. I can't tell you the number it was, but we had quite a few just-fresh college graduates who were ready to tackle anything, but didn't have a lot of experience and also didn't know anything about what couldn't be done. So it was a very vibrant young work force added to the melting pot.

The third group, which is a group I mentioned that started, these people that started the Space Task Group that came from the NACA and Langley Research Center, Chris [Christopher C.] Kraft [Jr.] and Kenny [Kenneth S.] Kleinknecht and Max [Maxime A.] Faget and Bob [Robert R.] Gilruth, Charles [W.] Mathews—Chuck Mathews—were fabulous people. Their management style was so positive and so focused. They were strong engineers. They were basically engineers, but they knew how to do things. You could tell they had a background of accomplishing things and making them happen, and they just set their mind about it. That was the whole tone of this Space Task Group, was accomplishment and all of us being part of a team and working towards it. It was a very good environment.

Now, the fourth group came on a little bit later, but they were critical to actually implementing this worldwide network and staffing it. This is a group of people, they were tech reps from the Philco Corporation, were hired. Again, there was about twenty of them, and they came in and they were a little different. They weren't aircraft designers like the people from AVRO. They were range people and people who'd worked in ground support operations, radar

sites, and probably control centers in other programs. They had this background about how you did support of these ground electronics facilities that supported aircraft programs and probably early space program. Again, they were experienced. They believed they knew their jobs and how to do it, so they set about doing this job with us. Here again we had this good-sized cadre of people that knew how to do the kind of things we knew we were going to want to do. So that mix of those four groups together was a great mix.

RUSNAK: Being in the second group that you described, the college graduates—

ALDRICH: Well, I didn't put them in the order either of creation or importance. I just—that's the sequence I used.

RUSNAK: In that sequence you were in the second group, I guess. Did that group receive specific training or was it more sort of mentoring underneath the more experienced people? What was the training process you underwent?

ALDRICH: Well, there was definite mentoring, because I feel mentored by some of these names I mentioned, particularly the individuals I've already mentioned from NACA and Langley, all exuded that kind of engagement leadership. There wasn't a separation; we were all a team that was tightly interwoven. Also the people from Philco and AVRO, I worked with Fred Matthews in particular. But then we started to—let's see, did I say Philco? Did I confuse that? I meant AVRO. The man that I particularly worked with—let me start that over. Of the AVRO group, I worked with Fred, and it definitely was a mentoring situation.

The Philco people that we worked with, again, the people who went to the remote sites with, even though each site team was kind of led by the NASA assignees that went to the site, the Philco person that was there was very strong, very knowledgeable, and that was sort of a mentoring, too. You learn from all these people, and there was day-to-day engagement, not just in the exercises you'd do or the specific times you'd come together and review something, but just day to day. It was that way.

Training came in a variety of ways, but a good part of what we were doing was inventing what we were going to do, what the remote site functions and roles were going to be and what the consoles would be like. Another group was doing the control center. I didn't work so much in that other than this trailer, although I did on the second control center in Houston.

Once we kind of had the concept of the network and the concept of the stations, then there was a long period of working on the procedures and the documentation. We actually trained ourselves and each other by developing the procedures for these missions. We developed the mission rules that we would fly the missions to. That involved primarily the way we'd engage the spacecraft and how we'd operate it and what we'd do with problems that occurred in the spacecraft, but it also involved the interactions with the crew and what they would do. So the first of the mission rules were developed during this time.

We also placed a lot of value on being able to fly these missions, placed a lot of value in knowing a lot of detail about the spacecraft and how it worked and how the astronauts had to fly it. So during the same time period, we started to build a thing called a Spacecraft Systems Handbook. The first one was built for Mercury, but then it was built for Gemini, it was built for Apollo, and I'm sure it's still built for Shuttle. This Systems Handbook was fairly detailed layout of each system in the spacecraft to be functionally accurate, so you could understand it

from an engineering sense, but then highlighted from the operational features, where the switches were and what they did, where are the telemetry points and what they did.

One of my assignments was to work on the first Spacecraft Systems Handbook for the Mercury spacecraft. I did that with two engineers that we brought down from McDonnell Aircraft in St. Louis. Ed Neiman and Dana Boatman came and lived in Houston and worked with us. There's some more mentoring. These people were experienced in aircraft systems. We built the concept for this handbook just like we built the structure and the concept for the mission rules. Beyond that, each of the console operators that would operate in Mercury and then later had their own set of documents about their job, called Console Handbooks. We worked on building them.

So part of our training was conceiving of how this operation would be as a collective group and kind of building it up, but learning as we did it, and part of it was building this documentation set that we would then use to do those jobs with. The third part of the training was doing the simulations.

Once we got the Mercury network, it started to be built. Once we got the control center and once we got the Mercury spacecraft simulator at Langley Field, you could now start having simulations of running these missions and flying these missions and interacting with the crew. Right from the very beginning, again, this group of expert people from these different places, I would credit the people that came from Langley because they were the senior people, but I'm sure the contributions came from the AVRO people and their experience and the people from Philco and their experience. Very realistic simulation was always a hallmark of doing these missions right from the first, and it carries over today to what goes on for Space Shuttle and Space Station here in the control center here.

During this period after the flight monitoring trailer work, my principal assignment was to work on the remote sites and what their configuration would be in terms of consoles and therefore what procedures we'd use and what we'd monitor and how we'd make decisions. We defined a three-console format for the Mercury remote sites: a capsule systems monitor and a capsule communicator [Capcom] and an aeromed monitor. In those days, that equipment was being built by Western Electric Company. They were some also very strong people I met there that I worked with, in conceiving what these consoles would be and then in working with them. Western Electric Company was in New York, downtown New York City.

There were like fourteen remote sites around the world that support Project Mercury, but one of the sites they built was both a development and training site over at Wallops Island [Virginia], and that was the first one that was put in place, at Wallops. So it was a job of getting prepared to start training to use this equipment and also developing the procedures. Several of us had the responsibility to go over to Wallops and work with the equipment as it was being put in place. It got to be a full Mercury station there for a period of time. I think the antennas were there and the consoles were there, and you could support a Mercury mission from Wallops if that had been a place you want to do it. But what it was used for was procedures development and weaving together the remote site operation in conjunction with what the control center was going to do in Florida.

During one fairly extensive period, I bet I went over there half a dozen or a dozen times and worked on this process of how the remote site work would come together. I believe the Western Electric contract for this remote site equipment was out of NASA Langley, out of the Instrument Research Division. There was a fellow over there in charge of the division named Barry Graves, who I thought a lot of also. He was an inspirational guy, and we periodically

would meet with him and his people because he was kind of doing the Western Electric and the remote site and managing that contract, even though in the Space Task Group we were the users and we were getting the hands-on of how to put it together.

I guess I've talked us to the point where we had this team of people made up with these different constituents, and we got the first cut of this documentation. We'd got a feeling for what the ground stations are going to be like in conjunction with the control center, and the next period was, we moved into running worldwide simulations, I mean real simulations, not just doing it on paper and doing it there at Langley. We went from the check-out phase at Wallops to having Wallops support closed loop simulations between the control center in Florida, which was now coming on line and Wallops.

Later, one of the first sites to be available that was an operational site was what we called the Atlantic tracking ship, which was the *Rose Knot* Victor. We ran a series of simulations out of Mayport, Florida, with the *Rose Knot*, working with the Cape to further hone this kind of developing how the network and the control center would work together. I can't remember in those days if that was too early or whether we tied the Mercury simulator in, but there was a very high fidelity Mercury simulator, spacecraft simulator for the crew to train on being built there at Langley. It came along in the same time frame.

Over this period of time, we first went remote site training at Wallops to the *Rose Knot* in Mayport. Then we got to the point where most of this was up and we're getting ready to have the first orbital operations, and we switched to running a series of simulations where I led the team that went to Guaymas in Mexico. But now there were teams for all the sites, and I think all of the sites in the Mercury network were in this simulation. It must been in the spring of 1961.

We went down, my team went to Mexico, but, of course, Bermuda was kind of an alternate launch control center. They picked up the latter part of the flight out of the Cape.

So Bermuda and the Cape were bigger than the rest of the remote sites, but the Cape was the control center and Bermuda had a pretty big team, and then all of the rest of the remote site had this configuration of three: CapCom and systems monitor and aeromed. We had them at the fourteen stations around the world and we supported real worldwide sims [simulations] with real communications up and real—I'm sure by that time, the crew were tied in in the simulator, and it was a complete flight simulation.

This was just prior to the Mercury Atlas 3 [MA-3] flight, which was not a manned flight, but it was intended to be an orbital flight. I guess it wasn't. I think it was initially planned that it was not an orbital flight, but we sent all the teams out to pretend that the launch would be. There were two two-week visits to Guaymas to support that, and during the transition period they switched to an orbital flight, I think, maybe based on the success of Mercury Atlas 2. Then it wasn't successful. It didn't go orbital, but we played the whole thing like it was real flight and the whole network and all the control center was up and it was the first complete simulation.

I went through that sequence about these stations because you asked about training, and this realistic simulation over and over again in these various ways was a real part of the training. There wasn't a training organization at that time other than the organization to plan the simulations. We just didn't have enough background to have a training program. We were learning what we were going to do and then building to do it as we went along, but there was a lot of hands-on real playing it through. So I would call it training, but it was first-time training.

RUSNAK: Definitely on-the-job.

ALDRICH: Yes.

RUSNAK: With something like these remote site simulations, were you actually at these different sites or did you just particularly go to the Guaymas one in Mexico?

ALDRICH: No, I think people were at every one of the sites around the world starting at this point.

RUSNAK: Were you personally, I guess, is what I was asking.

ALDRICH: I was at Guaymas. I was the capsule communicator at Guaymas. It was very real. We had the full team at each site. I think for that flight, I think Dan Hunter was the spacecraft system monitor. He was one of the Philco tech reps. I believe Bill [William S.] Augerson was the aeromed. But I didn't recheck my manning list to see who was at which of the Mercury missions with me, so it kind of blends a little bit. Also, some of the sites around the world were more key than others. Of the [thirteen] sites, only half of them had voice communication with the control center. You couldn't talk to the flight director at the Cape from [six] of those sites. They only communicated via teletype.

So at these sites, like the ships, that only had teletype communications, everybody knew the mission sequence, everybody could synchronize their clocks, but when you wanted to talk to Chris Kraft or Gene Kranz at the control center, you would write out what you wanted to say on a piece of paper, you would hand it to a teletype operator, and he'd run over to the teletype

machine and type it in. Then it would take some period of time and it would type out at the Cape and play out there. Someone would tear it off and run it over and give it to whoever it was supposed to go to, and they'd read it. They'd write an answer, they'd hand it to the teletype operator, he'd go back to the teletype machine at the Cape, type it up. It would come out, come to yours, he'd carry it and bring it to you.

Now, that whole process might take somewhere between three and five minutes if it was really working well, but that was the best communications you had from [six] of these sites, at Canton Island, at Canary Islands in the Atlantic, and Canton Island in the Pacific, at the *Rose Knot* in the Atlantic, and the *Coastal Sentry* [Quebec] ship in the Indian Ocean, at Zanzibar off the African coast, at Kano in Nigeria. All of these places we sent teams that were trained and knew what we were doing and had all the procedures and had full site support there, but the best communications that they could engage in to be prepared and then support this flight which was going to come over and was going to be at best a seven-minute pass, was this teletype.

Other sites, the other seven sites—[seven voice sites also included Bermuda and Woomera, Australia], I've described how the control center at the Cape and the site in Bermuda were more substantial and had a more direct involvement and more communications, radar systems, but the other seven, Guaymas was one; and Port Arguello in California; and [Kaui Island,] Hawaii; and Muchea and then Canarvon in Australia; Corpus Christi [Texas]; they had voice lines. So, you know, you could punch up and talk, and you could talk to the flight director at the Cape. So it was a little different, but once the spacecraft started to go around, everybody got the same seven-minute pass and everybody was trying to fly the same mission and support the same analysis of the data and the same mission rules. So this was part of what we blended together.

Some of these sites had different jobs. The site in Bermuda had the job of backing up the launch if the Cape lost track or lost communications. Bermuda could do those jobs. The sites on the west coast, the Guaymas site and the Point Arguello site, were the sites which the retro rockets would be fired in Mercury to cause the mission to terminate and the spacecraft to land in the Atlantic Ocean. So the site in Guaymas and the site in Point Arguello had a specific key aspect of the mission that they were going to be the hands-on location for.

So when I went to Guaymas, all of the simulations we had there involved whichever length of the mission you had, the retrofire occurring in the spacecraft flowing from there. And you had control at these sites. Each of the sites had a command system, and you could command an update of the clock in the spacecraft, which was counting the minutes of the flight and was synched with ground time. You could command a clock that was counting down on board to retrofire. It had the retrofire time in it, but you could change that time or you could send retrofire direct. You had a red switch and you could fire the retrorockets in the Mercury spacecraft. I think those are the three commands. There might have been some others, but those were the ones that most directly interacted with the mission flow.

RUSNAK: Was it then just a natural move for you to go from having worked on, I guess, the prototype for these, like at Wallops Island, to becoming a remote site flight controller?

ALDRICH: Well, that was the plan all along. The plan was that we were going to have a series of young NASA engineers. Some of them were these people that came at the same time I did and some were young people that were from other aspects of the NASA organization at Langley, but they were all young NASA people. We kind of knew the number of people we'd need to support

these flights. So there was a building of a plan to have how many ever, twenty or so capsule communicators that were NASA, young, pretty much young engineers, and twenty or so systems monitors that were the Philco tech reps. I'm not as aware exactly how we collected all the aeromeds, but they were all doctors, I think most military background doctors.

So this team was being structured in terms of how to acquire enough people to staff these things. At the same time, we were working out the consoles and working out the procedures. The whole plan was that this was all going to come together. I think mostly I just recently talked about training and projected that development of some of this and then the simulations. But while we were training and simulating, we were also building the plan for the size of the force of the flight controllers we'd need at the Cape and at Bermuda, but then around the world.

RUSNAK: Tell us something about some of the unmanned Mercury flights that you worked on. You mentioned MA-3, for instance, but I guess I'm also thinking of ones where they would have had either one of the monkeys or the chimpanzees on board.

ALDRICH: Well, there were a very important series of unmanned Mercury flights that I didn't have too much to do with. There was small launch vehicle called Little Joe, that was launched at Wallops Island a number of times with various configurations of Mercury spacecraft on it to check out the spacecraft hardware and the sequencing. There was another team of engineering people that ran those tests, but they played up to getting the experience and the knowledge of how the spacecraft would work and being sure we had it to do the jobs we wanted to do it. So they were important.

Then there was the Mercury-Redstone series of flights where there was several unmanned flights of Mercury Redstone before the [Alan B.] Shepard [Jr.] and the [Virgil I. "Gus"] Grissom flight, which were the first manned flights. That was very important both in terms of proving the spacecraft and its interface to the rocket and then proving the role of the crew. I didn't work on any of those, but we followed them and we were very interested in them and they helped build the knowledge base and the strength of the team that could tackle the orbital flights that came later.

The first one that I really worked on that was a flight was the one I mentioned, was MA-3. I went down to Guaymas. Everything before that was developing these procedures, developing these engineering ground systems, and working out how we would work from a remote site network point of view. So MA-3 was the first flight and it seemed very realistic. We were prepared to do an orbital flight with it, but it didn't go orbital. And we spent four weeks in Guaymas leading up to MA-3, with a gap.

So by that time the spacecraft was getting pretty mature. The team was getting mature. We'd now deployed worldwide. The crew was getting mature.

The next flight was MA-4, which didn't have a chimp, but it had a simulated astronaut on board. It was prepared to go orbital and fly a mission and it look like a crewman. You couldn't talk to it, but it was prepared to do all the things. It was a one-orbit flight, orbital, and it came five or six months later in the summer of 1961. We deployed again, I think mostly to the same sites we were for MA-3. I know for me it was back to Guaymas. We had the same sequence. I think we were down there for about four weeks with a gap in the middle getting everything up ready to go.

We came back and went down again, but we were there for MA-4. The role I had at Guaymas in MA-4 was to back up the onboard retrofire. We now had this automated thing on board that was going to go orbital. It was going to go one flight and it was going to fire the retrorockets over Guaymas and land in the Atlantic Ocean. The automated system was going to do that. But the job at Guaymas was to monitor that. Couldn't talk to a crewman, but you could send retrofire command. So the procedure was that one second after the clock fired the retros on board, we'd send it from Guaymas, which we did, and, of course, the retros fired the way they were supposed to.

So I was curious at that point in time if our command got in, if perhaps our command did it, because a second's not quite enough you can tell for sure. So I was interested in the replay of the tape and the data. But it turned out it worked exactly the way it was supposed to. It fired directly on time, and one second later the command was received by the spacecraft and would have fired them if they hadn't already gone. So this is getting to be pretty realistic training now. We're getting to the point where everybody's doing these jobs for real. That was what happened at Guaymas, but every site got to monitor the data, interpret it, interact with the control center, make their data reports and send them in. It was getting to be a pretty mature team. Now, this is only the summer of '61. This is only two years after we'd started all this. Wasn't very long.

One other thing I was going to tell you about Guaymas that was interesting to me. On this trip to Mexico for MA-3 in the spring of '61, this was really before we'd flown any of these things with crewman in them, and we had to go through Mexico City and get sort of a political briefing on how to behave in Mexico and how to behave as a representative of the United States. We went down and met with the people in the American Embassy in Mexico City before we went over to Guaymas so they could kind of lay out the land for us.

While we were down there, we were there just a week or so after Yuri Gagarin's flight, and we were in Mexico when the Bay of Pigs happened. This was several, some weeks, a month before Al Shepard's flight, so here we still had actually not executed any of these missions that we were set about to go. Here we were sitting there, and these things are going on in the world around us. It was a very unusual feeling to be in Mexico and the Russians now have men in space. We're talking about it and now we've invaded this other Spanish-speaking neighbor and we're sitting in Mexico. So that was very early in my political career, but it made an impression.

RUSNAK: I imagine it did. You mentioned obviously Yuri Gagarin's flight and Al Shepard coming in and not quite catching up, but at least we've got somebody in space. What were your thoughts when the Russians beat us to this other milestone?

ALDRICH: You mean Gagarin?

RUSNAK: Yes.

ALDRICH: Well, I don't think we had any—at the level that I was working, I think this whole team was working, I don't think we had a lot of real knowledge about what the Soviet schedule was going to be. I think it was just a surprise when Gagarin flew. There's probably people in the United States somewhere that knew they were getting close and were key to it, but nobody—I mean, we weren't focused on that and I don't know if we would have, you know, we would have interacted with that information anyway. I don't know how that was played. So it was a surprise when Gagarin flew.

That brings up another subject, which is the mood of this team and the focus. I don't think any of us had any doubts that we were going to do this. As new and different as it was and as challenging as it was, we were playing through this and we all believed we were going to do it. So when Gagarin flew, it would be a disappointment, but it was a little bit unexpected. "Oh, it's happened already." You know, I think the next thought is, "Well, we're going to catch right up. We're going to get there." We didn't feel put down, I don't think. We just felt disappointed we didn't get there first, but we were just about to be there, too.

RUSNAK: Not too terribly long afterwards, Shepard does go up and then it's barely weeks later when President [John F.] Kennedy says, "Well, let's go to the Moon." Did you feel as confident then that that was a goal you could achieve?

ALDRICH: Well, the first part about Shepard, that was a great excitement when he flew. Again, knowing what I know now, looking back on the career and how hard it is to do things, you might have had more doubts, that would have been a problem. But we didn't doubt these things in those days. We just went for it. In fact, early in this period, leading to these Atlas missions, the Atlas had a terrible record. During the '57, '58, I don't know when they started, but during the period I know about, '59, '60, '61, the Atlas was about 50 percent successful and not successful. Yet here we're going to put men on it and be successful every time, which we were. We were confident to do that, but it was a big challenge. Today people might be more cautious than we were then. I don't know. But we didn't doubt it.

Let's see. Ask me again what you asked about that.

RUSNAK: Basically just your reaction to Kennedy's announcement after only having fifteen minutes in space.

ALDRICH: I remember the day that happened. We actually heard the speech when we went out to lunch. We were at Langley and drove out somewhere to lunch and heard it on the radio. I think the reaction would be a little surprised that we were ready to announce such a step, but clearly where we all wanted to go and expected to go. So it was a great inspiration, the speech that we were going to do all these things and keep going. That was a big step beyond the period we were working on then.

Probably the biggest question about it is whether you could do it in ten years, by the end of the decade. It probably wasn't quite ten years, but by the end of the decade. That question was there for a long time. You worked to make it happen, but no one knew what hurdles there would be along the way and what we'd have to deal with. We had some hurdles, but we made it.

RUSNAK: You certainly did, with months to spare, even.

ALDRICH: With months to spare. It's interesting during this time period, really before Shepard. I had worked in this for a couple of years. It's like we were talking, you know, we knew we were going to do this, but not everybody did. During that time period at some point, my dad asked me when I was going to actually go get some real job to work on. I mean, "This is nice to work on these esoteric things, but when are you go start and actually work on something?"

RUSNAK: Hopefully he changed his mind.

ALDRICH: It wasn't long. We showed that we actually were working on something.

RUSNAK: Now you go back to work and you get a couple more unmanned orbital flights before sending up John [H.] Glenn [Jr.]. So can you tell us about those?

ALDRICH: Yes, we got one more. I mentioned how retrofire occurred over Guaymas for the first revolution well. With the Mercury trajectories we were flying, which probably were due east out of the Cape—I wasn't paying any attention to that or at that time—the later orbits, retrofire was better over Point Arguello, which now is Vandenberg Air Force Base, but then it was a Navy facility called Point Arguello.

So for the next flight, I was at Guaymas for MA-3 and MA-4. For MA-5, for which Enos was the passenger, I led the team that went to Point Arguello. We went out there and again ran a series of simulations. I can't remember if we made two trips or not before Enos flew, but when we would go out, we'd be there at least a week before the flight and we would run a number of days of simulation. We didn't run just one. We would run them over and over. So there were a lot of simulations. And then Enos flew. Enos had problems on his flight, or the flight had problems with Enos on board. So at the end of the first revolution, the spacecraft was acting up and its thrusters weren't all working. So there was a lot of concern that it wouldn't be able to hold the right position for retrofire.

That set up a scenario during the second revolution where the spacecraft went east after passing over the east coast and each site looking if these thrusters were working right or they weren't. In general, the reports were that it was not working right. The way the Mercury

worked, they had two sets of thrusters. They had some small thrusters that had a narrower band than some big thrusters that gave you outer bands, an outside band. In one of the directions the spacecraft was regularly going out and hitting the outside band and the bigger thruster and kicking back in. And because it was the bigger thruster, the fuel was depleting more rapidly. The bigger concern would be what if something happened to that thruster? Then there'd be one direction where it couldn't control anymore, and you'd set up an inability to hold the right attitude. You had to have the retrorockets pointed in the right way when you fired them, so it would slow the spacecraft in the right manner and it then would dip into the atmosphere.

So the sites that monitored this as it went around were repeatedly seeing the problem. There was also a thermal problem in the spacecraft that I think started earlier, but as I recall, that condition had occurred and then seemed to get better. I'm not sure we would have ended the flight based on the thermal conditions, but this attitude control and thruster and propellant usage during the second revolution was quite a concern.

The last site before we came up on Point Arguello was Hawaii, and they were asked did they see the thrusters, the wrong thrusters firing that's going out of bounds, and the answer was yes. So the question was whether we're going to bring it in. Both Hawaii and Point Arguello had communications with the Cape. Chris Kraft was the flight director at the Cape. As we came over Point Arguello, we were asked, are the wrong thrusters firing? The capsule systems monitor had his console with a lot of displays, but to see whether the thrusters fired, he had to look at the recorder. He had a pen recorder beside the console, and he had to look on his pen recorder and see if these thrusters that shouldn't have been firing were now being called on because the one that were supposed to be used weren't working.

I would want to check, I believe [Dick Rembert] was the systems monitor at California. I should have checked on that before I came here so I could be sure. Next time I talk to you, I'll be sure and either give Hal credit or say that was mixed with one of the other missions, it was somebody else.

Anyway, the report was that California, we also saw that the thrusters weren't working right. We reported it to the Cape, and within just ten or twenty seconds of when we had to fire retro rocket for rev two, the decision was made by Chris at the Cape to terminate the flight. A preferable way to do that would have been to update the clock over Hawaii on board, so that the clock would synch down to the right time and you could tell ahead of time everything was lined up and was going to happen. But he wasn't quite sure that that was the right decision until it got to be no more time to play, so we couldn't update the clock. We had to send retrofire from Point Arguello, from California. And we did. We sent them, and the little lights came on in the console. In fact, we had retro 1, 2, and 3 on the console and it came on 2, 1, 3, but they all came on, which was what needed to happen. The spacecraft did reenter, and Enos was recovered, and that was what happened at California on MA-5.

We went back to the hotel after that, and I was really pleased with the performance of the California team, but when you arrived out there from Langley Field with a systems monitor and an aeromed person. We also had these critical sites we had an astronaut that would come, getting ready to have an astronaut there that could talk to the crew from any of these critical sites if we needed to. I believe [L. Gordon Cooper] was there for Enos. But when you arrive out there, here's this tracking station. I mean, it's an impressive station. You got these consoles [unclear] but it has telemetry systems and radar systems, this big team of technicians that operate this equipment, and there's antennas out there. You know, you depend on that site to work. It

was operated, I believe, by Bendix Corporation under contract to NASA in the early years, the remote sites.

But you arrive, and there's a team that's there full time that runs all of this equipment. You're just kind of the console operators. So I get back to the hotel after we did all this, and I thought, boy, I'm sure glad the right displays showed up on the right pens, and I'm sure glad that when you threw that switch, the command really went out the antenna.

We had to go back for one more shift to do something, so we went back, and I one more time went through the data and made sure that what we saw was really what we saw, and it was. It all worked right, but it wasn't until after the fact that I realized how much responsibility that we had, that we depended on this site team of people and how well their job had been done and how prepared they were. Because when we get there, you run sims and you interact with the team, but they have checked this equipment out and they had made sure they were ready. So that was another big piece that I got a lot of appreciation for by this thing working right. That was a good time. Enjoyed that.

RUSNAK: Can you give a little bit of an idea of what the atmosphere is like at one of the remote sites? Just describe the setting and the feeling to be out there.

ALDRICH: Well, I've enjoyed my international connections during my career tremendously. My first of those was going to Mexico for early Mercury flights, and enjoyed it a lot. They had a team of Bendix people in Mexico also that we got to interact with there, but we did go through the embassy in Mexico City and we went to the ambassador's house and were hosted.

Then we got to the site. We lived in Guaymas, which at that time was a nice, little Mexican city. It had a dirt main street. When we would fly in and out of Guaymas, it had a dirt airstrip. I remember taking off in a—it must have been a DC-3. I'm sure it was a plane that was tipped, you know, on a tail wheel. There were crates of chickens in the back. So it was a great experience.

The other thing we found was, that they had a beautiful hotel in Guaymas, right on the bay. It was what in those days you'd call a resort hotel—beautiful pool, deep-sea fishing opportunities down at the dock. The one thing they had that was wonderful was superb air-conditioning. We would go into those hotel rooms in Guaymas and turn on the air-conditioning full and pull the shades and leave it up the entire time we were there.

At night we'd have to go to work, because the launch could be any time you wanted, and the way that it was scheduled at the Cape was always at 6 or 7 or 8 a.m. Cape time, which means the countdown, particularly on the West Coast, started about midnight or eleven o'clock and would count down to this early morning launch.

So every night we'd—we'd decide during the day what kind of a nap you'd want to have, and then you'd go through an evening and you might rest a little bit more. But when it got to be really late at night, you were going to work. We'd go out to the site. There is a pretty little station out in the desert, outside of Guaymas. You'd have the big antennas at night that you'd see, that were lighted in a special way at Guaymas at the console.

One of the most important pieces of equipment that we had in Guaymas for these simulations we'd do there and these missions was the bottle of Kaopectate, and it would sit up on top of the console. One of the worst things could happen is if somebody decided they need it so

bad, they'd take it home with them, and then you'd show up and there wouldn't be a bottle of Kaopectate, and that was a big problem. [Laughter]

RUSNAK: It sounds like you guys got one of the better sites. We've heard some interesting stories about some of the African sites, for instance, and the tracking ships that didn't have quite as nice facilities, I guess.

ALDRICH: Well, this was one of my first experiences—it was essentially my first experience overseas. I'd been to Canada, but that's a little different. When you'd go south of Guaymas to get to this tracking station, there was a very big railroad yard that the road went right through. It was the place at that time where the Mexican workers that wanted to work in California or in the Western United States would gather to sign up and get on the trains and go north. They were called *braceros*, which I don't know what that means in English, but there were thousands of these braceros. They're hoping to get signed up and hoping to get a train and transported north.

Every day we'd go down, we'd drive down out of the city and through, and we'd drive through this great big area where these thousands of Mexican workers had gathered, kind of sitting around, waiting on whatever schedule they were on to get where they wanted to go. So it was a period where it was very fascinating. I learned a lot. Had a good time. Accomplished what we wanted to do.

RUSNAK: Where did you end up for John Glenn's flight?

ALDRICH: For John Glenn's flight, I went back to California, to Point Arguello. The site in Point Arguello is on top of—there's a—I guess you probably wouldn't call a mountain, but it's a very high hill with a peak and the site's right at the top. Right at the base of it that you'd drive by on the way to this peak are some Atlas launch pads. In those days we used to drive by the Atlas launch pads on the way up to the peak.

In later years we didn't need a tracking site at Arguello anymore, so that had a fixed lifetime, but the Atlas sites we drove by were what were converted to the Shuttle launch pad at Vandenberg Air Force Base that, as I'm sure you know, was completely built and was within months of being operational when we had the *Challenger* accident. So that location had a lot of continuity from Atlas to this little site we'd go to Space Shuttle Program. Now it's, I think, being used for some commercial launches or maybe used for some—I think this very small launch vehicle that we, Lockheed Martin, have, was launched from that site, which in no way makes use of it, but I think the point is, the history there is not over yet. There'll be another phase to come, whatever it will be.

So I went back to Arguello for John Glenn's flight and supported it there. We were now pretty familiar with these Mercury orbital flights and we were pretty familiar with the station, and things worked well there. I'll tell you, at California, at least, the degree of concern with the heat shield on Glenn's flight was not nearly as dramatic as it was in the control center at the Cape. I mean, we knew of the nature of what was being worried about, and we knew it was in work, but the degree of concern over it was not nearly as strong. We pictured John's flight being pretty successful and going pretty well, and we tracked it for our three orbits and didn't have to do anything like retrofire with John. So it was—I don't know if you'd call it a textbook Mercury

mission, but I think it was close, from the Point Arguello point of view and from the team I had there.

RUSNAK: Were the activities for you any different now that there's a man on board?

ALDRICH: Well, you'd like to think there was a lot more public interest or interest in that nature, but I didn't sense it. It seemed like pretty much the same. The activities were pretty similar. Again, we were doing now what we had been through in a lot of sims and in a few missions. We kind of thought we knew what we were doing, and that's the way it worked. I wouldn't think there was a lot more hype.

I did fly from there to the Cape. I brought the data and the tapes and flew straight to Cape Canaveral. It's interesting, that's probably the last intercontinental flight I made on propeller aircraft in my career. We took a—DC-7s, were they? Anyway, we flew propeller aircraft from there, landed in Dallas, landed at Orlando, and went over to the Cape with the results. The team was still exuberant, excited at the Cape by the time we got there.

RUSNAK: Did you have much of a chance to work with the astronauts on a personal basis?

ALDRICH: Yes, I worked with each of the seven astronauts and most of the ones that followed, on a personal basis. First at Langley with the seven, it was such a small team. We were all together in two buildings and we saw each other all the time, and in these training sessions.

But then we started going to these sites. Because they wanted to have an astronaut, even though my job and the fellows like me, the young NASA engineers were called the Cap Coms,

we had the CapCom console with the clocks and the retro command and some other display and communications, there was an astronaut there at the key sites that would talk to the crew if it was needed. So the MA-3 flight, [M.] Scott Carpenter went with us and was down there for that period of time. MA-4 was Wally [Walter M.] Schirra, and -5, I think, again [Gordon Cooper]. Then -6, for Glenn's flight, it was [Wally Schirra]. So you'd get to spend weeks at a remote site with those guy. You really get to know them. But we over the years got to know them pretty well.

RUSNAK: Any stories you'd like to share about them in particular?

ALDRICH: No. [Laughter]

RUSNAK: At least not that can go on tape, huh?

ALDRICH: Well, I mean there's nothing. They're dramatic personalities and they were in the fullness of life and full of fun and they were confident in the job they were going to do, too. So they are great people to be with.

Yes, I'll share a story about Wally. When we were down in Guaymas, must have been for 5. I can't remember some of the names, but the site manager for Bendix at the Guaymas site was a big likeable guy, too, very robust. One night we all went to a restaurant that was out on a hill overlooking the bay in Guaymas, and we were eating out of doors, probably ten or a dozen of us, and Wally and this site manager were sitting there.

One of the things they do in Guaymas, probably all over Mexico, is they put a big bowl of jalapenos on the table, just so you'll have them. I mean, they're not something you order; they're just there. So here's this big bowl of big green complete jalapenos, and Wally and this site manager get into this discussion about jalapenos and how many you could eat. So they challenged themselves to who could eat the most, and they start eating these things, and they were up in the twelve and fifteen number and still going. Well, it turns out for part of Wally's career in the Navy before he was doing this, he'd been stationed in San Diego, and jalapeno-eating had been big on his regime. So he was an expert, and so I think he won the contest and he did it legitimately. He could really—he put down at least fifteen of those things, one right after the other.

Another story was the astronauts and Corvettes. Of course, these West Coast things, you'd fly into Los Angeles, but there was also a lot of things at the Cape. There was a period there when the astronauts would either fly into the Cape or fly into Los Angeles, the local Chevrolet dealer would give them Corvettes to drive while they were there. So you'd frequently run into these guys and they'd have their Corvette, and you'd go somewhere with them. Corvettes in that time period were very high-performing cars. Corvette's been over hill and dale with how much they performed and what they were like, but in the early sixties, they were really hot. In fact, one of the times I drove one of them and the tachometer on it's got a little green band you're supposed to get into for each gear you shift, was no way I could get into the green band. I mean, you just couldn't do it. [Laughter] And I think most of the astronauts get into the green band a lot.

RUSNAK: I wouldn't be surprised.

Going on to the next Mercury with [M.] Scott Carpenter, and he had some problems on his flight. What are your recollections of that?

ALDRICH: Well, this was a time of adjustment in how these teams that support these flights were being worked. I think there's a pretty good description of it in Gene Kranz's book, but for MA-7 I was asked to come to the control center in Florida and start getting ready to be the spacecraft systems monitor in the control center. So that's what I did for Mercury 7, and I did it in an understudy capacity. Walt [Walter J.] Kapryan was the systems monitor for that flight and dealt with and managed the problems you're talking about that Scott had. I was side-saddle with him on the console for MA-7, but I didn't interact with the decision process extensively.

RUSNAK: Is there anything you'd like to say about Walt Kapryan? I'm just curious about him personally.

ALDRICH: Walt was at the time one of the most knowledgeable and experienced engineers on the Mercury spacecraft. When you wanted to talk about Mercury in an engineering sense, Walt would be a key guy.

RUSNAK: So did you learn a lot from him as you're going into this position?

ALDRICH: Yes. But again we're looking at the Mercury spacecraft and we're flying these missions that we'd flown. So it's really the transition from a remote site scenario to a control center scenario. So you learned more about the countdown and about the different individuals,

there's more of them at the control center, and you get to see what the lead systems guy in the process would do. So it was an extensive training process, but it was on something you already had a lot familiarity with from a different point of view, or a different perspective.

RUSNAK: How did this opportunity come about for you?

ALDRICH: As best I understand the way things were going at the time, there was more and more difficulty drawing on the engineering organizations within NASA to support the key systems positions at the Cape and maybe in other ways. The decision, I think, had been made or was in the process of being made to create an all-flight operations directorate mission team that covered all the positions—environmental control, which had been an engineering position, systems monitoring, and all the others. I think as that was being worked on by Chris and Gene and others, I was one of the people they considered for that and that was the time I was asked to come do it.

RUSNAK: Which was the first mission then that you worked on that solo, per se?

ALDRICH: Well, I worked that solo on Mercury 8 and Mercury 9. I was the capsule systems monitor at the control center in Florida.

RUSNAK: Well, Schirra had a pretty good flight on Mercury 8.

ALDRICH: Schirra's flight was good. In fact, that was also the first flight that I deployed either to the remote site or to the Cape from Houston instead of from Langley Field. We made the switch between those flights from Langley to Houston so that I went from here down there. In fact, it was kind of like going home. We were brand-new in Houston. Everything was new and different, and we went back to the Cape for a flight and it was kind of like going back to familiar territory.

In fact, I was going to tell you another thing that happened to during that time period that was interesting. After John Glenn flew, the country, or the agency, decided to send his spacecraft around the world. It visited sixty cities around the world. I was asked to kind of be the NASA lead for that for the first half dozen cities, which I was eager to do. They built a nice little trailer that you could tow with a pick-up truck that the Mercury would mount on and then they had a series of tall display boards that would kind of tell the story. They loaded this all on a C-124 transport.

So I was asked to do this as one of eight people or so that did the whole sequence all around the world. I caught up with the 124 and the spacecraft in Bermuda, which was the first stop. They unloaded it all there and we took it down into Hamilton and set it up. Then I was sort of in charge of answering questions and being the NASA expert in place. Had a nice two- or three-day stay in Bermuda, then we packed it all up and flew to Bogota [Colombia] and did the same thing in Bogota, and then Santiago [Chile], and then Buenos Aires [Argentina], and had a nice time in each of those places.

In Bogota, that's very high in the mountains and we had this big load on the 124. We would fly in the 124 with the spacecraft. We couldn't take off from Bogota with enough fuel to

go to Santiago with this big load. So we took off and flew to Panama, which is right down at sea level, and filled the gas tanks and then flew to Santiago.

In Santiago, we had a NASA tracking station for unmanned programs. I'd had no connection with them, but when I got there, I was met by the NASA station manager. It wasn't a Bendix guy here. It was a NASA person out of—I think they were out of Langley. They might have been—I'm not sure when Goddard [Goddard Space Flight Center, Greenbelt, Maryland] came on. I have almost the feeling it was out—anyway, met by the NASA station manager and invited over to his home and also to the home of other people running the site. Had a nice stay there and then went to Buenos Aires and got to see that city.

In each of these places I was the spokesman to describe John Glenn's spacecraft, this exhibit. Next we were going to go to Rio [de Janeiro, Brazil]. That was going to be the end of my tour, and I got a call from Gene Kranz. He said, "We're about to do this next flight with Scott Carpenter, and you're assigned to this job. We've got to have you back here." So I had to cash in and fly back from Buenos Aires to the Cape and do the Carpenter flight, and I missed Rio.

When we flew from Santiago to Buenos Aires, we flew right up and through the pass where there were huge mountains on both sides where the 124 couldn't fly over. In fact, if you know this story about the party that was stranded there many years later that led to the book *Alive*, we flew right by—maybe it was before. Maybe I knew it when we flew over, I don't know. Anyway, flew right through the pass. You could look up and see where that all played out and took place. So anyway, I did that between Glenn and Carpenter.

Then I did the Cape and then I was talking about Wally's flight.

RUSNAK: Well, if we could take a moment to change out our tape.

ALDRICH: Okay.

RUSNAK: Okay. You were just telling us about the story between Glenn and Carpenter's flight. If we could also talk about Cooper a little bit and his flight. I know he had a couple of systems problems go wrong with his mission.

ALDRICH: Yes, but Cooper's flight was pretty nominal, too, really. The thing I remember most about Cooper's flight was the fact that it was now almost a twenty-four-hour flight. It was getting to be a long time and this was really the first long-duration flight in the manned space program. We were so keen on doing that right, that we actually built a place with living quarters next to the control center at the Cape so that the flight controllers could stay over and key members of the team would be right there, and you wouldn't be transitioning out of the area and coming back between the shifts.

So I remember most in Cooper's flight the quarters there and how this whole team just gathered up at the control center and stayed over. I don't particularly relate to the detailed problems that Cooper had. I think that his spacecraft—his flight was a pretty good flight. We all felt good about it. Good way to end the Mercury Program.

RUSNAK: Yes, it certainly was. He did have problems. Obviously he was able to overcome some minor difficulties and land close to the pick-up ship and everything.

You had mentioned that now you were starting to come from Houston to the Cape. So if you could tell us something about the move to Houston, what the general mood about moving the Space Task Group to Houston, and also moving the control center from the Cape to Houston.

ALDRICH: Well, that would probably start with the selection of Houston as the site for the Manned Spacecraft Center. When we were well into Mercury at Langley, there got to be a lot of discussion about a new home. I guess probably after the Kennedy announcement that this was going to be big and Apollo was going happen, there was a lot of discussion about where the new home would be.

The first manifestation of that was the discussion about we would be moved up to Goddard, and we would be part of the new Goddard Center. In fact, for a period of time at Langley, our paychecks started coming from Goddard to the people in the Space Task Group rather than from the Langley place, or at least that's what they said on them, was Goddard Space Flight Center. But although it was close enough, one time we went up and drove around Goddard when it was under construction, there was never any more serious engagement of that. We didn't get very involved with Goddard.

In later years, the people at Goddard have told me that the administration building there, the key management building at Goddard, was actually laid out and the configuration was kind of specified by Bob Gilruth, but I don't know if that's true or not. That's what they think, anyway. It's a multi-story building and it's a little different than the kind of character building that they thought they might have if Goddard had done it some other way.

So then they had this gathering up of really deciding where the home of the Manned Spacecraft Center would be. Several places were under consideration. One was in San

Francisco [California], and one was in Tampa in Florida, and another one was in Quincy [Massachusetts] in the Boston area. Of course, my wife and I were from Boston, and I thought we were kind of reaching out to go to Virginia, never mind going to Texas. So we thought the idea of Quincy would be a good place. I don't think it was very seriously under consideration, but maybe because of the Kennedy connection or something it found its way on the candidate list.

We got the feeling that Tampa or Houston were probably the most likely, partly because of the requirements for the location, which was deep-water access and number of days outdoor working conditions you could have in a year. Really, a southern location much better fit the requirements for the location that they thought were important. Then the proximity of water transportation to the Cape caused it an eastern southern location.

So it wasn't a surprise when Houston was picked. The one thing that was a surprise was that they picked it, they announced it, at least, within weeks of Hurricane Carla, which had been in *Life* magazine, and this place was devastated in Hurricane Carla. There's been nothing like it since. I mean, this specific location for the Manned Spacecraft Center was the centroid of this hurricane and where boats in trees, and pictures of snakes crawling. So we announced we found the absolute, most wonderful spot for the Manned Spacecraft Center is this area south of Houston. That was surprising a little bit, but anyway, that's what the pick was.

Then the next period was, well, what's the plan for moving there? A lot of people didn't know much about Houston. I know in my case, my wife and I said, well, we know where Dallas is, but where do you suppose Houston is in Texas? And we got the map and looked and here it is over by the water and we said, well, that's interesting. We owned a place on Chesapeake Bay in

those days just up from Langley Research Center. We thought, well, we'll be able to get a place on the water here.

Some months later after we were actually here, we drove around the coastline here and found out that it's a lot harder to get a home on the water here than you might think with all the coastline, because so much of it is low and a lot of the places on the water are not your residential communities. They're recreation communities. I gave some consideration maybe to staying on the East Coast at Langley or not, but even though I thought about it seriously, it really wasn't a contender. This was so exciting and so dynamic and so challenging, you couldn't sign off at this point. We just had to go for it.

RUSNAK: One of the things I was wondering about was moving the control center to Houston. Did that seem like a logical move?

ALDRICH: At first it seemed a little strange, because that was the centroid of everything we were doing. To me, technically it didn't seem like an issue. I mean, it didn't seem like a technical problem. We could certainly do it, but it wasn't quite clear how it would work with the separation, but it turned out it worked well. As we did it, it got to make sense and it got to be more, I guess, natural-seeming as we worked in that mode.

RUSNAK: This, I think, makes a nice transition into the Gemini Program, which is now going to be the intermediate step between that and Apollo. With the last Mercury flight did you move directly into Gemini?

ALDRICH: Well, let's see. I can't remember exactly when I started working on Gemini, but I think it was pretty much like that. I remember the activities going on that led to the determination that McDonnell would build a two-man spacecraft, Gemini, which would really be like a big Mercury but it would have two people and could do some other jobs. I can't remember [James A.] Chamberlin's first name.

RUSNAK: Jim.

ALDRICH: Jim Chamberlin. I remember him having meetings upstairs at Langley while we were still working on Mercury where the Gemini team was coming together and planning what it would be. So we were starting to get a good vision of the Gemini Program, but I can't remember exactly when I picked up working on Gemini. I know we went to the Cape and supported Gemini I and Gemini II, and I felt like we were on board and trained in the spacecraft by that time. But I think there was time between Mercury and Gemini to make the transition and come up to speed.

I don't think there was too much of an overlap, although before we moved to Houston, we also had some new people that were going to be involved in Apollo coming on board. These were people hired to be in Houston, but they reported to Langley because we were still there. In fact, maybe that's part of the earlier question about the move to Houston. I believe some of the technical and administrative people started moving in the fall of 1961 to Houston, but the flight operations team hung together. No, it must have been the fall of '62. No, it couldn't have been. It was the fall of '61. But the flight operations team had these Mercury flights to fly and we kept

flying them. So we kind of were the last to leave Langley and to move as a group to set up camp down here in Houston. And that would be right, the timing.

As early as the fall of '61, Space Task Group people were moving from Langley Field to Houston and setting up camps in the different buildings we had leased. The operations team pressed right on. But then in the spring of '62, after Glenn's flight, we now put together coming here, and between April and July we moved and we went out here. So before that time, before the spring of '62, we already had a lot of this work going on about the engineering people conceiving and contracting for Gemini. We had people that were going to work in Houston on Apollo reporting to Langley, because the operations organization was still there even though the plan was to be here. They worked for a few months there and trained with us, got familiar with us, and then we all came to Houston in the April to July time frame of '62.

RUSNAK: How did you get up to speed on the Gemini spacecraft? Did you have a chance to get some hands-on work there? How did that work?

ALDRICH: Well, because the contractor was the same, McDonnell, and we had these McDonnell people, we had Ed Neiman and Dana Boatman and several others in the flight operations team as part of us, and I had been to the St. Louis plant so many times on Mercury, it was a smooth flow and we came up to speed. It wasn't really a different group of people we were dealing with; it was really just an upgraded spacecraft within the same team.

RUSNAK: What sort of tasks were you looking forward to doing on Gemini?

ALDRICH: Well, Gemini picked up right where Mercury left off. I mean, we had now our concept of operations in place. We were feeling confident with knowing how to do it and with some success. And [Gemini] was just a bigger spacecraft that did some more things and involved some different environments in terms of the number of astronauts and timing, but it was really a very logical buildup and flow. There was some different hardware in terms of we now had a different launch vehicle. The Titan II was different. So some things were different, but it seemed like an easy transition in terms of learning some new stuff and making that the next step in our repertoire.

Probably the biggest change in Gemini in these flight operations and ground support, at least in terms of the remote sites, is that we now switched to computer-processed data to some degree at the remote sites. In Mercury, there had been no ground processing other than radar tracking and trajectory calculations, the kind of things you needed to fly the orbital and the launch and entry trajectories and the parameters related to that. They were done by computers, but the data processing was all done by hand. You'd look at it on analog displays, on meters, or on these strip charts and read the number and write it down.

In fact, in Mercury we developed what we've called all those years a summary message. That's a summary of the spacecraft data, and the first one had about twenty parameters from the Mercury spacecraft that each site would read out, write on their list, and send in by teletype, and it would be compiled in the control center so you could plot a trend of what the data was. That doesn't sound like much data, but the Mercury spacecraft itself only had eighty-eight parameters that came down on telemetry. They had a mechanical commutator on board, and it had eighty-eight pins, and they could be either measurements like oxygen pressure or events like these retro rockets firing, but there were just eighty-eight of them.

So at the remote site, we took the top twenty, wrote them out by hand, gave them to the teletype operator. He would send them in. The job in the control center would be to get them and put them side by side and plot them. I guess they went to the other sites, too, so any of the systems monitors at the sites, whether at the control center or elsewhere, could do this, but it was all manual, all by hand.

In Gemini, I believe it was a UNIVAC 1218, was the name of the computer that was selected to run at the ground stations around the world. Now it would strip out the data, and it would automatically make the stack of data and automatically transmit. So you're now one step in the age when we're monitoring by computers. We're looking at digital information, and we've gone the next step. That's the biggest change to the sites, I think, for the Gemini Program.

You're going to ask me in a minute about the change in the control center, which was much bigger, but the ground stations were upgrading, too, and there were new consoles. They were a little different consoles. I don't remember much about them because I didn't do the remote site job in Gemini. But I did do the management of the spacecraft data, and so the summary message and the computer processing of the systems data on the spacecraft were pretty important.

RUSNAK: Why don't you go ahead and tell us about the changes in the control center then.

ALDRICH: We were working in Houston now, and we'd had all this stuff. Like I say, we had a real vision of what our operations concept and approach was, and we were looking to refine it and build on it, not to change it. So when we built the first control center in Florida, I'm sure we

drew in a lot of experience from a lot of people, but there wasn't any prior background of flying these kinds of missions. So it was concocted to be what it would be at the time.

Now we're going to build one in Houston, and it was going to based on a job we had some understanding of. We structured something that was, (a), a lot more computer-controlled, but, (b), a lot more like what we had in Florida than different. We still had the same number of consoles, the same number of people. I'm sure a few things were added, but it was laid out the same way.

The big difference was, we had these big mainframe computers now, and we could display the data on video screens and on big wall screens. For the trajectory team at the Mercury Control Center, they had these mechanical plot boards where they would watch the radar track, stands two-thirds the height of that wall and about four or five feet wide. They had several of them, and they would use ink pens on paper to plot the trajectory and they'd watch the thing go up. They had these right in front of their consoles and they'd watch it go up. Now, of course, it was back displayed in color on these big screens in the control center here in Houston. So, big upgrade in technology, very focused on doing the job that we had learned a lot about how to do, and our idea that that was the way we wanted to do it, but we wanted to expand it into what Gemini and Apollo was going to require.

So we had a team of people led by Gene Kranz up here. We worked at the Stahl-Meyers Building, which is up where Wayside crosses the Gulf Freeway. It's now the Oshman's distribution center. We worked in there and we laid out this control center, how many controllers there would be, how many back rooms, what the consoles would be like, how each console would be used, how the data would flow. We conceived of the Houston control center, and then it was built and it was ready in time to support Gemini III.

At that time we were certain about our systems and our process in Florida, and we'd flown Gemini I and II. So for Gemini III, the control center in Florida was prime and the one in Houston was backup, and both were manned by experienced flight control teams and both went through the job and we compared. There was a little bit of a crutch here in Houston at that point. The flight dynamics people I talked about a few minutes ago on the team had their displays on the plotters installed in the control center in Houston so they could see those, because they were a little nervous about these back-lighted displays that were going to be the prime ones for the control center. So at least for Gemini III and a couple of flights had the old plot boards there, too, so you could be sure you knew what you were looking at.

We did an interesting thing for the spacecraft systems monitoring in Houston the first time. We now had these video displays. But the way we'd looked at the systems data in Florida in the past, we had about eighteen meters across. The meters were analog and they had scales that were made up and the needles would say what the readings were for pressures and temperatures. We had little pointers that you could manually set on each meter so that you had limits, and if the thing went out, it would key you. I can't remember if—I think it probably lit a light, orange or red or both.

So when we saw we were going to move to these consoles in Houston with these video screens and have a lot more data, I can't give the readout of how many parameters Gemini had compared to Mercury, but it was a lot more and it was a big data stream now, we were concerned we wouldn't be able to do the flight control monitoring job the same way because we wouldn't have these analog meters you could look at and these limits to set. We were just going to have a table of numbers on the screen and we didn't know what to do about that.

So we built these computer displays that were meters. They were meters, sketched out by the computer, and had the needles and had the other ones. For the first few Mercury flights, we had a replication of the meter console in Florida on the console systems and EECOM [electrical, environmental, and communications] in the control center in Houston. They worked fine, but what we found out was actually the table of data, digitally, that has been used since, really was easy to use. In fact, you can get a lot more on the screen, and you could group things together and see them. So even though we went to all the trouble of building those, they didn't carry over anything of real significance, and they didn't last very long. But we did it. So the flight dynamics guys had their plot boards and we had our meters, but we were in this new-technology control center.

I went to the Cape for Gemini III, and we had a backup team in Houston. Then for Gemini IV we switched, and we had the prime team in Houston and the backup team in Florida. Maybe we didn't have a backup team. I don't know. I'm sure I was here for Gemini IV.

RUSNAK: Was each controller then responsible for the design of their own console? Was there a group?

ALDRICH: Well, there was a group. For instance, the aeromedical people weren't a part of this little flight operations organization that Gene had. They wouldn't be sitting there with us every day working on this. But we had a group of people that were some of the lead systems and trajectory and procedures people that worked for Gene, and we would consult with them. We'd consult with the aeromeds and we'd consult with the people that operate the control center

system overall. We sort of worked as a requirements design team to put this control center together under Gene. It was some of his key people.

RUSNAK: Tec [Tecwyn] Roberts is a name that's generally associated with the design and construction of the control center. I was wondering if you had any interaction with him.

ALDRICH: Well, yes, because even after we got to Houston we were all pretty tightly coupled. We did work with Tec, but I believe Tec—I think he would have been more attuned to the flight dynamics requirements, organization, computing, trajectory processing, and the very big responsibilities, big areas of the control center that weren't in my particular area of focus. In fact, I think Tec was pretty heavily involved in the design of the control center at Florida, too. I've talked about Frank [Chalmers], but I think Frank didn't stay with us too long. I think Tec was also a key person in that as well.

RUSNAK: Now that NASA's had a couple of years of space flight experience and is expanding its rosters to get the new program Gemini and get people into Apollo, what sort of other groups of people were they bringing in? You had mentioned before the four kind of key people at the beginning. Were you seeing changes to the composition at NASA at the time?

ALDRICH: When we moved to Houston, there was a great increase in the overall size of the Space Task Group, or whenever it became the Manned Spacecraft Center. There was a huge amount of additional people brought on board. It was no longer this very tight, small organization that started. These people came from a variety of places. It was no longer a

collection of these and a collection of those; it was a broad assimilation of people. It started, as I pointed out, while we were still at Langley. We were seeing new people intended to be part of the operations organization coming in, but there were other people in other organizations of the Center also coming on board.

RUSNAK: What effect did that have on NASA's culture or the way of doing things?

ALDRICH: I had the feeling that the Space Task Group and the Manned Spacecraft Center developed a culture of how to do these technical programs and these challenging new things based on the vision of these early people from NACA that I talked about—Gilruth and Mathews and Kraft and [Sigurd A.] Sjoberg and Kleinknecht and a number of others. They set a process of being successful in this business that was just the essence of this organization, and it continued. It was there at Langley, but it was also here in the early years in Houston, and it continued as the Manned Spacecraft Center got its site built and we all filled these buildings, and it got to be big, and we got into Apollo. It never seemed different. It seemed a very fine organization with great vision and great leadership.

Another person who I respect tremendously is George [M.] Low, and he didn't come into it at the Langley time period, but he came into it soon thereafter, and he was out of the same mold of people. Outstanding.

RUSNAK: Did this corps of people who were coming out of Mercury bring with them certain lessons learned that you felt were most valuable that were directly applied to Gemini?

ALDRICH: We brought more than lessons learned; we brought the whole process. I mean, we converted the Mercury documentation, the countdowns and the procedures and the mission rules. We moved to a new scope of Systems Handbook because Gemini was actually a lot more complicated. Console procedures. All of that wasn't brought on as lessons learned. It was evolved, and by the same people that built the first set and some new people created the second set, and then the same thing for Apollo beyond that. So we were the benefactors of our own lessons learned and we were reapplying them as we went, I would say.

RUSNAK: If you could then lead us into some of the Gemini missions, you mentioned the first few that were run from the Cape, and then with Gemini IV, the [Houston] control center was taking the lead. What was your role in these and what specific events from the flights, here and there, stick out in your mind?

ALDRICH: Well, at this time frame, somewhere in this time frame we've just been talking, we got big enough that we got a bigger organization, and I was made head of Gemini systems organization. I guess it was a branch or a section, I don't remember. Maybe it was a section. But I was the head of the Gemini systems organization, which meant each of the flight controllers that was going to work at one of these locations, remote site or control center on Gemini, worked under me. My scope was expanded to train, acquire, have the people that would be GNCs [Guidance, Navigation, and Control officers] and be EECOMs and the back-room support people and their staff that would go with them to the remote sites.

So the whole job of ground flight control for Gemini fell under me, and that involved not only training, but this documentation for each flight, for each spacecraft, for each flight, the rules

and the support documentation. This team of people I had would do those. I mean, you wouldn't wait for the mission rules to be delivered to you; you would crank them out. You'd work on them. The team would do them, and so they didn't have to be trained on them because they create them. So that was the job for Gemini.

I was still a GNC operator, but there were a number of others because now we were on multiple shifts for every flight, and we had back rooms here in Houston where there was substantial additional monitoring capability and staff that were part of our team that would look at specific areas of electrical or reaction control system. So that's what I did.

The flights went quickly in Gemini. We flew something like the ten manned flights in eighteen months and the last five in six months. They came one right after—they came so fast. We got our teams ready and we were all together doing it. You didn't have to have exactly a training period. You just had to bootstrap yourselves to the next one and be sure your level of knowledge was capable and that your documents were now correct and focused. So it was a very dynamic period and very good. I had this team of people.

At some point these Philco people that were part of that team looked at Gemini became Philco-Ford. I don't remember exactly when that was, but this was the same group that we'd had at Langley pretty much that were Philco initially. So it worked pretty well. I had the people in the control center, but also the ones that went to the remote sites for the Gemini spacecraft.

RUSNAK: From a technical perspective, Gemini had a couple of new things on board, a couple of new systems, like fuel cells, for instance, and the computer. How did these items affect your job? How did you learn about them and what do you remember of them from their performance?

ALDRICH: Well, we learned about them the same way. We had this on-site part of the team that was from McDonnell Aircraft. They were engineering specialists and who would tie us into the engineering organizations in St. Louis. What we did was tackle these systems and learn about them. These operators, one of the things they had to do was draw the systems schematics for the system they would work on. So you had to draw a fuel cell schematic and cryogenic tankage schematics and learn about them.

I remember going to St. Louis a number of times to meet with the design engineers on these systems and the other people that worked for me did, too. So we had the responsibility to learn about them, and we had the connection with the supplier, McDonnell, that had the information available. We just had to convert it to the kind of format and understanding we wanted to support real-time flight operations. And that is what we did.

RUSNAK: This is obviously just one instance, but you talk about working with the people from McDonnell to learn about these. Did you likewise work with the MSC engineers themselves, the NASA folks on these?

ALDRICH: Oh, yes, worked extensively with the NASA engineers, and they had expert teams in each of these systems areas also. I think not so much in Gemini as in Apollo and later, that we had a big relationship with the JSC organization. I think in Gemini most of the engineering organization at JSC was already working on Apollo. Gemini was kind of a follow-on to Mercury that we did as an operations team and as a center. But I think the design phase of Mercury didn't last too long from what JSC was focused on, and Apollo was such a broad, new dimension that

the engineering organization mostly focused on that. That doesn't mean you couldn't get any kind of expert help or advice that you would want.

RUSNAK: Can you remember any instances from the flights where you turned to the engineering team?

ALDRICH: Well, the engineering team was there for every flight. We had a mission support room for every flight and on-call availability of key people in our Johnson organization, but also key people in our contractor. But it wasn't as big and formalized as we got to in Apollo, where we put in place a very broad and rigorous ground support real-time monitoring network.

The new systems on Gemini, you've referred to some of them. The key things in Gemini that we had to do beyond Mercury that were critical to Apollo was, one, we had to explore extravehicular activity, we had to do EVAs [extravehicular activity], we had to do rendezvous, and we had to do docking. Apollo was going to require them. Mercury wasn't designed with those things in mind, and so that was the focus for Gemini.

You're right about the fuel cells, and we had a lot of interest in fuel cells and had some problems with them. The EECOMs that used to work for me in Gemini used to keep a little running tab on their console about how many cells in the fuel cells had failed. There were like three fuel cells and each one had maybe four cells in a stack. They had the tendency to degrade over time, so they kept a running tab of fuel cell stacks on their console.

We also had some problems in Gemini with the thrusters that controlled the spacecraft. We would struggle with spacecraft control and thrusters, but mostly the Gemini systems worked. We did explore these new dimensions—longer flight times, EVA, and rendezvous and docking.

The people that worked for me were responsible for the systems on board that did that and monitoring in real time and advising the rest of the flight team about options and what we could do.

RUSNAK: The most harrowing moment on Gemini was probably the Gemini VIII mission.

ALDRICH: Gemini VIII mission was a big challenge. It was not too harrowing, because it was such a quickly occurring problem that—I guess it was Armstrong and Scott had this occur, and it either occurred over Hawaii or prior to Hawaii, and it was so rapid that by the time we acquired and talked to them, they had already dealt with it and solved the problem, and I mean backed out of the problem, separated. So you didn't get a lot of before-the-fact flight control assessment and decision-making, because it happened. That was an instance where crew training was vital, and if the crew hadn't been up to that, there'd probably been no way to take care of it.

But it's interesting, all of us, including the crew, thought that this thing had occurred, this rapid spin-up of the spacecraft, occurred after the Gemini had docked with the Agena for the first time. We docked with the Agena and were flying along, starting to do the docked-flight program and they had this rapid spin-up and out-of-control situation. They and all of us that I knew in the control center believed the Agena was the cause of this problem. This thing, now, we'd flown Geminis before, we'd had all this experience over the past, and we were comfortable with our spacecraft. We docked with this brand-new unknown thing and had this problem.

And it was interesting because the propulsion system on the Gemini for OMS [orbital maneuvering system] and RCS [reaction control system] was part of my responsibilities in the GNC area, and we didn't know for several days exactly what had caused that problem. We knew

that we recovered. The crew and the flight control team tied the mission off and ended it off successfully. But it wasn't until they flew the tape from the console at Hawaii back to the control center and we played into my console, my GNC console in the control center, I had the little green lights for all the thrusters up, and you could see this green light come on that was the Gemini thruster that stuck on and—like that [snaps fingers]. I knew and we all knew that it, in fact, had been the Gemini that had had the problem and not the Agena. Maybe there was somebody else who knew that that had been the case, but I hadn't talked to him. We didn't know. The team of flight controllers on Gemini that we had, none of us knew it until we saw the Hawaii tape. The displays at Hawaii weren't sophisticated enough or too abstract for the flight control there. I think they played their tape back, but they didn't have any live display that would key that. They probably would have to go into a detailed data analysis to find it. Their job was to pack up and get home. But the control center console just had it right there.

RUSNAK: It was obviously a problem that, as you mentioned, the flight crew was able to take care of through training and then you were able to analyze through the setup of your console, so preparation seems to be key for this. So I'm wondering if there were other moments in the Gemini program where you felt that your or the crew's training and preparation really came into play, if there were any other moments that you recall.

ALDRICH: Well, this isn't something that would relate to the jobs that we had on the systems consoles, but the flight termination, the mission termination before launch on Gemini VI was an extensive attest to the fact of how well trained the crew was, because the situation that led to the shutdown of GT-6 on the pad could well have caused the crew to call an abort and abort the

spacecraft. The fact that they didn't, I've never had a detailed discussion with them about it, but it was certainly the right thing to do. It probably took feeling and intuition beyond just the situation as it was faced, they faced, but it showed how well this team was coming together, how capable the crews were and how well trained they were. That could have been a bad day, and it turned out to be an okay day.

RUSNAK: And you managed to get up and do a rendezvous as well.

ALDRICH: Got up and did a rendezvous that was just tremendous. In fact, you were talking about how some of these early missions and projections impressed us. I think the 76 [GT-7/GT-6] rendezvous impressed me as much as anything we'd done up to that time. It was fabulous that we could make that kind of thing happen. It was so real. It just worked. And nobody had done it before.

I remember one of the responsibilities we did have in the GNC area was the budgets for the fuel systems on board the spacecraft. We had this great debate about how much of the onboard propellant the Gemini spacecraft would have to use to do the rendezvous, how much it would take and how much we could allocate and when we'd have to cut off and say we can't keep trying this rendezvous anymore because we'll be out of propellant to come home. There was really no basis of prior experience to base that on. You kind of had to do it through intuition and engineering analysis and what the trajectory requirement was going to be and what the spacecraft would take to do that. We went round and round on that.

I remember one day we finally had a meeting where we were going to cut that. We talked through that again. Chris Kraft went up to the board, and he said, "Here's what we're

going to do," and he lined it up. He says, "We're going to allocate this much. This is going to be it, and that's what's going to happen," and solved the debate. And lo and behold, when we flew, that's what it took. He was more decisive and more focused on leading us to the conclusion he felt we ought to come to than any of us were, and he was right. It's a little like the Schirra story on GT-6 I just talked about. I mean, these people knew how to do these things.

RUSNAK: The incident you mentioned with fuel for rendezvous, if I recall, they attempted a rendezvous of sorts on Gemini IV with their Titan booster and ran into these problems.

ALDRICH: Well, those weren't quite the same problems. That was more a lack of full appreciation for orbital trajectory, that we hadn't stepped up to thinking that through and everybody being communicative about it and understanding it. So he was just maneuvering in the wrong direction. He was maneuvering in a way that would cause separation, trying to cause closure. I don't know why we—probably there had not been the right amount of communication and planning. I'm sure there were people in our trajectory organizations that knew about the orbital dynamics situations and what that would cause, but that hadn't been well enough talked through and understood. So it clearly didn't work, but I think after we analyzed it, we understood why.

That really didn't relate—I mean, we were now talking about getting beyond that problem and doing the rendezvous with the right kind of trajectory process and maneuvers, but even so, it wasn't clear how many of those maneuvers or how accurate they could be or how the alignments would be or that little visual tracking would be as to how much just to stay on those

trajectories and pull that off, and that's what we were working in this part I talked about what the budget would be for the whole job.

RUSNAK: Gemini IV was also, of course, most famous for the first American EVA. So I was wondering what you remember of that and what effect missions with EVA had on your position, if any?

ALDRICH: Well, missions with EVA were definitely part of what we were responsible for in terms of monitoring and following. Ed [Edward H.] White's EVA was another dramatic thing. I don't think we were usually very surprised these things that we planned to do would happen, but after they did happen, we felt great about it. That was great opportunity. We needed to do it, we planned it, and it happened.

Later in Gemini there were some problems with heat load in the suits during EVA and with clouding of the visor with moisture. Most of the monitoring of those things involved advice to the crew about calling things off or slowing down or backing off or getting back in. There wasn't much you could do to fix those problems in real time, but they were worked on between missions by the engineering people. These would be people in the engineering department at JSC in the Environmental Control Branch or whatever they might have been called. So there were adjustments made to the equipment from flight to flight for the EVA performance. But in real time it was mostly operations caution and procedure and how to do the most you can do but stay out of trouble or back out of trouble.

RUSNAK: You had mentioned also the Gemini 76 mission, where you've got two spacecraft up at the same time. What sort of challenges did that have for the flight controllers, where you were controlling two and not just one spacecraft?

ALDRICH: I can't remember how we split the data on that between the consoles and the people, but we worked out a way to do it, and it seemed to work well. I don't recall a problem with that. Now, of course, we could have had some problems maybe that would have given us trouble, but we didn't and it worked for us.

RUSNAK: It was a good rehearsal for the Apollo mission where you do essentially have two spacecraft at the same time.

ALDRICH: And they were good—we did. In Gemini, we had this team of people that worked for me, they were EECOMs and GNCs that did Gemini. We had another organization that did the Agena. They had, I think, a systems person and a propulsion person. So we had four consoles doing Gemini and Agena. Agena didn't fly on all the Geminis, but it took all the preparation and training to be as accomplished for when we did fly then as anybody else in the control center was. So it was an about equivalent-sized team and a lot of work.

When we went to Apollo, we now had the CSM [command and service module] with an EECOM and a GNC, and we had a LM, lunar module, with an electrical console and a propulsion control systems console. So it was a similar balance, a similar layout, a similar concept for the two spacecraft in both.

But when we had two Geminis, that was a little different. That then took the Gemini side of that equation with an EECOM and GNC and gave them two spacecraft at the same time. We did a hand-off and sharing. I can't remember the details of it.

RUSNAK: Since you started on Apollo, the two programs overlapped obviously in terms of the operation of one and development of another.

ALDRICH: Yes.

RUSNAK: Were you trying to juggle both programs at the same time, or on the operations side did you not get into Apollo until they'd closed the doors on Gemini?

ALDRICH: Well, as I tried to describe earlier—maybe I don't know enough about it—on the engineering side, we sort of had different engineering teams working Gemini and Apollo. Most of the engineering organization at Manned Spacecraft Center was working on Apollo. We had some help on Gemini, but I think mostly we were using the McDonnell organization as our engineering support. But as we approached Apollo, we didn't have two operations teams. We just had an operations team that was manning these multiple shifts during Gemini that had grown out of the smaller team we had in Mercury, and now we had this team of people. And we had a group of people working on operations for Apollo, but it was not, for the most part, the experienced team that had done the missions in the control center on the two prior programs.

So at one point fairly on into Gemini, my job changed and I became head of what was called the Gemini and CSM Systems Branch. Mel [Melvin F.] Brooks was made head of the

Agena and Lunar Module Systems Branch. So we melded the team of people who'd been working CSMs and LMs for Apollo and pretty much, for the most part, weren't experienced flight control people or at least they weren't on an ongoing basis doing the Gemini flight control and Agena flight control. We moved them and melded with the people who were doing… Agena and Gemini, and we started to blend the two. Now we're working into doing simulations of both and starting to do the Apollo missions operations documentation and handbooks and procedures and mission rules. So there was a blend in the office even though Gemini was flying and we were doing the console work for Gemini.

In fact, as we come up on Apollo, AS-204, by that time we had had a complete meld, and the teams that were in the control center when AS-204 was doing its testing and we had the fire and the terrible problem, was the Gemini team now molded into an Apollo team. Certainly in the CSM systems area it was.

RUSNAK: Prior to the 204 accident, did you work on any of the unmanned Apollo launches?

ALDRICH: No, there was another team of people. We had a series of Saturn launches that tested the vehicle and then we had some CSM boilerplate, or maybe better than boilerplate, spacecraft fly on some of them. We had these Big Joe flights with some spacecraft test equipment out in [White Sands] New Mexico. There were people working on those. I think some of them had been spun off the Gemini Program at some point to go work on that. But this team of systems people I had, had not. I didn't have any Saturn people, so I didn't have to deal directly with that. The boilerplate spacecraft that we had weren't particularly like the CSM flight spacecraft. So none of the operators I had did that.

I remember Glynn [S.] Lunney took a group of people out to White Sands for several of the Big Joe flights, and they worked on those flights and supported them. They were part of the operations team. I'm not sure who they were besides Glynn. It wasn't a big team, but we were involved in that manner.

RUSNAK: During this period as you're heading up the CSM systems and you have these systems people underneath you, how did you guys feel about the performance of North American and the Block I spacecraft prior to the fire?

ALDRICH: Prior to the fire, we didn't have an uneasy feeling about the spacecraft, but we were just coming off Gemini. We were trying to learn it. I mean, you couldn't call us expert on CSM systems or in detailed collaboration with the North American people at that time. We talked a little earlier about the transition from Mercury to Gemini, the same people in St. Louis and the same organization. That didn't happen when we started Apollo.

We had now a new contractor, North American in Downey [California]. I remember the trip. I went with Chris Kraft and several others at some appropriate point in time when operations started to focus on Apollo. We went to Downey and we spent a number of days talking with the engineers in technical management there about the lessons we'd learned in Gemini and what we thought you ought to worry about in design of a spacecraft. We had a good set of interactions, but they're new people. That was when I met George [W.] Jeffs and Dale [D.] Myers. They were the two senior people at North American in Downey that were leading the Apollo effort. We were starting to develop an interface and a relationship. We thought there were things they ought to know about spacecraft, but they were things like we learned with fuel

cells and thrusters and the flight experience we had. We weren't questioning their ability to design an Apollo. It was a big job and a lot of people, and there was a lot going on. We had a lot of our engineering organization at the Manned Spacecraft Center engaged with them.

So I think our biggest worry coming up on the operational phase of Apollo was just we as a flight control team being able to become knowledgeable enough and smart enough and develop our process well enough so we'd be prepared to do our job. We weren't thinking about other things.

RUSNAK: You were assigned to one of the shifts for the 204 fire, for the mission.

ALDRICH: I was. I was in the control center when we had the fire, plugged into the GNC console. It was an event that happened. There was no lead-up to it or warning, and it happened.

We'd had some things not go right in some of these unmanned tests we'd run. We'd had quite a lot of them in Mercury, and some things happened in Gemini. But this was our first really serious failure. Frankly, it was quite a surprise. It was devastating. We didn't know what to do.

I talked early on about we always had this feeling of confidence, that we could do what we were going to do. That's how we waded into it. We overcame things as we went, and things worked for us well. This was clearly not that. It was quite a change.

It was like it's been years and problems since, though. This team took hold of it and set about to figure out what we had to do to recover and how to get back on track and where to go next. Everybody converged on that, and we went forward.

RUSNAK: Were you involved with the investigation at all?

ALDRICH: Not with the investigation, but I was asked by Chris to review the audio tapes the day after it happened and see what we could learn from that. So I made detailed log of the audio tape during the problem period. That took a little doing. It was a challenging thing to listen to. But what I found out also was that not all of the loops came from the Cape to Houston. So even though we got that and figured out as much as we could from it, we found out later that there was more audio that the Cape had that added to that story.

RUSNAK: I hadn't heard that before. Did you also review any of the data from the consoles or your particular one out there?

ALDRICH: No. No, it went beyond the point of data just in a few seconds. Now, there was a great amount of analysis afterward to figure out what caused the fire, and I worked quite extensively in that. During this time period I was getting to be more involved with the Spacecraft Program Office than we'd been in Mercury and Gemini. I guess in Mercury the spacecraft program office was pretty small. Gemini, also fairly small. But in Apollo, there was a pretty big Apollo Spacecraft Program Office [ASPO], so I was getting more involved with them in that as a representative of flight operations.

After the fire, there was quite an extensive analysis to figure out what caused it. Some very bad situations were turned up immediately, but the specific—to have a fire, you need three things: you have to have oxygen, you have to have a spark, and you have to have something that's flammable. We knew where the oxygen was, and we found that there were a lot of

flammable things, more than we'd ever worried about looking for, but we still didn't know where the spark came from. So there was quite a lot of analysis to try to pin that down. I think there was a conclusion drawn finally that it was a piece of experimental equipment that was added in the cockpit. That didn't play a big role in what we did next, but you still have to try to analyze what happened and tie it off.

So what did happen was, following the accident, we clearly had to do a redesign of the spacecraft. George Low, the Apollo program manager, he started having a detailed series of reviews to decide what to redesign and work the redesign. After the initial, I'm sure, pretty intense period of that, he started having a review once a month in Bethpage [New York] with the lunar module, even though it wasn't implicated, and once a month in Downey with the command service module, where that redesign was going on and also the latest spacecraft were coming into play.

My job got to be to each month go the change board meeting by the Apollo program manager in Downey and participate in that review. That's what I really mean about getting more directly involved with the program office. In the prior programs, I don't think we had a member of the flight control organization per se participating in the program management change boards, but with this initiative and this big job on Apollo, that became what we did and it carried over into Shuttle. I was involved from then on as long as I was flight operations in the program office change meetings, and this kind of kicked it off.

What we found with the Apollo was that not only were there some really bad items of crew equipment that were brought into the cabin that were flammable, but that if you going to have a fire in pure oxygen, even the aluminum lines in the spacecraft were flammable. You could burn aluminum easily. And we had to find any electrical problems that we'd want to get

rid of. We had to change out some of the metallic equipment in the spacecraft, particularly these aluminum lines. I'm sure we made some other changes.

The interesting thing that George Low did, he asked the engineering organization and he asked mission operations, flight operations, who had a lot of experience with these vehicles now, "What other changes should we made to the command service module, not just as a result of this fire, but other areas you have suspected or known weaknesses that we could strengthen during this period of redesign?" We had a list. We put together a list and we submitted it, and he made other changes, not just fire-related changes. That had a big impact with me.

After the Space Shuttle *Challenger* accident, I was in charge of the program and I ran the change board for the Space Shuttle and particularly the Space Shuttle Orbiter. Not for the Space Shuttle Orbiter—for the Space Shuttle. The decision I made about how to go about tackling that problem then, I based really on participating with George Low and how he did the recovery and the engineering credibility from the AS-204 fire to flying again on Apollo 7.

In the Space Shuttle *Challenger* recovery period, we made over two hundred changes to the spacecraft and to the operations and to the ground facilities, and only a handful of these were related to the problem with the solid rocket booster. That was structured exactly on the kind of thought process and change management flow with the organizations that I saw George Low do after the fire.

RUSNAK: He's often given a lot of credit by people who are involved with Apollo for really guiding the program as a whole after this whole period. It's interesting to see that his influence is still playing out years later in the Shuttle program. I guess in terms of time, it wasn't all that

long after the 204 fire that they were flying manned missions. It was something like eighteen months.

ALDRICH: Yes. It was a great recovery. You asked about feelings about North American and lack of confidence or other feelings about having them proceed. I didn't have those feelings at that time, partly because I was already getting close to the North American team and working with them. Clearly there were deficiencies there, but I wasn't caused to think about it in that context immediately and I didn't, but in retrospect, looking back, I think the fact that we had this spacecraft that was essentially a test chamber or a test environment that was in pure oxygen, there were a number of failings in what we'd set up and what we were doing that was beyond just the design of the command service module. That's a bigger area of consideration, that you have this chamber with pure oxygen and people in it, and what you do to be sure that's a safe thing to do. I mean, we'd done it in Mercury and in Gemini and had not had a problem, but we knew what we were doing and we had some of the best engineering minds that existed working on this thing. So I think collectively we missed some things there that we shouldn't have. Rockwell, then North American, was a party to that, but we were all a party to it. That's the way I felt about it.

I did have to deal with that some, because right about that time we were starting to work on a program called the Apollo Applications Project. Bob [Robert F.] Thompson was working on putting that project together. It was based on using various Apollo pieces of hardware for orbital test environment beyond Apollo. It wouldn't be tied to going to the Moon. Of course, the CSM would be a key part of that, because it would be the vehicle that the crew would live in and would transfer in.

So I was asked to be involved in some deliberations about [Apollo Applications Program] and should it be built by somebody else, should it be assembled by somebody else, and what would we do with these CSMs. But in the end, we analyzed the problem for the fire, we analyzed the changes we got to make under George Low. We rallied the team and rallied North American with us, and we didn't ramp off.

I guess one of the things we maybe did in that time, was that the time we brought [Boeing] in a separate system integration analysis contractor for Apollo? I think that happened, and so that was probably a good step. It didn't involve maybe making a change with how you built CSMs or who built them that would be very difficult to struggle with and it might or might not be a positive step.

Certainly the NASA program and, from my view, the North American team recovered from that. Both what we did in Apollo and what we did in Space Shuttle Orbiter following that, I've been very proud of and I think the team has a right to be very proud of.

RUSNAK: It certainly does. Aside from the immediate period after the fire, did you sense any change in mood around NASA from the period before the incident and in the months, again not immediately preceding afterwards, but as you were getting closer to the flight of Apollo 7?

ALDRICH: No, I didn't. I still sensed the same "can do" attitude and "we will do" attitude and eagerness to work on it and work together to get it done. It raised the question even more of whether we could get to the Moon within the decade, but nobody dwelled on that. I mean, we just set about getting on to the next step as quickly as we could. I think that would be also a tribute to George Low, who said, "Let's not find the minimum fix and move as fast as we can,

but let's find what it takes to make it right and set about doing that and do it as expeditiously as we can."

RUSNAK: Some of the people suggested that even in this later period that they felt even a greater sense of this "can do" attitude than they did earlier on, because they've had this whole string of successes and then now they're going in this mode, well, we need to really double our efforts to make everything successful, and become less complacent, I guess.

ALDRICH: My corner of the organization, which is the flight operations corner, throughout this thing was consistent. It's just like we felt about everything else: "We're going to make that happen now."

RUSNAK: Getting Wally Schirra and the other two up on 7, it turned to be a very successful mission. Were you still looking forward to being in the control room, or were you looking to other positions?

ALDRICH: Well, I can't remember the exact timing, but what we felt we had to do for Apollo was to expand and formalize on this engineering support to the flight operations team. For Apollo we created an organization called M-E-R, must be Mission Engineering Room. Anyways, it's the MER, and it was run by and staffed by the JSC engineering organization and had some very good people there that would come to another area outside the control center. It was actually, I think, it's what's called Building 11, but I can't remember if 11 is the right number. Anyway, it's the building just over from the control center. They put essentially a

monitoring facility in there with displays and data so that the engineering could come together during the mission and actually look at the spacecraft data and analyze it and talk about it, but they wouldn't have to trained as operators. They were still engineers.

Then we also had teams both at Bethpage for the lunar module and at Downey for the command service module, and they were tied in. They sent some people into the MER, but they kept the bigger team back at the plants where the spacecraft were built. There had to be some way of pulling that organization together so it could work real problems and communicate things it was concerned about in an effective and controlled manner.

We created this organization called the Spacecraft Analysis Room, which is a room that was just off the front room in the control center. It was staffed by key people from the flight operations organization, who had people working with them that were actually running the flight on the operations team, but also by key individuals from the engineering directorate and from Grumman and from North American.

Also immediately in the Apollo time frame, my job became the key CSM person in the Spacecraft Analysis Room that we called SPAN. I believe Jim [James E.] Hannigan was the key person for the lunar module. We would be in that room, and all of the GNCs and EECOMs and the people that supported Jim for the lunar module and the people in the back room that supported the CSM and the lunar module also worked for us and developed their procedures and training and documents under us. But during a mission, we'd have all their control loops from the back room and the front room, but we'd be in the SPAN room and we'd be sitting with these key people from North American and Grumman and key people from the engineering organization who had their own lines of contact to the Mission Evaluation Room and to these other places.

This became a central point where whatever came up—the key thing in the mission operations team is to be prepared to deal with whatever thing happens with whatever time you have. So if something starts to take a bad trend, it's something you've got time to work on, then you want to draw on as much expertise and additional information as you have, as you can. If it's something you have to in seconds, you have to be prepared to do and do it what you can—call for help, there's no time. That's part of being trained to be an operator in the control room.

But many, many things are trends that happen, things the crew sees, things that we see on the data, and you can analyze. So there's a paper tracking process that goes in place. The operator in the front room will talk to me or Jim about it, but he'll also write down what it is and send it to us. We'll talk about it to key people in the SPAN room from these other three areas and decide what kind of help we think we need. But then we write a little task and send over the Mission Evaluation Room and say, "We're seeing this. What do you guys think? What should we do? What are the options?" and so forth.

That got to be a very effective method of operation with just about the right amount of separation between the organizations so each one could do the job that they were accountable, without stepping on the toes of the other part that had to do their jobs, but also very good communication and pretty good formal tracking and control. That was used through [Apollo] and on into [Shuttle] with great effectiveness. In fact, I did that in Apollo up to Apollo 15, when I stopped being in the flight operations organization.

RUSNAK: How would you describe the relationship between the mission operations people on the one side and the engineering people on the other, since obviously the SPAN and the MER were sort of the nexus of these two organizations?

ALDRICH: The people on the mission operations team were people who had been trained to do what I said a couple of minutes ago. They're prepared to look at things as they're happening, listen to things as they're happening, know what's supposed to be going on, what's a non-normal situation, and deal with it. And they've got to deal with it within the time available. If something is leaking and it's going to be gone in ten seconds, if you're going to do anything, you've got to do it in ten seconds. If it's going to be gone in a week, you've got some number of days you can work on it. These people have to be able to understand the problem, have a feeling about what the implications are, and clearly know the timing of the options.

We're going to get to Apollo 13. That's a perfect example of this, what I'm talking about. What's the problem? What are the possible options? What are the time frames that have to be dealt with to either enable the options or make them impossible? That's what the mission team had learned to do in Mercury and Gemini and some of these early Apollo flights.

In the Mission Evaluation Room, these are the people that design these systems. They understand them. They know all the problems they had in tests. They know the design choices that were made as they were evolved. They know some of the warts that are there that maybe never had to surface because they went past, but they're still part of the history in those systems. But they're not used to interpreting a few pieces of data that come over a wire. And they're definitely engineers. They're thinking, you know, "To do a good engineering job, I'm going to have to take the time to think this through and lay out a plan and then evaluate it, and if you only give me a short period of time, I can't do that." So they're engineering and they're key to making the best engineering and the best analysis of all the data, new and fresh and historical,

and the stuff in the archives, whatever they can get their hands on and do the best engineering analysis and provide that to be applied to a situation you might dealing with.

SPAN is working with the front room to be sure we anticipate or are working with the problems that are potentially coming up or that the team is envisioning, working with the people on the engineering side who have the ability to come up with the most detailed engineering analysis and put together the set of recommendations that could be drawn on, and try to marry the two in terms of scope of what's done, time frame, and be sure we provide the best input to the operations team in the time frames they need it that can be developed.

RUSNAK: I think that's a very nice summary of the responsibilities and how these each worked. How did these work in actual operation once you get on a mission? Did everything flow as planned?

ALDRICH: Yes, it worked well. I suppose there were some discontinuities getting all this started in the beginning, but I don't remember them. I just remember the long hours of doing this and what an effective broad-based team of operations and engineering we had across the country that were necked through here to support these spacecraft and astronauts that were doing these things.

RUSNAK: Do you have a particular counterpart in the Mission Evaluation Room that you perhaps worked with more closely, or your information from the CSM would go to?

ALDRICH: We obviously had multiple shifts, so I didn't it all the time. I know [T. Rodney] Rod Loe did some of the shifts, and I just haven't looked at some of these manning lists. I can't remember just who else might have done them.

RUSNAK: I was wondering who on the engineering team might have been a key contact of yours or something like that.

ALDRICH: Well, we had kind of a formal flow of these written chits. The most impressive person in the Mission Evaluation Room during this time was Don [Donald D.] Arabian, who led these teams in the Mission Evaluation Room and led some of the most challenging analyses that had to be done either during flights or between flights. He was incredibly capable of doing that well and did it time after time, but he wasn't the direct interface. We had questions over and answers back, and that kind of an interface. If this got to be problematical enough, we'd have meetings where we'd come together and then Don would be there and I'd be there and Jim Hannigan and others, and we'd chalk talk and have engineering meetings. Don really led that activity and we led the SPAN activity. He had this communication of what we wanted worked on and what they thought we ought to be doing. It flowed more on paper than on a face-to-face kind of a thing.

RUSNAK: We've certainly heard some interesting stories about Don Arabian.

ALDRICH: Yes, Don was incredible.

RUSNAK: And he was a character and certainly did an outstanding job. If we could take this moment to pause and change out our tape again.

We're back again. Let's talk about some of the Apollo flights. When we were off tape, we mentioned Apollo 8, and that I understand you had an early role in planning for this mission. If you could tell us about when you first heard about sending this second manned Apollo flight to the Moon, what was your reaction and what you did after that?

ALDRICH: Well, I remember that happening. I think Cliff [Clifford E.] Charlesworth called me and said we were going to have a meeting, and went in. I can't remember the group that was together. It was a small group, with Chris Kraft, and talked about going to the Moon. It sounded like a great idea to me. It sounded terrific. There wasn't any reason that the command service module couldn't go to the Moon, other than we'd only flown it in orbit once successfully. But all of its systems we'd already worked.

It seemed to me that Apollo 8 was a much bigger challenge for the trajectory people because this is now something beyond Earth orbit. I didn't have a personal feel how prepared or ready they were to do that, but I didn't doubt for a minute that they could. So it just seemed like a great adventure and a great next step, so we started working on it. It was a very impressive thing to do, and it worked really great.

RUSNAK: Where did you see this mission fitting in, in terms of sort of a personal accomplishment? A lot of people have mentioned that Apollo 8 is sort of a highlight for them, because here we are, we're actually going to the Moon. They're not landing; these are the first

people to go around. Of course, they did that reading on Christmas and all of that. So I was wondering where you felt this mission fit in for you personally.

ALDRICH: Well, it was very impressive personally. We all enjoyed it. The biggest thing, I guess, for the command service module is that the phase of the mission where you'd go into lunar orbit puts you in a place that you haven't been before, because now you're in a place where your spacecraft engines have to fire again to be successful, to come forward with the return of the mission. So it definitely put a high requirement and focus on the main engine of the command service module, which was called the service propulsion system, or the SPS. So we gave it a lot of attention, but it was not that unusual a mission to do.

It also gave us a new opportunity in terms of monitoring the missions, because for the first time you now had continuous contact with the spacecraft for long periods of time. Always before, from the beginning periods in Mercury where we had these gaps in communications and this teletype and lack of connections between places, including the spacecraft, till the late Gemini, early Apollo, where we had pretty good voice communications with the sites, you had still periods where you weren't over station, where the spacecraft was out of communications with everybody, and you had those a goodly percentage of the time every orbit.

When we left Earth orbit to go to the Moon, starting with Apollo 8, you now picked up the deep space flight network with the stations in Goldstone [California] and Madrid [Spain], and they had a series of them in Australia, but they're all right around [Canberra], the area around [Canberra]. You had now the spacecraft there and you could talk to it and look at it continuously. You could monitor these systems continuously. You had continuous communication with the crew, all the way till you get to the Moon and then you had to go behind

the Moon periodically, which was another situation to deal with. But mostly you had full-time communications. That was a big change for the operations team and your ability to know what was going on and react at any point in time with anything you wanted to react with.

RUSNAK: Were there any surprises from that mission that you came across, or did everything flow smoothly?

ALDRICH: As I recall, it flowed smoothly. It was a good mission for us. I don't feel uneasy about it. Certainly the time when the crew was in lunar orbit was a tremendously impressive time, and it happened at Christmas. It was just a fabulous thing.

RUSNAK: So was there emotional meaning for you with this mission? Did it have any kind of significance in that aspect?

ALDRICH: Beyond what I've already said? [Laughter]

RUSNAK: Yes.

ALDRICH: No, I don't think so.

RUSNAK: Then you have Apollo 9 coming in where it's the first flight of the lunar module, and Apollo 10 where you're taking both spacecraft to the Moon but not quite landing, and then 11 you land. I was wondering what your thoughts on any of those missions were.

ALDRICH: I didn't pay much attention to Apollo 9, because it was a lunar module mission. I was surprised following it, but more than that afterwards about the extent of testing that was required and how difficult it was to test the LM in all those modes. I didn't know about that leading up to it because I hadn't worked on it, but it was quite a fine mission, well executed and extensively complex.

The same thing's true about 10, although 10 was pretty close to the normal lunar landing time line. It didn't concoct a lot of unusual things to do it. You pretty much just tried to do everything except land. That was a good mission. So many things to get to work, and they all worked. It was good.

RUSNAK: Think they could have put 10 on the Moon?

ALDRICH: I don't have any reason to think they couldn't. But who knows what they were prepared to do. If they hadn't trained for it, may be it would have been more difficult. It they'd trained for it, I'm certain they could have put it on the Moon.

RUSNAK: Obviously the next mission, Apollo 11—

ALDRICH: Apollo 11 was a wonderful mission.

RUSNAK: Were you on console?

ALDRICH: I was in the SPAN room during Apollo 11, during the landing.

RUSNAK: So were you also there during the first EVA?

ALDRICH: I can't remember. We had so much time on the Moon, so many EVAs. I can't remember where I was. But I was on every Apollo mission up until 15 and at least one shift in the SPAN room.

RUSNAK: The next mission, 12, had a little bit of excitement early on when it was hit by lightning.

ALDRICH: Yes, and that's another wonderful example of the training and simulation and self-training and team-training that we'd been through. I was on console. Seems like I was on console at the GNC, but I'm sure I wasn't. I might have come in and been plugged in at the GNC console, because I wasn't on shift in the SPAN at that time. Anyway, I was there, either in the SPAN room or the front room. John's [Aaron] ability to deal with that was just fantastic. I mean, it showed what simulation and training could do and what knowing your systems really well can do. That's what we would have hoped to have been able to do in every situation, and he got a chance there to show he was able to do it.

RUSNAK: What did you think about the ability of the mission to continue and go on to the Moon?

ALDRICH: At the time I thought that was great. It was good that we could do that, and the mission proved out that it was a good decision. Some of the things I've learned and been through since, that would be a hard decision to make, to continue. It'd be a hard decision to make.

RUSNAK: So at the time then you didn't have any particular reservations about there being any system damage or anything like that as they're going through the Earth orbit?

ALDRICH: I think I was confident we could determine what tests to run and that we could run those tests and get a system evaluation that would give us confidence to proceed, and that's what we did.

RUSNAK: Of course, they went on to have a pinpoint landing and also a very successful mission.

ALDRICH: Yes, very successful. I was very impressed with the ability to land next to the Surveyor. I thought that was a great statement in terms of our ability to first know where the Surveyor is, but then to target and land this thing—you know, target the descent so that it was within the range of the crew to make, but then Pete's [Charles Conrad, Jr.] ability to bring it down. The whole thing was just—that was probably more impressive to me than Apollo 8 was, I would think, that you could decide to go land next to that thing—we'd only been to the Moon to land once—and to land beside it, that's pretty good.

RUSNAK: Yes, it certainly shows the skill of the planning team, the controllers, and the astronauts to actually pull this off and land within a couple of hundred yards or however close they were.

ALDRICH: Yes.

RUSNAK: Then that was followed by Apollo 13, which turned out to be unique, so could you tell us about your experiences with that flight.

ALDRICH: Well, on Apollo 13 we had the problem occurred at about fifty hours. That was in the evening, seven or eight o'clock, I guess, Houston time. I was on SPAN, but I was in sitting next to the EECOM or the GNC. We were just kind of talking. I mean, there wasn't a lot going on. It was getting to be nighttime. We had all the events occur and, frankly, the team I had there on console, in the front room and in the back room… We didn't know what to make of it.

First of all, we thought we'd boil it down to something simple and obvious that we could figure out and get beyond. As it went along, it became clear it was more extensive and more significant than what we knew it was. I had a lot of good people working for me in those days. There wasn't anybody I didn't have confidence in.

But the person I had the most confidence in, in my organization was John Aaron, and he had worked the day shift and was home either in bed or getting ready to go to bed. So after I watched this for an hour or so, of us trying to figure out what these measurements meant and what the crew could tell us and we weren't converging, I called John. I said, "John, you've got to

come down and help us figure out what to do." And he did. I can't remember the time line now of finally figuring it out, but we got it figured out.

The most impressive thing, I think, that happened in the Apollo 13 mission was, other than the fact how well this team worked together, the multiple teams, not just one set of console people on one team, but the whole set of teams worked together, the most impressive thing we did was to be able to put the pieces together and lay out the time lines in a way that—the fact that we knew we had to power the command service module down to a very low point where it essentially was not operational, but the fact that before we did that, we had to transfer the state vector from the command service module to the lunar module was an absolutely critical thing to do. The team collectively figured that out, planned it, and committed to it before anybody went forward on some plan and got us out of sequence so that couldn't be done. If we'd gone and couldn't have done that, we might have found some way to recover. I don't know what the thinking is, but it would have been tough.

The way I like to think about Apollo 13 is that it is the manifestation of this training and simulation we've talked about a number of times today. We never simulated that problem. We didn't ever train to learn about it or think about it. But we dealt with so many other ones with the people that had to deal with this one, that the ability to analyze the data, communicate as a team, lay out the options, and make the decision was ingrained in a way that even in this critical flight environment, the teams and the team leaders, the flight directors went about the process in a business-like way and did it in a way that put the pieces together correctly and were able to execute it.

It's sort of the final exam for this flight control and flight control training and mission support thing that we'd done all these years. I mean, you could have postulated that these prior

successful missions would have worked if they didn't have a mission team there, you know, if you'd given them the right information, the crews would have flown it, and that would have been that. I think that's not the case. We had many important things as a flight operation organization, but we never had anything with that degree of difficulty and challenge and complexity to deal with, and the team was up to it. It was done right.

RUSNAK: And obviously they got the crew back, so the team pulled together, passed their final exam, as you put it, with flying colors. So what was your role specifically with getting Apollo 13 back home?

ALDRICH: Once we had the problem and we restructured the teams, Gene Kranz created a team to work on the solution to the problem, essentially offline, to analyze what would go forward and what was going to happen and to feed the results of our analysis, tests, work into the teams that were on console to fly it. Gene had me on that team, and my job was to figure out what to do with this command service module that we were going to power down completely. We actually powered it down to four amps of power, and the normal command service module took something like thirty-six amps of power continuous. We had to power it down where it would run with no fuel cells and run just off the batteries we had on board.

But then at a point we had to power it all back up, it all had to work, and it had to fly the entry and the landing, or the splashdown. So my job was to line out that sequence, the specific sequence of crew procedures and switches and checklist to do that. I worked during that period with the other team members that were doing other parts of the mission and with the crewmen

that were in the simulator simulating parts of the mission to see what the command service module sequence would be. We put that together.

There was some concern from my engineering team over in the mission support room that we talked about. They were concerned about powering down that low and about things getting too cold and freezing, so even though when you powered up to use the power remaining, things would be frozen or have an off-nominal temperature and they wouldn't work. We had to cut the line between how much power there was in these batteries total that you could use either now or later, but you wanted to have enough to get all the way to the end versus the things that people felt we had to keep operating, we couldn't take offline.

We struck a pretty sparse balance for the bulk of the mission. It was only in the last couple of hours, hour, two hours, that we brought all the power back on. Up until then, we ran at this very low level. But we made those choices. We lined out the time line for the command service module, and we built the checklist for the crew to bring it all back up and then to fly the entry. That was the job I did. That was a hand-written checklist. I still have it.

RUSNAK: Really? That's quite a memento to end up with. Do you think the flight control team or the engineering team, really everyone that worked on that, did you learn anything in particular from this instance that was perhaps applied to preventing such things or to revamping training? Anything like that made have had an effect on the preparation for future missions?

ALDRICH: Everybody learns from an experience like that. It brings out the best in the people that are involved, and they learn how well they know what they think they know, and they see things that would be good to be more accomplished in. So I think there was probably a lot of

organizational training, not just the mission operations team, but the engineers and the engineering organizations that supported it, and the people that analyzed it afterwards.

But I have more the feeling this demonstrated what we already had in our repertoire in our ability to work as a large combined group of teams than something that gave us lessons learned that made changes in directions. I think it was good that we were that well prepared. These missions we've talked about today leading up to that are what caused that preparation, but also the wisdom of the people that structured how we'd do those things, how much simulation we'd have, how much training, how much realism, solving problems that were real problems. So I would say mostly it was a demonstration of what we already knew we wanted to be able to do.

RUSNAK: It was really the ultimate test at this point of the flight control team and the demonstration of their abilities and the ability to work together with the engineers to pull off something that you really hadn't planned for specifically, but was sort of a culmination of these skills developed.

ALDRICH: Yes. See, we hadn't planned for it specifically, but we had. We dealt, to deal with unknown problems that would occur and surprise us, so we'd done that. But this particular one had never been sprung on us to surprise us, so it was a completely fresh problem. But we'd had lots of fresh problems in simulation. Some of them probably didn't hang together as well as this one did. They might have been a little bit unusual problems, but we would always deal with them in training, just like we would deal with them in a real flight.

RUSNAK: During these types of simulations for Apollo, would you be going in the SPAN room as well and running evaluations on the kinds of problems the sim guys would be throwing the control team?

ALDRICH: Yes. We didn't have the Mission Evaluation Room up and the people in Bethpage and Downey up as extensively in simulations, but we did it enough so they would know the kinds of questions and work out the details of the interactions and communications well.

RUSNAK: For the final two Apollo missions that you said you were involved with, 14 and 15, do you have anything in particular you wanted to say about either of those flights?

ALDRICH: No, they were good flights and I liked them. I think for 15, I can't remember how involved I was. I remember I was also at a set of activities down in Florida during that time frame. I was transitioning to my next job. I think 15 was the last one in the control center, and then 16 is when I wasn't doing it anymore.

That doesn't mean I was done with the control center, because my next job was deputy manager of the Skylab Program at Johnson. Within a very short period of time, Skylab started to fly and we had problems. As the deputy program manager with all this operations background, I was right back in the Mission Evaluation Room and back in the mission control area working on those problems.

RUSNAK: Do you want to go ahead and go into the Skylab Program today?

ALDRICH: Yes, I think we could do that.

RUSNAK: How did the opportunity come up for you to move into the deputy manager position?

ALDRICH: That was a little interesting thing to me. I was eager to kind of expand my abilities, my job. Sometime right prior to this happening or six months prior, Gene was about to name a new group of flight directors. They were adding to the number of flight directors because some were not flight directors anymore and the jobs were getting bigger. So I applied for it. I felt like I probably deserved to be selected, with my background and all the things I'd done, so I thought it was a fairly honest thing to do. After some deliberations, Gene came back and said, no, can't be a flight director. I was a little surprised at that.

It was not very much longer after that, then one day Chris Kraft called me over and said, "I want you to go be the deputy program manager in Skylab." Now, I think the two things were connected. I think probably if I had stayed in FOD [Flight Operations Directorate], I like to think I would have been a flight director. That was sort of the next step. But moving into program management was a whole new direction for my career, and it set the stage for some fabulous things that have happened since that time. So probably Gene and Chris had some good ideas what ought to happen. Anyway, that's what did happen.

RUSNAK: What was the stage Skylab was in when you moved over to the program?

ALDRICH: Well, it was pretty far advanced. There were two program offices. There was one at Johnson and one at Marshall. In the early days, not long after Gemini, the Johnson engineering

organization had started to build this thing called the Airlock Module in St. Louis, which, I guess, probably came out of this Apollo Applications Program I talked about. It was going to be an airlock that would be part of an orbiting station that would have systems for crew support, but it would also have a hatch for EVA. It would be kind of a central command control point for an orbiting station. I'm sure it was part of Apollo Applications initially. So it was under development.

But as Apollo Applications evolved into the Skylab Program with the orbital workshop, the responsibility shifted and the responsibility for this airlock module shifted to Marshall. They were also building the part of the Skylab that were called the Apollo Telescope Mount [ATM], which was a series of solar experiments, very extensive solar investigations from orbit, and the Orbital Workshop, which was a Saturn [IV] upper-stage outfitted as a lab instead of as a propulsion stage. So Marshall was doing the bulk of what was the hardware for this Skylab Program as it matured.

The program office at Johnson, under Kenny [Kenneth S.] Kleinknecht, had evolved where Johnson was responsible for flight operations and for crews and for flying the Skylab. They were also responsible for a whole series of medical experiments and medical equipment and crew support equipment that would be in the Orbital Workshop. They were responsible for a series of Earth resources experiments and a new module to house them called the Multiple Docking Adapter.

So when I got over there, all of these pieces of hardware were well along in development and the bigger parts of the workshop itself were being done out of Marshall. We were doing a series of very important things in equipment support, the crew, and some of the other experiment areas, and we were also planning the execution of the flight program for Skylab, not the on-

console stuff and not the shifts and the control center—Gene Kranz had a team to do that—but the bigger picture of crews and the flight of Skylab and what it would be.

So I moved in under Kenny. I was his deputy and worked on all of those things for him and ran meetings for him and ran change boards in conjunction with him or as an alternate to him, and that was my job in Skylab, and that's where the program was.

We could backtrack on the timing of that. I don't remember the timing of Apollo 15 or 16, which was when I started that, but it looks like this was a 1971 time frame when I went over to do that, and we flew in 1973. So that's how close together my moving into Skylab and how ready all of this was to go forward. It was a new experience. It was a good experience. I was working with a lot of people I already knew on things that I had a lot of familiarity with in terms of this program being so close to its operations phase. It seemed like what I'd been doing getting ready for some of these other missions when I was in missions operations organization.

RUSNAK: As you mentioned, Marshall had more responsibility for essentially the spacecraft here than in Apollo, for instance, or earlier ones, since they were doing the whole orbital workshop and everything. How did this play out into relationships between JSC, or Manned Spacecraft Center, and Marshall?

ALDRICH: Well, there have been a variety of periods the whole space program, where Marshall and JSC have been done both complementary things and they had been somewhat in competition for various things. Marshall was very well equipped to do this Skylab workshop, and I think it was a good assignment to their center to do them. There was a good relation between Kenny Kleinknecht and Lee [Leland F.] Belew, who was the program manager at Marshall. There were

probably some bumps along the road in terms of how this program would be put together and which pieces Johnson would have, but by the time I got there, that was all played out and it was just going together.

The first time I ran into some competition between Johnson and Marshall was right after we launched the Orbital Workshop. The Skylab 1 first flight had the micrometeoroid protection on the outside of the workshop come off during launch, and it took one solar array with it and pinned down the second one, so that the spacecraft got into orbit without thermal protection and with somewhat limited power. So we had a big scramble to decide what to do with that. We were planning to launch the first crew within a week or about that many days, and we had to decide what to do with this workshop. We had to analyze it first to find out what the situation was and how bad it was, and then decide what to do.

The biggest problem was the thermal problem. It immediately got to be too warm inside the workshop for the crew to work effectively in it. I'm sure it had thermal implications for the performance of a lot of the systems. So this temperature was a big concern. Both Marshall and Johnson immediately moved out to figure out how we could quickly ameliorate the overheating in the workshop.

Marshall worked on sort of an awning that you could deploy from the command service module and hook over the orbital workshop so it would be under a solar shield. At Johnson, we were talking about it, and it seemed like that would be a complex operation to accomplish, to figure out exactly how you're going to hook this thing and get it deployed and do it from the command service module flying around. We came up with the idea that a better plan might be to use this airlock that we had in the side of the workshop that was meant for putting experiments outside. If we could just put an umbrella up that would provide the solar protection over the

workshop, you could solve the problem quickly from the inside, and you wouldn't have to have these two vehicles trying to fly together and crews EVA trying to hook something that had never been hooked before.

Don Arabian was part of this group that discussed how we could recover from this. He proposed and then led the development of the parasol, which was, in fact, built here at Johnson and was a system that could be deployed by the crew from inside the orbital workshop and provide the coverage over the Skylab that you would need to change the temperatures. So after a few days of these deliberations, both centers, we had a meeting at Marshall, where we went down, and they presented how you could do the system that they'd come up with, and we presented from Johnson this parasol system.

The senior leadership, which I'm sure included George Low, but I'm not sure who all, heads of the centers, and leadership from Washington, I can't remember who all the decision makers were, other than Chris Kraft, but in the end, the decision in that meeting, after a long day, was to go test the parasol, build it and test it, and if we thought it would work, that's what we'd go with. It was already being built.

I think we flew back from that meeting and Don had a demonstration model of the parasol already built and over in one of the high-bay buildings at the center. I think that was the night I stayed all night while we tested deploying it in a 1-gravity situation, which wasn't a totally adequate test, but it was a pretty significant test of how this thing would work.

So in the end, the Johnson solution was the one that the NASA agency chose to go forward with. That was a Johnson-Marshall competition a little bit, but there was a lot of things over the years between Johnson and Marshall. We are the two strong manned spaceflight

engineering organizations and both very capable and both wanting to do these things. I've seen that competition in a number of ways and mostly very positive.

We flew the parasol, found a way to package it at the feet of the crew in the command service module and fly it up, unstow it and get it out and deploy it, and it worked. It didn't work too well. The material on the parasol did not have a particularly long lifetime in ultraviolet. It was known, I think, even as we flew it and more determined early on that it wouldn't last for the whole Skylab Program. So we then proceeded to further develop the details of the mission using the Marshall awning that would go over the lab and how we'd install it and deploy it. Downstream we changed it out and replaced the parasol with the awning. So both solutions were used, but we used the parasol on the quick recovery.

I think after the crew on Skylab 2 was up and did that and inspected what had happened with the solar arrays, we then realized you had a chance of deploying the second solar array. The tools were built to be carried up to release that solar array and put now 50 percent of the power back in place that the workshop was supposed to have, and really from then on let the Skylab proceed in a fairly normal series of mission activities.

RUSNAK: The first crew did quite a successful job at deploying the solar shade and a few weeks later getting and fixing the solar array, too. Did you pay a lot of attention to the operation side of the first couple of Skylab missions?

ALDRICH: Well, I had a double change of jobs. I was the deputy Skylab manager during the Skylab workshop. Not long after that, Glynn Lunney asked me to come be the deputy program manager in the Apollo Spacecraft Program Office. By that time Apollo was over, and the Apollo

spacecraft we're talking about were the Command Service Modules for Skylab and the one for Apollo-Soyuz. So just before the second Skylab flight, I moved to work for Glynn and be responsible for the Command Service Modules.

On the second flight, the second manned flight of Skylab, we had two failures, two unrelated failures in the propulsion system of the command service module almost immediately after launch that were very difficult to analyze and, depending on the nature of what it meant, a very difficult decision as to whether we could leave the command service module up.

The command service module for its orbital maneuvering has four separate reaction control systems. They're at 90 degrees apart around the service module part of the Command Service Module. After launch and within a couple of days docked to the workshop, we had two of those four start to show leaks. One leaked completely out, and I think the other one started to and we shut off isolation valves, so that it was disabled, but it held its propellants.

It was then a problem to figure out what that meant and whether we could trust—you couldn't rely on the command service module performing its mission and bringing the crew back if the other two failed or maybe even one of the other two, probably even one of the other two. You could do pretty well with two of them, but one wasn't enough, and none wasn't acceptable. So we had a lot of analysis.

This was another analysis that Don Arabian was heavily involved with, and particularly the one that leaked completely out. So I worked with Don in the MER and worked with the analysis that was going on at North American to find out what happened. It was eventually concluded that the plumbing candelabra that connected the propulsion lines in that module to the thrusters, there was data in the engineering records that showed the nuts hadn't been properly torqued. There was a wrench interference problem that you could get into that would cause the

nuts not to be properly torqued, and then that could cause propellants to leak through the nuts. So it wasn't that we could fix that one, but we could analyze that one and find out what happened and then look at the records on the two good ones remaining, and even the third one that was shut off, and isolate that problem to only one thruster.

The other reaction control system that had been turned off, after monitoring that and seeing that leakage was stopped and the leakage rate when it was not isolated, it was pretty easily we could tell, we could leave that off for the fifty-six days and bring it on and it would have a slight leakage, but it would be acceptable for use during the entry.

So, a very elaborate and complicated set of analysis, without being able to touch the equipment, that was going on in the MER and at North American. That kind of fell under me as I transitioned from Skylab in a more direct responsibility just for the Command Service Modules that were the North American contract that supported Skylab.

I don't remember what you asked anymore. That's the sequence of how I moved from one aspect of that to another.

RUSNAK: That does answer my question, because I was asking about the operations of Skylab, and clearly the problems with the CSM involved that. Since we have made the transition to you being the deputy manager of ASPO, why did Glynn Lunney choose to bring you over there? Or was that something you were looking for?

ALDRICH: It was a surprise to me. Glynn and I had worked on a lot of things together and had been good friends for these prior years, so we knew each other really well. I think when Jim [James A.] McDivitt left and Glynn became the Apollo Program Office manager, he needed to

find a deputy, and I don't know what thought process he went to pick me, but I do know that he was aware of my knowledge of these spacecraft systems and my familiarity with the North American organization, having worked some of these other things we talked about on the redesign on CSM and that sort of thing.

RUSNAK: So then were these two activities going simultaneously, did you leave Skylab and go directly over?

ALDRICH: I left Skylab and went directly over. I believe Kenny Kleinknecht continued on until the Skylab flight program was over, but then he left, and I guess, he became head of flight operations. He moved on. So for the period after Skylab had flown, we still had a lot of follow-on, closeout stuff to do. So from some period after that, I was still the Skylab program manager, but it did not involve a high level of activity and certainly no flight-critical or engineering analysis activity. It was more you had to have a manager in terms of tying the program off.

RUSNAK: When did your involvement with the Apollo-Soyuz Test Project begin?

ALDRICH: It sort of happened immediately when I went to work with Glynn on—you called it ASPO. Apollo Spacecraft Program Office. When I went to be the deputy of the Apollo Spacecraft Program Office, I immediately also inherited the Command Service Module we were going to use to fly the ASTP. In fact, two of them. We had a backup and we were also, for ASTP we were building a docking module, which was the module required to interface the Soyuz with the Command Service Module. They were not atmospherically compatible, and so

you couldn't dock the two together. You had to have some way to balance the atmospheres. You had to convert from a pure oxygen in the Apollo to essentially an 80-20 nitrogen-oxygen, like they had in the Apollo-Soyuz. The docking module was structured to do that, and North American was building that module also. So that was what I inherited at that time.

Also, the docking system between the Apollo and the Soyuz was a new system, and it was based more on the design concept of the Russian system than on the systems we'd used in Apollo. But North American was building the American side, and what we now know as NPO Energia, or RSC, what they call themselves now, was building the Russian side, but to the same design to come together. It was androgynous in that both sides were identical, so when they'd come together, any one would mate with the other… and we were building one in America and one in Russia. We subsequently had to do some testing to make those prove that they worked.

RUSNAK: What did you think of this whole concept of an ASTP mission, about working with the Russians who previously the space program had been competing with?

ALDRICH: Well, I was just thrilled to get an opportunity to work on the program with the Russians and the things you could find out there about what they did and how they did it. I had initially been postulated to be on the early team that went to Russia in 1969 or '70, but the way responsibilities played out, I really didn't get a chance to do that at that time. I played through what we'd been talking about up until about 1974, after the Skylab kind of wound down. Glynn asked me to start stepping into some of the Russian interactions that were going on, which I did. So I kind of got caught up on the way the Apollo-Soyuz Program was organized and who the players were and what they were doing, and got a direct role as Glynn's deputy in executing that.

RUSNAK: What were some of the biggest, I guess, cultural and technical issues you came up with? On the technical side, you mentioned the atmospheric differences in the pressure, but I'm wondering what some of these other things are.

ALDRICH: Well, of course, the atmospheric differences, that wasn't something we discovered. That's something that was identified right at the beginning. We knew we had to have a docking module to interface the two so we could change the environment in the docking module to match either the atmosphere in the command module or the one in the Soyuz, depending on which one you're going to open up into.

Culturally, the difference that is most noteworthy and most apparent is the language difference. It's a big difficulty. It's a big difference. It was then. It is now. But the remarkable thing is that, other than that, what I found was how well we worked together with the Russian engineers and how much like us they were. We found the Russian engineers were more like American engineers than any other nation that we had worked with. They think the same. They deal with problems the same. It might have to do with the fact that they'd had a very successful operation program in space that no other nation had. But whatever reason, there was a great ability to come together and work together and think and do things together.

During the five years of ASTP, starting before I really got directly involved, but then into it, there were great friendships established, not between just American and Russian engineers, but also among families. It got to be a very good group of strong, warm feelings between the teams that were working on these programs. I didn't sense anything but the same kind of desire

to work this out and make it happen and get on with it and do it on their side, the people who we were working with, and ours.

There's a very interesting follow-on to that. We had these relationships and this good feeling about working together, but then making it happen, flying Apollo-Soyuz, and having it be successful. For whatever the political reasons, going from [President Richard M.] Nixon to [Gerald R.] Ford to [James E.] Carter, after Apollo-Soyuz's single flight, we stopped. Those of us working here at Johnson had expected and had hoped that we would continue to fly and expand into some other missions, but the international politics took a different direction.

So for the next twenty years, we really didn't do anything in particular with the Soviets, then Russians, except for the aeromedical people. The medical people here in the United States here at Johnson and at other places and the Soviet medical teams continued to work together and have exchanges of what they found in space and scientific assessments of their findings. But other than that, there wasn't a continued program. It stopped in 1975. There were discussions of doing something with Shuttle and Salyut or some other combination, but they never panned out. So we didn't do it anymore.

In 1992, really in late 1991, we were asked in the Space Station Program by Congress, why it is that we weren't considering the Soyuz as a rescue vehicle for the Space Station Freedom. [Senator] Barbara Mikulski held a hearing, and key witnesses were Dick [Richard H.] Truly—I can't remember whether he was already NASA administrator or he was associate administrator. He might have been the administrator. I think he was the administrator of NASA. He was a witness, and Yuri Semenov, who was the chief designer and the head of then NPO Energia, and now I can't think of their new name, but it's Energia in Kaliningrad, and a key

official from the State Department. She had them come testify in the fall of [1991] about why, with *Freedom* wanting a rescue vehicle, why we weren't considering the Soyuz.

So we put together a team and we went to Russia in 1992 to talk to Energia about using the Soyuz. We got over there, and guess what happened? It's the same people. It's not just the same organization, it's not the same programs; it's the same individuals that we had these warm friendships with twenty years before. Here they are, still there. During ASTP we never knew what organization they were from. They said they were from the Soviet Academy of Sciences. We met in downtown leased facilities. That's all we knew. We even did a test program, a docking test program with our docking hardware and theirs in Moscow, and we did that in a leased facility in Moscow. So we never connected with exactly who they were or what they were doing.

Showed up in 1992, drove out to Kaliningrad through the gates, we're in the office that [Sergei] Korolev had when he did the space program. It's now Yuri Semenov's office and conference room, and it's the same people.

RUSNAK: There probably weren't as many of the same people on the American side, though.

ALDRICH: Well, there weren't as many. There were some, but probably I was kind of the spearhead of the new group. Some of the same people on the American side were still involved around the center, but not on that team that went over to figure out what to do with the Soyuz.

RUSNAK: So where they happy to see you?

ALDRICH: They were delighted to see us. Same old friendships. Viktor Legostayev is one of the guys that was a working group head on ASTP, and he was sort of Semenov's deputy in 1992. We just struck right up again and talked about the old times and the new times. It was a good reengagement.

RUSNAK: Was NASA able to take in the experience from Apollo-Soyuz and apply it to the more recent dealings with the Russians?

ALDRICH: Well, in Apollo-Soyuz we had a goal. We had a goal of flying together and coming together in space. We talked a lot internationally about demonstrating space rescue, but we also built some very unique hardware and mission sequences to pull it off. We weren't demonstrating a generic capability; we were demonstrating specifically finding a way to do it. I think both sides were very pleased to be engaged to do it. We were successful, and we understood the way we did things. One of the working group teams was an operations team. We considered operations from their perspective and ours and worked out how we would do ASTP. So it was good.

I think when we came together in 1992, we weren't doing ASTP again, but we were meeting accomplished teams who knew about human space flight and had been successful in a variety of programs, and we were coming together now to talk about how we'd maybe do something together in the future. Our first meeting over there where we took a team from Johnson and analyzed the Soyuz system and what Freedom would have for requirements and how it would work and where there would be difficulties and what changes we'd have to make, and we went forward from there.

Another aspect of ASTP in terms of problems, I was talking about this docking system which was really based on the Soviet androgynous design with petals that would come together instead of a probe and drogue like we'd used. We designed a system together, and then we built the United States' half on the United States side, and the Soviet half on their side. We wanted to test them, so we tested them both here in Building 16. We ran a test of that system, and then we ran a test of the flight hardware in Moscow and a docking simulation before shipping our half to Florida and their half to Baikonur [Cosmodrome, Khazakstan, USSR] to fly.

During that time frame, it turns out these two similar systems had not only the petals where they come together, but they had alignment pins. Each system had one male pin and one female socket 180 degrees apart. So when you came together, the alignment pins would center and would help make a very precise alignment. There got to be some concern expressed on the Soviet side that the shape of the male pin and the female socket was such that under a very specific flight condition, they might bind. These pins that are supposed to give you precise alignment could in fact cause you to bottom out and not contact. They got more concerned about it than we did. We thought it was an extremely low-probability case that could happen and that also physical forces probably would be such that a condition wouldn't and it would be all right.

After deliberating it, we set up the process of having not only a meeting every six months, one six-month period in Moscow and one in the United States, but also having weekly telecons [telephone conferences] about progress as we approached this flight the last year to two years of flight. On these telecons we were talking about this and what we'd do. We decided that there was enough credibility in the Soviet concern that we would change slightly the design of the alignment pin, and so we did. We just changed and rounded off the corner, made it a little more forgiving on entrance. These systems were already in Moscow being tested. So we

changed the alignment pin in Downey and flew it across. I went across with the North American program manager at that time, and we made the change there in Moscow in this test facility where we were doing this testing. We never got it to jam during test with the old system, but we changed to the new and proceeded on from there to deliver and fly.

So that was an instance where the Soviet concern was greater than our concern, but as a collective body of two organizations—Glynn Lunney was the technical director for the United States and Dr. [Konstantin Davydovich] Bushuyev was the program manager or technical manager on the Soviet side, and they collectively decided to do this, and we did. That was one of the things that we went through.

Another experience I would relate about Apollo-Soyuz and how this played out. We had a good engagement, a good technical coming together of these organizations. But the Soviet program had been flown in secrecy over the years up till then, and we knew they'd had some failures, and some failures were known about and maybe some weren't. One of the things that Glynn Lunney insisted upon was full disclosure of the failures and then the fixes that they'd implemented in the Soyuz. That was going on about the time that I came on board. On my first trip to Moscow, that was a key debate.

On their side, it was very difficult for them to describe in open detail their failures and particularly describe the changes that had been made to the Soyuz to account for the mission where it had decompressed on reentry and killed the three crewmen. But over time and over some amount of prodding, Glynn achieved full disclosure. They reported all of that. I think by the time we flew, in fact before we flew, we'd had such a coming together of these teams and their ability to work together, that even that most difficult thing on the Soviet side played out in a way that was very positive.

RUSNAK: What do you think the U.S. gained from their interaction with the Russians on this? Were there any technical or operational, or otherwise, items that were ways of doing that you had picked up from the Soviets?

ALDRICH: I think what the United States gained more than anything else was a knowledge and familiarity of their programs and their hardware and their organizations and people. I don't think we learned how to do anything we didn't already know how to do, and we didn't have to go forward and strive to achieve some new capability that we didn't already have. But I think from the United States side, we didn't know where this would lead, and we thought it was probably a positive direction. It would lead to future activities, which it has, even with the twenty-year gap. It led in a direction where there would be other things and broader things.

From the Russian side, I have to say at that time the Soviet side, what it did for them was imply parity of their program and their hardware with those equipments on the United States side that we taken into the Moon and having successful manned landing on the Moon repetitively. They had not achieved that. Although they had extensive capability in Earth orbit, to take people up and down, and to stay in Earth orbit for periods of time, they did not have systems like the ones that we took to the Moon. But when we did this thing together, it looked we shared and matched. It gave implication that our programs were equal. They, I don't believe, in fact at that point time, were.

In fact, there's been an awful lot said about the Shuttle-Mir Program and how much we've learned from that, we Americans learned from the Mir. I think we've lost sight of how

much we learned on Skylab and how much we already knew and the things we did in Skylab, and I think we were ahead of the Russians then in long-term orbital duration.

I remember the period when we were making the in-flight repairs on the Skylab EVA that we talked about. At that time we had Russians visiting as part of the ASTP here at Johnson, and I remember them. I remember meeting in Chris Kraft's office where these senior representatives of the Soviets were at Johnson, and we described for them what we were doing on Skylab to recover it and EVA. They were speechless and wide-eyed at the idea of EVA repair on the Skylab. It's not something they'd conceived of. They couldn't imagine it at that time.

It was a funny meeting. They were here to work on ASTP. We were doing that on Skylab, and they were amazed at our operational flexibility and capabilities, and yet one of the other things that we showed them was a heat protection tile for the Space Shuttle Orbiter that we were starting to create, that was going to be on our new spaceship, all at the same time.

RUSNAK: I don't know if that went a long way to demonstrate parity of programs or not. How do you think really the technology on each side lined up? Well, obviously functionally it compared, but I mean how did they stack up in reality?

ALDRICH: Well, the Soviet, now Russian, equipment has some really unique capabilities that are consistent. They tend to make systems and equipment that is rugged, that'll work in any environment, that is very capable mechanically, and strong and durable. Their equipment from the beginning, when their payloads were so much heavier and larger than ours, they could launch things that large and heavy, but they had to, because that's the way their equipment was. I think even today their equipment is based on that rugged, durable kind of capability.

The company I work for now participates with the Russians in flying the Proton, and the Proton is that kind of a vehicle. You roll it out to the pad, you pop it up, and you light it off, and it goes. The equipment that the United States has built over the years has tended to be designed to eke every bit of performance out of it. It's more like a fine watch. It's highly refined, it's very elaborate, but it may also be a little bit more—have the potential for difficulties. It's a much more refined kind of equipment.

At that time when we came together, the Soyuz spacecraft was a very capable system. They'd flown it a lot. It did its job. We had this equipment we'd done the lunar mission with. It was also very capable. But over all the years, and even to today, our use of computing equipment and electronics and miniaturization has been far beyond what they felt necessary to move into. Whether they had the abilities or whether they didn't, they tended to build things that were more like I previously described, and we tend to build these complex, elaborate systems.

RUSNAK: I wanted to now give you a chance to make any final remarks on ASTP or the Apollo Program in general, because that was all the questions I had had up to this point.

ALDRICH: Well, I'm not sure I have more to say about Apollo. It was marvelous, and it was a program that would be very hard to do in any environment. The way the nation came together and did that was remarkable.

Apollo-Soyuz, I spent a lot of time working with the Russians in the seventies and in the nineties. It's a good coming together. I have enjoyed working with the Russians. They've accomplished some very extensive things, and we have. We're clearly both going together as nations, but also as partners in the future.

RUSNAK: Now with the International Space Station, everything going well, you're obviously having a much greater opportunity to work with the Russians on a regular basis, but I think that'll be the subject of a future interview. I did want to give Rebecca a chance to ask any questions.

WRIGHT: I have one quick one. I think you alluded to the answer already, but as here from the beginning of the program, the space program, and you watched the workforce grow and you watched more people being hired in, was there some certain characteristics that you were all looking for as you were hiring these new people in to join the program and to make these goals come true?

ALDRICH: I couldn't put my finger on a consistent method for doing that. It had to do with multiple personal interactions and who the people were that were part of our team that were looking to do that and how they chose to bring people in. The answer's probably no. It was part of the time and part of the people that were doing it that made it work out the way it did.

RUSNAK: Unless you have any other remarks, I guess we can wrap it up for today.

ALDRICH: Good. Okay.

RUSNAK: I'd like to thank you for joining us.

[End of interview]